



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Autonomy Syllabus Scheme - II (2022-23)

for

Bachelor of Technology (B.Tech.)

in

Information Technology

(Second Year, Third Year, and Last Year)

including

Honours Degree Program

and

Internship Policy Manual

(With effect from A.Y. 2022-23)

From the Principal's Desk:

The challenges and demands of the dynamic industry increasingly require technocrats to be skilled, adaptive, and innovative. The National Educational Policy 2020 (NEP 2020) framed by the Government of India intends to induce a paradigm shift by re-conceptualising the higher education. Recent academic reforms recommended by the AICTE and UGC have also effectually upscaled the higher education system in India. It is further the role of HEIs to offer high-quality educational opportunities and enable the next generation to succeed globally. Hence, to adhere to the status quo, and enhance the academic standards and quality of engineering education further, it is essential to assimilate innovation and recurrent revision in curriculum, teaching-learning methodology, examination, and assessment system.

In congruence with it, the University of Mumbai has adapted Outcome-Based Education (OBE) system and has revised the engineering curriculum thrice in the last decade — as Rev 2012, Rev 2016, and the recent Rev 2019, 'C' scheme focusing on cutting-edge technology courses.

K. J. Somaiya Institute of Engineering and Information Technology (KJSIEIT), being an autonomous institute possesses more flexibility in adapting newer approaches to reach higher levels of excellence in engineering education. The Syllabus Scheme – I implemented under the academic autonomy conferred to KJSIEIT w.e.f. A.Y. 2021-22 already comprises of state-of-the-art courses and laboratory sessions on emerging areas of technology. With an ideology that the root of innovation is 'interest', the curriculum offers a wide range of elective courses — grouped into core and inter-disciplinary domains. At par with international engineering education, it follows a learner-centric approach, where the students could choose to study courses concerning areas of their interests.

This curriculum introduces Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses — that assure X factor in all the students of the institute. The SAT courses were practiced across the first three years of engineering, focusing on graduate attributes like work responsibilities towards society, problem-solving ability, communication skills, motivation for life-long learning, leadership and teamwork, etc. that could not be copiously imbibed through regular engineering courses. The inclusion of induction program for the First Year students is deliberated as per the guidelines of AICTE and helps students belonging to diverse backgrounds to adjust in the new academic environment.

However, sustained initiatives are required to assure efficiency, academic excellence, and growth. Hence, KJSIEIT Syllabus Scheme – II introduces 03 newer dimensions to Scheme – I: Internship, SBL of Foreign and Indian Languages, and Honours Degree — that shall be implemented w.e.f. from A.Y. 2022-23 across all the branches and all 04 years of engineering.

1. **Internship:** Firstly, the redesigned Scheme – II incorporates 14 Credits for Internship (cumulative 600-700 Hours), which shall be mandatory for all the students and is to be pursued during all 04 years of graduation. Based on the AICTE Internship Policy, this initiative shall enable graduates to respond to the current needs of the industry and equip them with skills required at national and global level. The students shall gain practical understanding and training on cutting-edge technologies and industry practices in a suitable industry or organization. While innovation and entrepreneurship are emerging as fulcrums of higher education, the internship will also provide an exposure to innovation, entrepreneurial, and incubation opportunities through various related activities, and instill a start-up spirit in the students.

Further, the students of KJSIEIT already have an exposure to the work culture and trends in industries through live / collaborative projects / product developments, etc. and they often contribute significantly to the society through various projects. Under autonomy too, through the component of Project-Based Learning included in the syllabus, the students develop Mini, Minor, and Major projects in Second, Third, and Last Year respectively concerning healthcare, agriculture, societal / industrial need-based problems, etc. Through duality of Major Project development and newly introduced activities / components as a part

of Internship, the students shall learn about research methodology, IP and IPR — resulting into generation of quality research articles, copyrights, and patents.

2. **Honours Program:** Another major initiative through the Scheme – II is the introduction of B.Tech. with Honours program for students who are desirous of pursuing focused interest in 06 emerging areas of technology recognized by AICTE: Internet of Things, Artificial Intelligence & Machine Learning, Cyber Security, Virtual and Augmented Reality, Data Science, and Blockchain. This Honours program is of high-end industry standards and shall offer multi-fold opportunities for the learners such as additional credits, specialization in the chosen domain, job-ready skills, multidisciplinary knowledge, etc.
3. **Foreign and Indian Languages:** As another initiative, the Skill-Based Learning (SBL) in Scheme – II shall also comprise of developing verbal and written communication skills in Foreign and Indian Languages, which is a blooming trend and future necessity for various career prospects. The students shall acquire these skills through MOOC courses, giving them opportunities to learn the target language from beginners to advanced level. These SBL and the TBL courses shall acquaint students with skills of digital age learning from online platforms, along with time management ability, ethics, and professionalism.

Through joint efforts of all stakeholders, newer initiatives, strategic planning, and efficient execution of neoteric educational practices with hi-tech wizardry, KJSIEIT is endeavouring to become a role model for all autonomous institutes across the nation.

Dr. Suresh Ukarande

Principal and Chairman - Academic Council

Preamble by Member Secretary, Academic Council:

K J Somaiya Institute of Engineering and Information Technology (KJSIEIT) has been granted academic autonomy by University Grants Commission (UGC) from Academic Year 2021-22 for 10 years. UGC states the benefits of granting academic autonomy to higher education institutes as ‘the freedom to modernize curricula, making it globally competent, locally relevant and skill oriented to promote employability’.

We, autonomous KJSIEITs Board of Studies in Computer Engineering (CE), , Artificial Intelligence and Data Science (AI-DS), Electronics and Telecommunication (ET) and Information Technology (IT) had prepared Autonomy Scheme-I curricula from Academic Year 2021-22 for 4 years undergraduate (UG) and 2 years of post-graduation (PG) in Engineering and Technology disciplines, exercising academic freedom, meeting the needs of Industry 4.0, addressing the world wide challenges and providing globally required exposure to our UG and PG learners, focusing sound theoretical background supported by practical experiences in the relevant areas of engineering and technology.

Industry 4.0 demands modern and industry-oriented education, up-to-date knowledge of analysis, interpretation, designing, implementation, validation, and documentation of not only computer software and systems but also electronics and communication systems, hardware devices and tools, trained professionals, ability to work in teams on multidisciplinary projects, etc. from engineering graduates. KJSIEITs autonomy Scheme-I syllabus was framed looking at the overall demands of Industry 4.0 and society to successfully acquaint learners with life-long experiential learning, professional ethics with universal human values, needed skill sets, in line with the objectives of higher and technical education, AICTE, UGC and various accreditation and ranking agencies, by keeping an eye on the technological developments and innovations.

It provides unique learning experiences to learners through extracurricular activities, innovations, and research with the introduction of Skill Based, Activity Based, Technology based and Project Based learning, showcasing learners' creativity, interest and talent by developing additional skill sets, social involvement and contributions through activities, case studies, field visits, internships, creative learning, innovative mini, minor and major project developments. This helped in strengthening learners' profile with increased chances of employability and avenues for start-ups. It is also provided with Value addition learning through MOOCs platforms such as IBM-ICE, Coursera, NPTEL, SWAYAM, Spoken Tutorial, Udemy etc.

We are happy to present the additional exposure to our learners under the Autonomy Academic Scheme-II, implemented w.e.f academic year 2022-23 for developing the intellectual climate of our country, bringing academic excellence in higher education system with the introduction of additional credit and audit courses for

1. Internships,
2. Skill Based Learning and
3. Honours Degree Programs in 6 emerging areas of technologies.

These additions are targeted for promoting academic, professional and personal development of learners through hands-on working experience under internships, exposure to foreign and Indian Regional Languages through MOOCs and award of specialisation through Honours Degree Program. Internships will channelize learners' working experience with Industries, Government Sectors, NGO, MSMEs, Long term Rural Developments, and Research, Innovation, IPRs and Entrepreneurial setup. Two innovative courses on skill based implementing NEP 2020 guidelines and Honours Degree Program along with Regular B.Tech degree will boost the knowledge of graduating engineers in emerging areas of technologies contributing largely for industrial and personal automation, cyber, digitization, digital currency, security and artificial intelligence sector.

We are sure that with Scheme-I in academic year 2021-22 and Scheme-II from Academic Year 2022-23, the blend of innovative learning components in the curriculum shall strengthen the research and entrepreneurial culture of the institute benefitting the graduating engineers immensely.

We would like to place on record our gratitude to the faculty, alumni, students, industry experts, academicians and stakeholders, helping continuously strengthen the academics, making KJSIEIT as one of best engineering colleges across nation and top most choice of engineering aspirants.

Dr. Sunita R Patil

Member Secretary, Academic Council and Vice Principal, KJSIEIT, Sion

Preface by Chairperson – Board of Studies (BoS):

Data is the proverbial new oil of the digital economy and Information Technology is the lifeblood for innovation and digital transformation – the contemporary watchwords of almost all the organizations. But innovation and digital transformation not only imply improving older processes and products, but reimagining them to deliver more value to the stakeholders. It also includes how businesses operate, automate, and speed up processes, create new revenue streams, develop cost-effective and feasible alternatives, and more. Information Technology and its corresponding technologies like Artificial Intelligence, Data Science, Internet of Things, Blockchain, Image Processing, etc. play a vital role in solving these challenges.

With immense aspirations to produce Information Technology engineers who can contribute in achieving such development goals for various organizations, businesses, and society at large, we have revised the Scheme – I syllabus and hereby introduce the Scheme - II syllabus of Bachelor of Technology in Information Technology – B.Tech. (Information Technology) programme, which shall be effective from Academic Year 2022-23. The revision reflects reorganization and inclusion of some state-of-the-art courses with an objective to empower students in achieving better employability, start-ups and other avenues for higher education.

The syllabus covers the core as well as cutting-edge technology courses in Information Technology, designed with consideration of current and futuristic trends in the industries. It focuses on outcome-based education, with precise outcomes defined for each course — those that map to the programme outcomes. The curriculum allows students to choose elective courses at the institute-level from multi-disciplinary courses, and prominently choose elective courses at department-level, which are grouped into 04 major domains: a) Artificial Intelligence, b) Network & Security, c) Multimedia, and d) Optimization. This domain-wise grouping of electives provides students with opportunities to have in-depth knowledge in the emerging areas concerning their own choice.

For the holistic development of students and to assure that all the programme outcomes are attained, the curriculum also offers additional SAT courses. It comprises Skill-Based Learning (SBL) for imparting technical skills as well other co-scholastic skills required for graduates, Activity-Based Learning (ABL) that focuses on learning by doing, and Technology-Based Learning (TBL) to engage students in life-long learning.

The curriculum further offers a Project-Based Learning (PBL) component in all the semesters of Second Year, Third Year, and Last Year with different technologies applied at frontend and backend to prepare students for varied needs of projects at the workplace. In congruence to the AICTE Internship Policy, students are also encouraged to take up Internships during their under-graduation, and the guidelines for the same are included in the curriculum. The learning from PBL and Internships shall help students in developing need-based or live projects to address the real-world issues of the society and/or industry — which is majorly emphasized by the Department of Information Technology. The amalgamation of all these learning components in the curriculum will nurture vast potential of the youths and contribute to the national development process in field of Information Technology.

The curriculum is the culmination of the efforts and meticulous work of all the members of the Board of Studies, subject-expert faculty members from other departments of the institute, external experts from academia, experienced professionals from IT companies, as well as the alumni working in IT companies across India and abroad. I appreciate and thank all these members to have contributed in making the contents truly superior through their knowledge and valuable time.

We, the Board of Studies in Information Technology believe that the curriculum will meet the expectations of all the stakeholders and they shall take the advantage of the dynamic features of the curriculum — making the teaching-learning process an exalted experience for all.

Dr. Radhika Kotecha

Head – Department of Information Technology and Chairperson – BoS in Information Technology

SEMESTER III - B.TECH. (INFORMATION TECHNOLOGY)**TEACHING SCHEME**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC301	Applications of Mathematics in Engineering – I	3 – 0 – 1	04	3 – 0 – 1	04	BS
ITC302	Data Structures and Analysis	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC303	Database Management System	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC304	Java Programming	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC305	Foundations of Software Engineering	2 – 0 – 0	02	2 – 0 – 0	02	PC
ITL302	Data Structures Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL303	SQL Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL304	Java Programming Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITPR31	PBL – Mini Project Lab I (Web App Development Mini Project)	0 – 2 – 0	02 ^s	0 – 1 – 0	01	PBL
ITXS33	SAT – III: Skill-Based Learning (Go Programming)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXS34	SAT – IV: Skill-Based Learning (Foreign and/or Indian Regional Languages – I)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		14 – 12 – 1	27	14 – 6 – 1	21	

*SAT can be conducted as TH or P or both as required.

^sLoad of learner, not the faculty.**EXAMINATION SCHEME**

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC301	Applications of Mathematics in Engineering - I	30	30	30	10	60	25	-	-	-	125
ITC302	Data Structures and Analysis	30	30	30	10	60	-	-	-	-	100
ITC303	Database Management System	30	30	30	10	60	-	-	-	-	100
ITC304	Java Programming	30	30	30	10	60	-	-	-	-	100
ITC305	Foundations of Software Engineering	20	20	20	10	45	-	-	-	-	75
ITL302	Data Structures Lab	-	-	-	-	-	25	-	-	25	50
ITL303	SQL Lab	-	-	-	-	-	25	-	-	25	50
ITL304	Java Programming Lab	-	-	-	-	-	25	-	-	-	25
ITPR31	PBL – Mini Project Lab I (Web App Development Mini Project)	-	-	-	-	-	25	-	-	25	50
ITXS33	SAT – III: Skill-Based Learning (Go Programming)	-	-	-	-	-	25	-	-	-	25
ITXS34	SAT – IV: Skill-Based Learning (Foreign and/or Indian Regional Languages – I)	-	-	-	-	-	25	-	-	-	25
Total		140	140	140	50	285	175	-	-	75	725

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, BS – Basic Science Course, PC – Professional Core Course, PBL – Project-Based Learning, SAT – Skill/Activity/Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

SEMESTER IV - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC401	Applications of Mathematics in Engineering – II	3 – 0 – 1	04	3 – 0 – 1	04	BS
ITC402	Computer Network and Network Design	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC403	Operating Systems	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC404	Automata Theory	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC405	Computer Organization and Architecture	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITL402	Network Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL403	Unix Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL405	Microprocessor & Microcontroller Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITPR42	PBL – Mini Project Lab II (Python-based Mini Project)	0 – 2 – 0	02 ^{\$}	0 – 1 – 0	01	PBL
ITXS45	SAT – V: Skill-Based Learning (Python Programming)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXS46	SAT – VI: Skill-Based Learning (Foreign and/or Indian Regional Languages – II)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		15 – 12 – 1	28	15 – 6 – 1	22	

*SAT can be conducted as TH or P or both as required.

^{\$}Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC401	Applications of Mathematics in Engineering – II	30	30	30	10	60	25	-	-	-	125
ITC402	Computer Network and Network Design	30	30	30	10	60	-	-	-	-	100
ITC403	Operating Systems	30	30	30	10	60	-	-	-	-	100
ITC404	Automata Theory	30	30	30	10	60	-	-	-	-	100
ITC405	Computer Organization and Architecture	30	30	30	10	60	-	-	-	-	100
ITL402	Network Lab	-	-	-	-	-	25	-	-	25	50
ITL403	Unix Lab	-	-	-	-	-	25	-	25	-	50
ITL405	Microprocessor & Microcontroller Lab	-	-	-	-	-	25	-	25	-	50
ITPR42	PBL – Mini Project Lab II (Python-based Mini Project)	-	-	-	-	-	25	-	-	25	50
ITXS45	SAT – V: Skill-Based Learning (Python Programming)	-	-	-	-	-	25	-	-	-	25
ITXS46	SAT – VI: Skill-Based Learning (Foreign and/or Indian Regional Languages – II)	-	-	-	-	-	25	-	-	-	25
Total		150	150	150	50	300	175	-	50	50	775

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, BS – Basic Science Course, PC – Professional Core Course, PBL – Project-Based Learning, SAT – Skill/Activity/Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

SEMESTER V - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC501	Internet Programming	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC502	Computer Network Security	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC503	Entrepreneurship and E-Business	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC504	Internet of Things	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC505	Department Level Elective – I	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITL501	Internet Programming Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL502	Security Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL504	IoT Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL505	Department Level Elective – I Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITL506	Business Communication & Ethics	0 – 4** – 0	04	0 – 2 – 0	02	BS
ITPR53	PBL – Minor Project Lab I (IoT with Web Application Development)	0 – 2 – 0	02 ^{\$}	0 – 1 – 0	01	PBL
ITXS57	SAT – VII: Skill-Based Learning (Aptitude / Logic Building & Competitive Programming)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXT58	SAT – VIII: Technology-Based Learning	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		15 – 18 – 0	33	15 – 9 – 0	24	

*SAT can be conducted as TH or P or both as required.

^{\$}Load of learner, not the faculty.

**02 Hours class-wise and 02 Hours batch-wise.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC501	Internet Programming	30	30	30	10	60	-	-	-	-	100
ITC502	Computer Network Security	30	30	30	10	60	-	-	-	-	100
ITC503	Entrepreneurship and E-Business	30	30	30	10	60	-	-	-	-	100
ITC504	Internet of Things	30	30	30	10	60	-	-	-	-	100
ITDLC505	Department Level Elective – I	30	30	30	10	60	-	-	-	-	100
ITL501	Internet Programming Lab	-	-	-	-	-	25	-	25	-	50
ITL502	Security Lab	-	-	-	-	-	25	-	-	-	25
ITL504	IoT Lab	-	-	-	-	-	25	-	-	25	50
ITDLL505	Department Level Elective – I Lab	-	-	-	-	-	25	-	-	-	25
ITL506	Business Communication & Ethics	-	-	-	-	-	25	25	-	-	50
ITPR53	PBL – Minor Project Lab I (IoT with Web Application Development)	-	-	-	-	-	25	-	-	25	50
ITXS57	SAT – VII: Skill-Based Learning (Aptitude / Logic Building & Competitive Programming)	-	-	-	-	-	25	-	-	-	25
ITXT58	SAT – VIII: Technology-Based Learning	-	-	-	-	-	25	-	-	-	25
Total		150	150	150	50	300	200	25	25	50	800

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, BS – Basic Science Course, PBL – Project-Based Learning, SAT – Skill / Activity / Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses and Labs (PE-DLC – I)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Advanced Database Management System and Information Retrieval (ITDLC5051)	Wireless Technology (ITDLC5052)	Computer Graphics (ITDLC5053)	Advanced Data Structures and Algorithmic Performance Analysis (ITDLC5054)
Advanced Databases and Information Retrieval Lab (ITDLL5051)	Sensor Network Lab (ITDLL5052)	Computer Graphics Lab (ITDLL5053)	Algorithmic Analysis Lab (ITDLL5054)

SEMESTER VI - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC601	Data Mining & Business Intelligence	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC602	Web X.0	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC603	Advanced Software Engineering and Project Management	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC604	Artificial Intelligence and Data Science – I	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC605	Department Level Elective – II	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITL601	Data Mining & Business Intelligence Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL602	Web Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL603	DevOps Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL605	Department Level Elective – II Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITPR64	PBL – Minor Project Lab II (AI-based Minor Project)	0 – 2 – 0	02 ^{\$}	0 – 1 – 0	01	PBL
ITXS69	SAT – IX: Skill-Based Learning (Mobile Application Development)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXT610	SAT – X: Technology-Based Learning	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		15 – 14 – 0	29	15 – 7 – 0	22	

*SAT can be conducted as TH or P or both as required.

^{\$}Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC601	Data Mining & Business Intelligence	30	30	30	10	60	-	-	-	-	100
ITC602	Web X.0	30	30	30	10	60	-	-	-	-	100
ITC603	Advanced Software Engineering and Project Management	30	30	30	10	60	-	-	-	-	100
ITC604	Artificial Intelligence and Data Science – I	30	30	30	10	60	-	-	-	-	100
ITDLC605	Department Level Elective – II	30	30	30	10	60	-	-	-	-	100
ITL601	Data Mining & Business Intelligence Lab	-	-	-	-	-	25	-	-	25	50
ITL602	Web Lab	-	-	-	-	-	25	-	25	-	50
ITL603	DevOps Lab	-	-	-	-	-	25	25	-	-	50
ITDLL605	Department Level Elective – II Lab	-	-	-	-	-	25	-	-	-	25
ITPR64	PBL – Minor Project Lab II (AI-based Minor Project)	-	-	-	-	-	25	-	-	25	50
ITXS69	SAT – IX: Skill-Based Learning (Mobile Application Development)	-	-	-	-	-	25	-	-	-	25
ITXT610	SAT – X: Technology-Based Learning	-	-	-	-	-	25	-	-	-	25
Total		150	150	150	50	300	175	25	25	50	775

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, PBL – Project-Based Learning, SAT – Skill/Activity/Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses and Labs (PE-DLC – II)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Big Data Analytics (ITDLC6051)	IoT Data Analytics (ITDLC6052)	Image Processing (ITDLC6053)	Cloud Computing and Services (ITDLC6054)
Big Data Analytics Lab (ITDLL6051)	IoT Data Analytics Lab (ITDLL6052)	Image Processing Lab (ITDLL6053)	Cloud Computing and Virtualization Lab (ITDLL6054)

SEMESTER VII - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC701	Artificial Intelligence and Data Science - II	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC702	Internet of Everything	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC703	Department Level Elective – III	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITDLC704	Department Level Elective – IV	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ILC705	Institute Level Elective – I	3 – 0 – 0	03	3 – 0 – 0	03	OE-ILC
ITL701	Artificial Intelligence and Data Science Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL702	IoE Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL704	Department Level Elective – IV Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITPR75	PBL – Major Project A	0 – 06 – 0	06*	0 – 3 – 0	03	PBL
Total		15 – 12 – 0	27	15 – 6 – 0	21	

*Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC701	Artificial Intelligence and Data Science - II	30	30	30	10	60	-	-	-	-	100
ITC702	Internet of Everything	30	30	30	10	60	-	-	-	-	100
ITDLC703	Department Level Elective – III	30	30	30	10	60	-	-	-	-	100
ITDLC704	Department Level Elective – IV	30	30	30	10	60	-	-	-	-	100
ILC705	Institute Level Elective – I	30	30	30	10	60	-	-	-	-	100
ITL701	Artificial Intelligence and Data Science Lab	-	-	-	-	-	25	-	-	25	50
ITL702	IoE Lab	-	-	-	-	-	25	-	-	25	50
ITDLL704	Department Level Elective – IV Lab	-	-	-	-	-	25	-	-	25	50
ITPR75	PBL – Major Project A	-	-	-	-	-	25	-	-	50	75
Total		150	150	150	50	300	100	-	-	125	725

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, OE-ILC – Open Elective - Institute Level Elective Course, PBL – Project-Based Learning, CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses & Labs (PE-DLC – III & PE-DLC – IV)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Reinforcement Learning (ITDLC7031)	Advanced Computer Networks (ITDLC7032)	Multimedia Systems (ITDLC7033)	Software Testing & Quality Assurance (ITDLC7034)
Machine Learning and Deep Learning (ITDLC7041)	Ethical Hacking and Digital Forensics (ITDLC7042)	Computer Vision (ITDLC7043)	UI/UX Design Specializations (ITDLC7044)
Machine Learning and Deep Learning Lab (ITDLL7041)	Digital Forensics Lab (ITDLL7042)	Computer Vision Lab (ITDLL7043)	UI/UX Design Lab (ITDLL7044)

Open Electives - Institute Level Elective Courses (OE-ILC – I)

Courses
Product Lifecycle Management (ILC7051)
Reliability Engineering (ILC7052)
Management Information System (ILC7053)
Design of Experiments (ILC7054)
Operations Research (ILC7055)
Cyber Security and Laws (ILC7056)
Disaster Management & Mitigation Measures (ILC7057)
Energy Audit and Management (ILC7058)
Development Engineering (ILC7059)

SEMESTER VIII - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC801	Blockchain and DLT	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC802	Department Level Elective – V	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITDLC803	Department Level Elective – VI	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ILC804	Institute Level Elective – II	3 – 0 – 0	03	3 – 0 – 0	03	OE-ILC
ITL801	Blockchain Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL805	RPA Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL802	Department Level Elective – V Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITPR86	PBL – Major Project B	0 – 12 – 0	12*	0 – 6 – 0	06	PBL
Total		12 – 18 – 0	30	12 – 9 – 0	21	

*Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC801	Blockchain and DLT	30	30	30	10	60	-	-	-	-	100
ITDLC802	Department Level Elective – V	30	30	30	10	60	-	-	-	-	100
ITDLC803	Department Level Elective – VI	30	30	30	10	60	-	-	-	-	100
ILC804	Institute Level Elective – II	30	30	30	10	60	-	-	-	-	100
ITL801	Blockchain Lab	-	-	-	-	-	25	25	-	-	50
ITL805	RPA Lab	-	-	-	-	-	25	-	25	-	50
ITDLL802	Department Level Elective – V Lab	-	-	-	-	-	25	-	-	25	50
ITPR86	PBL – Major Project B	-	-	-	-	-	50	-	-	100	150
Total		120	120	120	40	240	125	-	-	175	700

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, OE-ILC – Open Elective - Institute Level Elective Course, PBL – Project-Based Learning, CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses & Labs (PE-DLC – V & PE-DLC – VI)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Natural Language Processing (ITDLC8021)	Cloud Security (ITDLC8022)	Remote Sensing and GIS (ITDLC8023)	High Performance Computing (ITDLC8024)
NLP Lab (ITDLL8021)	Cloud Security Lab (ITDLL8022)	Remote Sensing and GIS Lab (ITDLL8023)	HPC Lab (ITDLL8024)
Explainable AI & Responsible AI (ITDLC8031)	Edge Computing (ITDLC8032)	Augmented Reality – Virtual Reality (ITDLC8033)	Optimization Techniques (ITDLC8034)

Open Electives - Institute Level Elective Courses (OE-ILE – II)

Courses
Project Management (ILC8041)
Finance Management (ILC8042)
Entrepreneurship Development and Management (ILC8043)
Human Resource Management (ILC8044)
Professional Ethics and CSR (ILC8045)
Research Methodology (ILC8046)
IPR and Patenting (ILC8047)
Digital Business Management (ILC8048)
Environmental Management (ILC8049)

List of Courses (With Theory / Oral Exams) -
Common Between B.Tech. (Information Technology) and Other Programs

Sr. No.	Semester	Course Code	Course Name	Programs Offering Same Course & Syllabus
1	III	ITC301	Applications of Mathematics in Engineering – I	<ul style="list-style-type: none"> • B.Tech. (Information Technology) • B.Tech. (Computer Engineering) • B.Tech. (Artificial Intelligence & Data Science)
2	IV	ITC401	Applications of Mathematics in Engineering – II	<ul style="list-style-type: none"> • B.Tech. (Information Technology) • B.Tech. (Computer Engineering) • B.Tech. (Artificial Intelligence & Data Science)
3	V	ITL506	Business Communication & Ethics	<ul style="list-style-type: none"> • B.Tech. (Information Technology) • B.Tech. (Computer Engineering) • B.Tech. (Artificial Intelligence & Data Science) • B.Tech. (Electronics and Telecommunication Engineering)

SEMESTER III - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC301	Applications of Mathematics in Engineering – I	3 – 0 – 1	04	3 – 0 – 1	04	BS
ITC302	Data Structures and Analysis	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC303	Database Management System	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC304	Java Programming	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC305	Foundations of Software Engineering	2 – 0 – 0	02	2 – 0 – 0	02	PC
ITL302	Data Structures Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL303	SQL Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL304	Java Programming Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITPR31	PBL – Mini Project Lab I (Web App Development Mini Project)	0 – 2 – 0	02 ^s	0 – 1 – 0	01	PBL
ITXS33	SAT – III: Skill-Based Learning (Go Programming)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXS34	SAT – IV: Skill-Based Learning (Foreign and/or Indian Regional Languages – I)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		14 – 12 – 1	27	14 – 6 – 1	21	

*SAT can be conducted as TH or P or both as required.

^sLoad of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC301	Applications of Mathematics in Engineering - I	30	30	30	10	60	25	-	-	-	125
ITC302	Data Structures and Analysis	30	30	30	10	60	-	-	-	-	100
ITC303	Database Management System	30	30	30	10	60	-	-	-	-	100
ITC304	Java Programming	30	30	30	10	60	-	-	-	-	100
ITC305	Foundations of Software Engineering	20	20	20	10	45	-	-	-	-	75
ITL302	Data Structures Lab	-	-	-	-	-	25	-	-	25	50
ITL303	SQL Lab	-	-	-	-	-	25	-	-	25	50
ITL304	Java Programming Lab	-	-	-	-	-	25	-	-	-	25
ITPR31	PBL – Mini Project Lab I (Web App Development Mini Project)	-	-	-	-	-	25	-	-	25	50
ITXS33	SAT – III: Skill-Based Learning (Go Programming)	-	-	-	-	-	25	-	-	-	25
ITXS34	SAT – IV: Skill-Based Learning (Foreign and/or Indian Regional Languages – I)	-	-	-	-	-	25	-	-	-	25
Total		140	140	140	50	285	175	-	-	75	725

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, BS – Basic Science Course, PC – Professional Core Course, PBL – Project-Based Learning, SAT – Skill/Activity/Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC301	Applications of Mathematics in Engineering – I	03	-	01	04
Prerequisites:	Engineering Mathematics.				
Course Objectives (COBs):	<ol style="list-style-type: none">1. To learn the Laplace Transform, Inverse Laplace Transform of various functions, its applications.2. To understand the concept of Fourier Series, its complex form and enhance the problem-solving skills.3. To understand the concept of Complex Variables, C-R equations with applications.4. To understand the basic techniques of statistics like Correlation, Regression, and Curve Fitting for Data Analysis, Machine learning, and AI.5. To understand some advanced topics of Probability, Random Variables with their Distributions and Expectations.				
Course Outcomes (COs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none">1. Solve the real integrals in engineering problems using the concept of Laplace Transform.2. Analyze engineering problems through the application of inverse Laplace transform of various functions.3. Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.4. Solve the problems of obtaining orthogonal trajectories and analytic functions by means of complex variable theory and application of harmonic conjugate.5. Apply the concept of Correlation and Regression to the engineering problems in Data Science, Machine Learning, and AI.6. Analyze the spread of data and distribution of probabilities by the concepts of probability and expectation.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Laplace Transform	Definition of Laplace Transform, Condition of Existence of Laplace Transform.	CO1	01	07	
	Laplace Transform (L) of Standard Functions like e^{at} , $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$ and $t^n, n \geq 0$.	CO1	02		
	Properties of Laplace Transform: Linearity, First Shifting Property, Second Shifting Property, Change of Scale Property, Multiplication by t, Division by t, Laplace Transform of Derivatives and Integrals (Properties without proof).	CO1	02		
	Evaluation of Integrals by using Laplace Transformation.	CO1	02		
2. Inverse Laplace Transform	Definition of Inverse Laplace Transform, Linearity Property, Inverse Laplace Transform of Standard Functions, Inverse Laplace Transform using Derivatives.	CO2	02	06	

	Partial Fractions Method to find Inverse Laplace Transform.	CO2	02	
	Inverse Laplace Transform using Convolution Theorem (without proof).	CO2	02	
3. Fourier Series	Dirichlet's Conditions, Definition of Fourier Series and Parseval's Identity (without proof).	CO3	01	07
	Fourier Series of Periodic Function with Period 2π & $2l$.	CO3	02	
	Fourier Series of Even and Odd Functions.	CO3	02	
	Fourier Transform-Fourier Sine Transform and Fourier Cosine Transform.	CO3	02	
4. Complex Variables	Function $f(z)$ of Complex Variable, Limit, Continuity and Differentiability of $f(z)$, Analytic Function: Necessary and Sufficient Conditions for $f(z)$ to be Analytic (without proof).	CO4	01	07
	Cauchy-Riemann Equations in Cartesian Coordinates (without proof).	CO4	02	
	Milne-Thomson Method to determine Analytic Function $f(z)$ when Real Part (u) or Imaginary Part (v) or its combination ($u+v$ or $u-v$) is given.	CO4	02	
	Harmonic Function, Harmonic Conjugate and Orthogonal Trajectories.	CO4	02	
5. Statistical Techniques	Karl Pearson's Coefficient of Correlation (r).	CO5	01	06
	Spearman's Rank Correlation Coefficient (R) (with repeated and non-repeated Ranks).	CO5	01	
	Lines of Regression.	CO5	02	
	Fitting of First and Second-Degree Curves.	CO5	02	
6. Probability	Definition and Basics of Probability, Conditional Probability.	CO6	01	06
	Total Probability Theorem and Bayes' Theorem.	CO6	01	
	Discrete and Continuous Random Variable with Probability Distribution and Probability Density Function.	CO6	02	
	Expectation, Variance, Moment Generating Function, Raw and Central Moments up to 4 th order.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. B. Grewal, Higher Engineering Mathematics, Khanna Publications. 2. E. Kreyszig, Advanced Engineering Mathematics, Wiley. 3. T. Veerarajan, Probability, Statistics and Random Processes, McGraw Hill.			
Reference Books:	1. R. Jain and S. Iyengar, Advanced Engineering Mathematics, Narosa Publication. 2. J. Brown and R. Churchill, Complex Variables and Applications, McGraw Hill. 3. M. Spiegel, Theory and Problems of Fourier Analysis with applications to BVP, Schaum's Outline Series.			
Useful Links:	1. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=25 2. https://nptel.ac.in/noc/courses/111/ 3. https://www.coursera.org/courses?query=mathematics 4. https://ndl.iitkgp.ac.in/			

Term Work (TW):	<ul style="list-style-type: none"> • Each student has to write at least 06 Assignments on entire syllabus. • A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as Mini Project in Applications of Mathematics – I and shall be graded depending on the performance of the students. • Term work evaluation shall be for Total 25 Marks based on Assignments on Entire Syllabus and Mini Project Presentation.
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC302	Data Structures and Analysis	03	-	-	03
Prerequisites:	Computer Programming (C / C++).				
Course Objectives (COBs):	1. To introduce the concepts of data structures and analysis procedure. 2. To conceptualize linear data structures and its implementation for various real-world applications. 3. To provide the understanding of non-linear data structures and its applications in developing solutions to real-world problems. 4. To impart knowledge of sorting and searching algorithms. 5. To develop an ability to design and analyze algorithms using various data structures. 6. To design and implement various data structure algorithms for solving real-world problems.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the fundamental concepts of data structures, analyse a given problem to identify suitable data structures applicable for solving it, and describe the complexities of algorithms designed for the same. 2. Apply the concepts of stacks and queues to develop real-world problem solutions. 3. Apply the concepts of singly, circular, or doubly linked list as per the requirements for solving real-world problems. 4. Apply the concepts of trees to develop real-world problem solutions. 5. Apply the concepts of graphs to develop real-world problem solutions. 6. Apply appropriate sorting/searching techniques for real-world problem-solving.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Data Structures and Analysis	Introduction to Data Structures, Need of Data Structures, Types of Data Structures: Linear and Non-linear Data Structures, Static and Dynamic Data Structures.	CO1	02	04	
	Introduction to Analysis, Algorithms, Characteristics of Algorithms, Time and Space Complexities, Order of Growth Functions, Asymptotic Notations.	CO1	02		
2. Stacks and Queues	Introduction to Stack, Stack as ADT, Operations on Stack, Polish Notation: Infix, Prefix, and Postfix Expressions, their Evaluation and Conversions.	CO2	04	10	
	Applications of Stack: Reversal of a String, Checking Validity of Expressions with Nested Parenthesis.	CO2	01		
	Introduction to Queue, Queue as ADT, Operations on Queue, Linear Representation of Queue, Circular Queue, De-queue.	CO2	03		
	Priority Queue, Applications of Queues: Scheduling.	CO2	01		
	Analysis of Stack and Queue Complexities and their Suitability for Solving Different Real-world Problems.	CO1	01		

3. Linked List	Introduction to Linked Lists, Singly Linked Lists, Circular Linked Lists, Insertion, Deletion, and Update Operations with Singly and Circular Linked Lists.	CO3	04	09
	Doubly Linked Lists, Insertion, Deletion, and Update Operations with Doubly Linked Lists.	CO3	03	
	Linked List Representation of Stack and Queue, Analysis of Linked Lists and its Suitability for Solving Different Real-world Problems.	CO3, CO1	01	
	Applications of Linked Lists.	CO3	01	
4. Trees	Introduction to Trees, Tree Terminologies.	CO4	01	06
	Binary Tree Representation, Operations on Binary Trees, Traversal of Binary Trees, Threaded Binary Trees, Analysis of Trees and its Suitability for Solving Different Real-world Problems.	CO4, CO1	03	
	Application-oriented Introduction: Binary Search Trees, B-Trees, B+ Trees, Decision Trees, Expression Trees, etc.	CO4	01	
	Application of Trees: Huffman Encoding.	CO4	01	
5. Graphs	Introduction to Graphs, Graph Terminologies, Graph Representation, Type of Graphs.	CO5	01	05
	Graph Traversal: Depth First Search (DFS), Breadth First Search (BFS), Analysis of Graphs and its Suitability for Solving Different Real-world Problems.	CO5, CO1	02	
	Minimum Spanning Tree: Prim's & Kruskal's Shortest Path Algorithm, Applications of Graphs: Traversal.	CO5	02	
6. Sorting and Searching	Introduction to Sorting, Sorting Techniques: Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort, Comparison of Sorting Technique Performances.	CO6, CO1	03	05
	Searching: Sequential Search, Binary Search, Hashing: Hash Functions – Truncation, Mid-square Method, Folding Method, Division Method.	CO6	01	
	Collision Resolution: Open Addressing - Linear Probing, Quadratic Probing, Double Hashing, Separate Chaining, Bucket Hashing, Analysis of all Searching Techniques.	CO6	01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. J. Tremblay and P. Sorenson, Introduction to Data Structure and its Applications, McGraw Hill. 2. R. Thareja, Data Structures using C, Oxford. 3. S. Srivastava, D. Srivastava, Data Structures through C in Depth, BPB Publications.			
Reference Books:	1. Y. Langsam, M. Augenstein, and A. Tenenbaum, Data Structures using C and C++, Pearson. 2. E. Horowitz and S. Sahni, Fundamentals of Data Structures, Galgotia Publications. 3. R. Shukla, Data Structures using C and C++, Wiley.			
Useful Links:	1. https://learndsa.kjsiet.in/ 2. https://nptel.ac.in/courses/106/102/106102064/ 3. https://www.coursera.org/learn/data-structures 4. https://www.codechef.com/			

Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC303	Database Management System	03	-	-	03
Prerequisites:	Computer Programming (C / C++), Basic Knowledge of Computer File System.				
Course Objectives (COBs):	1. To learn the basics and understand the need of a Database Management System. 2. To construct conceptual data model for real world applications. 3. To build a Relational Model from ER/EER. 4. To introduce the concept of SQL to store and retrieve data efficiently. 5. To demonstrate notions of Normalization for Database Design. 6. To understand the concepts of Transaction Processing - Concurrency Control & Recovery Procedures.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the basics and need of a database management system. 2. Design conceptual models for real life applications. 3. Create a Relational model from ER/EER. 4. Apply queries using SQL commands for databases. 5. Design normalized database by applying normalization process. 6. Explain the concept of transaction, concurrency and recovery.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Database System Concepts and Architecture	Introduction, Characteristics of Databases, File System v/s Database System, Data Abstraction and Data Independence.	CO1	03	05	
	DBMS System Architecture, Database Administrator (DBA), Role of DBA.	CO1	02		
2. Entity Relationship Model	Conceptual Modelling of a Database, Entity Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets.	CO2	03	06	
	Weak Entity Types, Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.	CO2	03		
3. Relational Model & Relational Algebra	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Key, Secondary Key, Foreign Key, Mapping the ER and EER Model to Relational Model.	CO3	03	05	
	Introduction to Relational Algebra, Relational Algebra Expressions for Unary Relational Operations, Set Theory Operations, Binary Relational Operation, Relational Algebra Queries.	CO3	02		
4. Structured Query	Overview of SQL, Data Definition Commands, Set Operations, Aggregate Function, Null Values, Data	CO4	03	09	

Language (SQL) & Indexing	Manipulation Commands, Data Control Commands, Complex Retrieval Queries using Group by.			
	Recursive Queries, Nested Queries, All Types of Joins, Introduction to PL-SQL, Integrity Constraints in SQL. Database Programming with JDBC, Security and Authorization: Grant & Revoke in SQL. Functions and Procedures in SQL and Cursors.	CO4	04	
	Indexing: Basic Concepts, Ordered Indices, Index Definition in SQL.	CO4	02	
5. Relational Database Design	Design Guidelines for Relational Schema, Functional Dependencies, Database Tables and Normalization, The Need for Normalization, The Normalization Process, Improving the Design.	CO5	05	07
	Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF), 4NF.	CO5	02	
6. Transactions Management, Concurrency and Recovery	Transaction Concepts, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View.	CO6	04	07
	Concurrency Control: Lock-based-protocols, Deadlock Handling, Timestamp-Based Protocols, Recovery System: Recovery Concepts, Log Based Recovery.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. H. Korth, A. Silberchatz, S. Sudarshan, Database System Concepts, McGraw Hill. 2. R. Elmasri and S. Navathe, Fundamentals of Database Systems, Pearson. 3. R. Ramkrishnan and J. Gehrke, Database Management Systems, McGraw Hill.			
Reference Books:	1. P. Rob and C. Coronel, Database Systems Design, Implementation and Management, Thomson Learning. 2. P. Deshpande, SQL & PL/SQL for Oracle 11g Black Book, Dreamtech Press. 3. G. Gupta, Database Management Systems, McGraw Hill.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc19_cs46/preview 2. https://onlinecourses.nptel.ac.in/noc21_cs04/preview 3. https://www.coursera.org/learn/database-management			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC304	Java Programming	03	-	-	03
Prerequisites:	Basics of Computer Programming.				
Course Objectives (COBs):	<div>1. To understand the concepts of object-oriented paradigm in the Java programming language.</div> <div>2. To understand the importance of Classes & objects along with constructors, Arrays, Strings and vectors</div> <div>3. To learn the principles of inheritance, interface and packages and demonstrate the concept of reusability for faster development.</div> <div>4. To recognize usage of Exception Handling, Multithreading, Input Output streams in various applications</div> <div>5. To learn designing, implementing, testing, and debugging graphical user interfaces with database connectivity in Java using Swings and AWT components that can react to different user events.</div> <div>6. To develop graphical user interfaces using JavaFX controls.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Explain the fundamental concepts of Java Programing.</div> <div>2. Use the concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem.</div> <div>3. Demonstrate how to extend java classes and achieve reusability using Inheritance, Interface and Packages.</div> <div>4. Construct robust and faster programmed solutions to problems using concept of Multithreading, exceptions and file handling</div> <div>5. Develop Graphical User Interface using Abstract Window Toolkit and Swings along with response to the events and database connectivity.</div> <div>6. Develop Graphical User Interface by exploring JavaFX framework based on MVC architecture.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Java Fundamentals	Features of Java Language, Introduction to the principles of object-oriented programming: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism.	CO1	01	06	
	Constants, variables and data types, Operators and Expressions, Types of variables and methods.	CO1	02		
	Control Statements: If Statement, If-else, Nested if, switch Statement, break, continue. Iteration Statements: for loop, while loop, and do-while loop.	CO1	03		
2. Classes, objects,	Classes & Objects: Reference Variables, Passing parameters to Methods and Returning parameters from	CO2	03	08	

Arrays and Strings	the methods, Static members, Non-Static members Nested and Inner Classes. Static Initialization Block (SIB), Instance Initialization Block(IIB)			
	Constructors: Parameterized Constructors, chaining of constructor, finalize() Method, Method overloading, Constructors Overloading. Recursion, Command-Line Arguments. Wrapper classes, InputBufferReader, OutputBufferReader, String Buffer classes, String functions.		03	
	Arrays & Vectors: One and Two Dimensional arrays, Irregular arrays, dynamic arrays, Array List and Array of Object.	CO2	02	
3. Inheritance, Packages and Interfaces.	Inheritance: Types of Inheritance in Java, member access, using Super- to call superclass Constructor, to access member of super class (variables and methods), creating multilevel hierarchy, Constructors in inheritance, method overriding, Abstract classes and methods, using final.	CO2	02	05
	Packages: Defining packages, creating packages and Importing and accessing packages	CO3	01	
	Interfaces: Defining, implementing and extending interfaces, variables in interfaces, Default Method in Interface, Static Method in interface, Abstract Classes vs Interfaces.	CO3	02	
4. Exception Handling, Multithreading, Input Output streams	Exception Handling: Exception-Handling Fundamentals, Exception Types, Exception class Hierarchy, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally , Java's Built-in Exceptions, Creating Your Own Exception Subclasses.	CO4	02	07
	Multithreaded Programming: The Java Thread Model and Thread Life Cycle, Thread Priorities, Creating a Thread, Implementing Runnable, Extending Thread, Creating Multiple Threads,	CO4	02	
	Synchronization: Using Synchronized Methods, The synchronized Statement	CO4	01	
	I/O Streams: Streams, Byte Streams and Character, The Predefined Streams, Reading Console Input, Reading Characters, Reading Strings, Writing Console Output, Reading and Writing Files.	CO4	02	
5. GUI programming-I & Database Connectivity(AWT, Event Handling, Swing, JDBC)	Designing Graphical User Interfaces in Java: Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features	CO5	02	09
	Event-Driven Programming in Java: Event-Handling Process, Delegation Model of Event Handling, Event Classes, Event Sources, Event Listeners, Adapter Classes as Helper Classes in Event Handling.	CO5	02	

	Introducing Swing: AWT vs Swings, Components and Containers, Swing Packages, A Simple Swing Application, Painting in Swing, Designing Swing GUI Application using Buttons, JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, TablesScroll pane Menus and Toolbar.	CO5	03	
	Database connectivity using JDBC: Introduction to JDBC, JDBC Drivers & Architecture.	CO5	02	
6. GUI Programming-II (JavaFX)	JavaFX Basic Concepts, JavaFX application skeleton, Compiling and running JavaFX program,	CO6	02	04
	Simple JavaFX control: Label, Using Buttons and events, Drawing directly on Canvas	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. H. Schildt, Java-The Complete Reference, Tenth Edition, Oracle Press, Tata McGraw Hill Education. 2. E. Balguruswamy, Programming with Java A primer, Fifth edition, Tata McGraw Hill Publication 3. A. Seth, B. Juneja, Java One Step Ahead, oxford university press.			
Reference Books:	1. D. Editorial Services, Java 8 Programming Black Book, Dreamtech Press. 2. Learn to Master Java, Star EDU Solutions 3. Y. Kanetkar, Let Us Java, BPB Publications.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc21_cs03/preview 2. https://onlinecourses.swayam2.ac.in/aic20_sp13/preview 3. https://www.coursera.org/projects/introduction-to-java-programming-java-fundamental-concepts 4. https://www.udemy.com/course/core-java-from-scratch/ 5. https://java-iitd.vlabs.ac.in/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC305	Foundations of Software Engineering	02	-	-	02
Prerequisites:	Fundamentals of Programming.				
Course Objectives (COBs):	1. To provide the knowledge of software engineering discipline. 2. To describe requirements and analyse it. 3. To do planning and apply scheduling. 4. To apply analysis, and develop software solutions using Behavioural diagrams. 5. To apply analysis, and develop software solutions using Structured diagrams. 6. To apply testing and assure quality in software solution.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain basic concepts of software engineering. 2. Explain various software development models. 3. Analyse the requirements to prepare software. 4. Prepare plan, schedule, and track the progress of the projects. 5. Design UML diagrams as per requirements of software solutions. 6. Test the quality of software solutions.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Software Engineering	Nature of Software, Software Engineering Myths, Software Process, Generic Process Model, SDLC.	CO1	02	06	
	Prescriptive Process Models: The Waterfall Model, Incremental Models, Evolutionary Process Models: RAD and Spiral Model.	CO2	04		
2. Requirement Analysis	Software Requirements: Functional & Non-Functional	CO3	01	03	
	Software Documentation: Analysis and Modelling, Software Requirement Specification (SRS).	CO3	02		
3. Software Estimation and Scheduling	Software Project Estimation: LOC, FP, and Cost Estimation Techniques.	CO1, CO4	02	04	
	Project Scheduling & Tracking, Gantt Chart, PERT/CPM	CO1, CO4	02		
4. UML Diagrams - I	Design Concepts, Data Flow Diagram,	CO5	02	04	
	Use Case Diagrams, Activity Diagrams.	CO5	02		
5. UML Diagrams - II	State Charts, Sequence Diagrams.	CO5	02	04	
	Class and Component Diagrams.	CO5	02		
6. Software Testing	Software Quality Testing: Strategic Approach, Strategies for Conventional Software.	CO1, CO6	02	04	
	Types of Dynamic Testing: White Box and Black Box Testing, Alpha and Beta Testing	CO1, CO6	02		
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01	

Text Books:	<ol style="list-style-type: none"> 1. R. Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill. 2. R. Mall, Fundamentals of Software Engineering, PHI.
Reference Books:	<ol style="list-style-type: none"> 1. P. Jalote, An Integrated Approach to Software Engineering, Narosa Publication. 2. I. Sommerville, Software Engineering, Addison-Wesley.
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/108/102/108102120/ 2. https://nptel.ac.in/courses/108/105/108105132/ 3. https://www.udemy.com/course/analog-communication/ 4. https://www.udemy.com/course/digital-communication-information-theory/
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 20 Marks (where each Test shall be of 20 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 45 Marks. • Duration of End Semester Exam shall be 2 Hours.

Lab Code		Lab Name	Credits			
			TH	P	TUT	Total
ITL302		Data Structures Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.				
Software Requirements:		Turbo / Borland C Compiler / Online C Compiler.				
Prerequisites:		Computer Programming (C / C++).				
Lab Objectives (LOBs):		1. To introduce the concepts of data structures and analysis procedure. 2. To conceptualize linear data structures and its implementation for various real-world applications. 3. To provide the understanding of non-linear data structures and its applications in developing solutions to real-world problems. 4. To impart knowledge of sorting and searching algorithms. 5. To develop an ability to design and analyze algorithms using various data structures. 6. To design and implement various data structure algorithms for solving real-world problems.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply the concepts of stacks for real-world applications. 2. Apply the concepts of queues for real-world applications. 3. Apply the concepts of singly, circular, and doubly linked list for real-world applications. 4. Implement tree and graph data structure for real-world applications. 5. Implement sorting and searching techniques for real-world applications. 6. Develop solutions to real-world problems and challenges in Data Structures in team as well as an individual.				
Lab No.	Experiment Title			LOs Mapped	Hours	
0	Lab Prerequisites			-	02	
1	Implementation of Stack using Array for real-world application.			LO1	02	
2	Implementation of Queue using Array for real-world application.			LO2	02	
3	Implementations of Infix to Postfix Expression for real-world application.			LO1	02	
4	Implementation of Double-ended Queue using Array for real-world application.			LO2	02	
5	Implementation of Singly Linked List / Circular Singly Linked List and various operations for real-world.			LO3	02	
6	Implementation of Doubly Linked List and various operation for real-world application.			LO3	04	
7	Implementation of Binary Tree and its Traversal for real-world application.			LO4	02	
8	Implementation of various operations on tree like – copying tree, mirroring a tree, counting the number of nodes in the tree, etc.			LO4	02	
9	Implementation of any one Graph Traversal Technique for real-world application.			LO4	02	
10	Implementation of any one Sorting Technique considering a real-world application.			LO5	02	
11	Advancement through Data Structures: a. Creation of Git profile for source code management. b. Solving problems of Data Structures using HackerRank, etc. platforms.			LO6	04	

Virtual Lab Links:	<ol style="list-style-type: none"> 1. http://cse01-iiith.vlabs.ac.in/ 2. https://ds1-iiith.vlabs.ac.in/data-structures-1/ 3. https://ds2-iiith.vlabs.ac.in/data-structures-2/
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments, to be performed in C / C++ / Java / Python. • Journal must include at least 02 assignments on content of theory course “Data Structures and Analysis” and “Data Structures Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
ITL303	SQL Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	MySQL / Online SQL Editor, JDK.				
Prerequisites:	Computer Programming (C / C++).				
Lab Objectives (LOBs):	1. To identify and define problem statements for real life applications. 2. To construct conceptual data model for real life applications. 3. To build Relational Model from ER/EER and use relational algebra. 4. To apply SQL to store and retrieve data efficiently. 5. To implement database connectivity using JDBC. 6. To understand the concepts of transaction processing- concurrency control & recovery procedures.				
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Construct conceptual model for real-world applications. 2. Create and populate a RDBMS using SQL. 3. Implement efficient information retrieval using SQL. 4. Implement view, triggers and procedures to demonstrate specific event handling. 5. Implement database connectivity using JDBC. 6. Demonstrate the concept of concurrent transactions.				
Lab No.	Experiment Title	LOs Mapped			Hours
0	Lab Prerequisites.	-			02
1	Identify real world problems and develop the problem statement. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.	LO1			02
2	Mapping ER / EER to Relational schema model.	LO1			02
3	Create a database using DDL and apply integrity constraints.	LO2, LO3			02
4	Perform data manipulations operations on populated databases.	LO3			02
5	Perform Authorization using Grant and Revoke.	LO2, LO3			02
6	Implement Basic and complex SQL queries.	LO3, LO4			02
7	Implementation of Views and Triggers.	LO4			02
8	Demonstrate database connectivity by preparing a simple form in any scripting language.	LO5			04
9	Execute TCL commands.	LO4			02
10	Implement Functions and Procedures in SQL.	LO3, LO4			02
11	Implementation of Cursor.	LO3, LO4			02
12	Implementation and demonstration of Transaction and Concurrency Control techniques using Locks.	LO6			02

Virtual Lab Links:	<ol style="list-style-type: none"> 1. http://vlabs.iitb.ac.in/bootcamp/labs/dbms/exp8/index.php 2. http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/index.php 3. https://dev.mysql.com/doc/refman/8.0/en/sql-data-definition-statements.html
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Database Management Systems” and “SQL Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code		Lab Name		Credits			
				TH	P	TUT	Total
ITL304		Java Programming Lab		-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.					
Software Requirements:		JDK, NetBeans, Eclipse					
Prerequisites:		Basics of Computer Programming					
Lab Objectives (LOB):		1. To understand the concepts of object-oriented paradigm in the Java programming language. 2. To understand the importance of Classes & objects along with constructors, Arrays, Strings and vectors 3. To learn the principles of inheritance, interface and packages and demonstrate the concept of reusability for faster development. 4. To recognize usage of Exception Handling, Multithreading, Input Output streams in various applications 5. To learn designing, implementing, testing, and debugging graphical user interfaces in Java using Swings and AWT components that can react to different user events. 6. To develop graphical user interfaces using JavaFX controls.					
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply the fundamental concepts of Java Programing. 2. Apply the concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem. 3. Apply the concepts of Inheritance, Interface and Packages. 4. Construct robust and faster programmed solutions to problems using concept of Multithreading, exceptions and file handling 5. Develop Graphical User Interface using Abstract Window Toolkit and Swings along with response to the events and database connectivity. 6. Develop Graphical User Interface by exploring JavaFX framework based on MVC architecture.					
Lab No.	Experiment Title				LOs Mapped		Hours
0	Lab Prerequisites.				-		02
1	Implement a Java program to various ways to accept data through keyboard				LO1		02
2	Implement a menu driven Java program which will read a number and should implement the methods using controlled structures.				LO1		02
3	Implement a program that using Class and Object.				LO2		02
4	Implement program for constructor in Java.				LO2		02
5	Implement a Java program for Vector and strings				LO2		02
6	Implement a Java program for Inheritance.				LO3		02
7	Implement a Java program for Interface.				LO3		02
8	Implement a Java program for package.				LO3		02
9	Implement a Java program for Exception.				LO4		02
10	Implement a Java program for Multithreading.				LO4		02
11	Implement a Java program for file handling.				LO4		02

12	Implement a Java program to create a simple calculator using Java AWT elements.	LO5	02
13	Implement a Java Program to simulate traffic signal light using AWT and Swing Components	LO5	02
14	Implement a Java program for database connectivity.	LO5	02
15	Implement a Java program to design a Login Form using JavaFX Controls	LO6	02
Virtual Lab Links:	1. https://java-iitd.vlabs.ac.in/ 2. http://vlabs.iitb.ac.in/vlabs-dev/labs/java-iitd/index.html		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments, to be performed in Java. • Journal must include at least 02 assignments on content of theory of course “Java Programming Fundamentals” and “Java Programming Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		

PBL Course Code	PBL Course Name	Credits			
		TH	P	TUT	Total
ITPR31	PBL – Mini Project Lab I (Web App Development Mini Project)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	JDK, MySQL.				
Prerequisites:	Basics of Computer Programming.				
PBL Objectives (PROBs):	<ol style="list-style-type: none"> 1. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used. 2. To practice the process of identifying the needs and converting it into a problem statement. 3. To apply engineering knowledge and modern tools/technologies for deriving solutions to the real-world problems. 4. To inculcate the process of self-learning and research. 5. To be acquainted with solving the problem in a group. 6. To improve communication, management and report-writing skills of the students. 				
PBL Outcomes (PROs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none"> 1. Identify societal / research needs, formulate problem statements, review research literature, and analyze complex engineering problems. 2. Design suitable solutions for the problems including scope, objectives, timeline, system flow, user interface, algorithms, etc. 3. Gather, analyze, and interpret data — and apply knowledge of engineering fundamentals, modern tools / technologies for development of solutions. 4. Analyze sustainability and scalability of the developed solution and its impact in terms of environmental, societal, safety, legal, cultural, health, etc. aspects. 5. Apply ethical principles, excel in written and oral communication, and engage in independent and life-long learning. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects. 				
Guidelines for Project-Based Learning (PBL):	<ol style="list-style-type: none"> 1. Students have to form a team of minimum 02 and maximum 04 members, based on their area of interest and size of project. Interdisciplinary (inter-branch) teams are encouraged. 2. Students should develop a Desktop / Web / Mobile Application with a proper user interface using any suitable technology like HTML5, CSS, etc. for front end and Java / Go at backend. 3. Students should carry out a survey and identify needs, which shall be converted into problem statement for Mini Project in consultation with Faculty Guide, Internal committee of faculties, and the Head of Department. 4. Projects should compulsorily be based on societal contribution (healthcare, agriculture, etc.) and reflecting role of engineer in the society. Students should try to take up need-based live projects so as to get exposure to communication with beneficiaries and skills for understanding client requirements. 5. Based on the idea presentation as well as discussion on feasibility, novelty, and contribution of the idea, a project definition will be finalized. 6. Students shall submit their implementation plan in the form of Gantt / PERT / CPM chart, which will cover weekly activity of the Mini project. 7. A log book is to be prepared by each group, wherein the group can record weekly work progress and the Faculty Guide can verify and record notes / comments. 				

	<ol style="list-style-type: none"> 8. Faculty Guide may give inputs to students during Mini Project activity; however, focus shall be on self-learning. 9. Students in a group shall understand the problem effectively, propose multiple solutions, and select the best possible solution in consultation with their guide. 10. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate. 11. The solution is to be validated with proper justification and report to be compiled in standard format of the Department. 12. With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, if the problem statement is huge and significant, a same problem statement can be worked upon for 02 semesters, i.e., same Minor Project in Semesters V and VI. Projects with a very large scope can also be taken forward to higher semesters, in consultation with the Head of the Department. 13. Students are encouraged to participate in Technical Paper Presentation competitions. 14. The students' group shall complete a project in all aspects including: Identification of need / problem, proposed final solution, Procurement of components / systems / data, Building prototype and testing. 15. Three reviews will be conducted for continuous assessment: one shall be for finalisation of the problem and proposed solution, second shall be for evaluation of work progress, and third shall be for evaluation of implementation and testing of solutions. 16. Mini Project shall be assessed based on following parameters: <ul style="list-style-type: none"> • Attainment of Course Outcomes. • Technical efficiency and quality of developed solution. • Innovativeness in solutions. • Impact on environment. • Cost effectiveness. • Sustainability analysis. • Societal impact. • Effective use of standard engineering norms. • Contribution of an individual as member or leader. • Clarity in written and oral communication. 17. Students are encouraged to publish a paper based on the work in Conferences / Student competitions.
Useful Learning Links:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc21_cs56/preview 2. https://www.coursera.org/specializations/core-java 3. https://www.udemy.com/course/java-se-programming/
Term Work (TW):	<ul style="list-style-type: none"> • Term Work shall be granted based individual's contribution in group activity, their understanding and response to questions. • Term Work evaluation shall be for Total 25 Marks — based on the following evaluation: <ul style="list-style-type: none"> ○ Presentation in Review 1 ○ Presentation in Review 2 ○ Presentation in Review 3 ○ Project Report and Log Book
Practical & Oral (P&O):	P&O examination will be of Total 25 Marks and shall be based on the Project Demonstration, Presentation, and Report.

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXS33	SAT – III: Skill-Based Learning (Go Programming)	-	02	-	02
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	go1.18.3.linux-amd64.tar.gz, Ubuntu Operating System.				
Skill Prerequisites:	Computer Programming (C / C++).				
Skill Objectives (SOBs):	1. To learn and understand the basic Go language syntax and features. 2. To understand use of Go language in concurrent Programming. 3. To learn Go from the ground up to gain a hands-on approach. 4. To use fundamental of Go Lang to build web application. 5. To create concise, efficient, and clean applications using Go Lang 6. To use Pointer, Array, Slice & Struct to build application.				
Skill Outcomes (SOs):	Upon completion of the course, the learners will be able to: 1. Apply Go Programming language fundamentals 2. Develop Go code using variables and types. 3. Use control & operator for writing go code. 4. Understand use of Array, Map, Pointer for developing application. 5. Develop function to solve problems. 6. Develop web application using Golang				
Module No. and Name	Subtopics	SOs Mapped	Hours / Subtopic	Total Hours / Module	
1. Introduction to Go Language	Go installation. Why Go? Basic Syntax Program Command-Line Arguments, Setting up Go ecosystem and IDE	SO1	02	02	
2. Types and Variables	What is a Data Type, Static vs Dynamic Typed Languages, Kind of Data Types.	SO1	01	04	
	Variables: Declaring Variable, Assigning, Variables Demo, Comment, Printing Variables, Declaring Variables. Variable Scope, Zero Values, User Input, Find the type of variable, Converting between types, Lab: Data types and Variables	SO2	01		
	String: Concatenating Strings, String to Numeric, Numeric to String, String Parser, Check String Data Length, Copy Data, Upper and Lower Case Characters.	SO2	02		
3. Control Statement & Operator	Operators: Comparison Operators, Arithmetic Operators. Logical Operators, Assignment Operators, Bitwise Operators	SO3	02	04	
	Control Statement: if-else and else if statements, Switch Statement, Looping with for, Switch Case, While, Break, Continue & defer.	SO3	02		

4. Arrays, Slices and Maps	Array: Introduction, Syntax.	SO4	02	04
	Slice: Introduction, Syntax.	SO4	01	
	Map: Introduction, Syntax.	SO4	01	
5. Packages & Function, Pointer, Struct	Function: Syntax, Return Types - Multiple, Named, Recursive Functions, Anonymous Functions, High Order Functions.	SO5	01	04
	Pointer: Introduction, Address and Dereference Operator, Declaring and Initializing a Pointer.	SO5	01	
	Struct: Declaring and Initialising a Struct, Accessing Fields, Passing Structs to functions.	SO5	01	
	Packages: Introduction, use and importance of packages.	SO5	01	
6. Web Development	Basic Web Development: HTML Tag, CSS, HTTP Server Request, Routing Handling requests	SO6	04	10
	MySQL Database Connectivity, Go Templates, Assets and Files, Forms, Middleware	SO6	04	
	Introduction to Concurrent Programming in Cloud Environment.	SO6	02	
Text Books:	1. A. Alan. Donovan, The Go Programming Language. 2. Introducing Go, O'Reilly Media. 3. A Torres, Go Programming Cookbook.			
Reference Books:	1. M. Andrawos, Cloud Native Programming with Golang: Develop Microservice-based High Performance Web Apps for the Cloud with Go. 2. M. Tsoukalos, Mastering Go: Create Golang Production Applications Using Network Libraries, Concurrency, Machine Learning, and Advanced Data Structures. 3. S. Agarwal, Learning Go Programming Build Scalable Next-Gen Web Application Using Golang			
Useful Learning Links:	1. https://go.dev/doc/tutorial/getting-started 2. https://www.udemy.com/course/go-programming-language-crash-course/ 3. https://gowebexamples.com/basic-middleware/			
Guidelines for Skill-Based Learning (SBL):	<ul style="list-style-type: none">• Programming labs shall be conducted as 02 Hours of blended theory and hands-on session.• The classes will be conducted as a flipped classroom, where students have to attend class after reviewing the lessons provided to them beforehand.• Discussion on the topics and implementation of programs involving the concepts mentioned will be performed during the assigned lab hours.			
Term Work (TW):	<ul style="list-style-type: none">• Term Work evaluation shall be for Total 25 Marks based on Practical Performance.• The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.			

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXS34	SAT – IV: Skill-Based Learning (Foreign and/or Indian Regional Languages – I)	-	01	-	01
Skill Objectives (SOBs):	1. Acquire reading and writing proficiency in the target language 2. Understand the common heritage of, and diversity among, countries that speak the target language. 3. Communicate and interact effectively with citizens of the target cultures				
Skill Outcomes (SOs):	Upon completion of the course, the learners will be able to: 1. Demonstrate of communicative proficiency in the target language. 2. Write the target language in formal expository prose that impede communication. 3. Learn through MOOC online courses to adopt hybrid mode of learning.				
Guidelines for Skill-Based Learning (SBL):	Each student has to complete any one Foreign and/or Indian Language MOOC course from NPTEL / Coursera / Udemy, etc. sites referring the given suggestive list of courses, but not limited to the list as it is a learner's choice for the interested course, to be completed during the semester time frame.				
Sr. No.	Suggestive List of Courses				
1	Introduction to Japanese Language and Culture				
2	German - I				
3	The Psychology of Language				
4	Spanish Vocabulary: Meeting People, Cultural Experience, Sports, Travel, and the Home, Careers and Social Events, Spanish Vocabulary Project				
5	A Bridge to the World: Korean Language for Beginners, First Step Korean, Learn to Speak Korean 1, The Korean Alphabet: An Introduction to Hangeul				
6	Complete French Course: Learn French for Beginners				
7	Complete German Course: Learn German for Beginners				
8	Spanish 1-4: Beginner, Elementary, Intermediate and Advanced (Only first 2 levels recommended)				
9	Complete Japanese Course: Learn Japanese for Beginners				
10	Complete Korean Course: Learn Korean for Beginners				
11	The Complete Russian Language Course				
12	Spoken Sanskrit: Basic and Intermediate Levels				
13	Applied Linguistics				
14	Fundamental Concepts in Sociolinguistics				
15	Introduction to Basic Spoken Sanskrit and Intermediate level to Basic Spoken Sanskrit				
Learning Resources (Suggestive Courses Links but not limited to these only):	1. https://onlinecourses.nptel.ac.in/noc22_hs84/preview 2. https://onlinecourses.nptel.ac.in/noc22_hs88/preview 3. https://onlinecourses.nptel.ac.in/noc22_hs123/preview 4. https://www.coursera.org/learn/spanish-vocabulary-meeting-people 5. https://www.coursera.org/learn/spanish-vocabulary-cultural-experience 6. https://www.coursera.org/learn/spanish-vocabulary-sports-travel-home 7. https://www.coursera.org/learn/spanish-vocabulary-careers 8. https://www.coursera.org/learn/spanish-vocabulary-project 9. https://www.coursera.org/learn/korean-beginners				

	10. https://www.coursera.org/learn/learn-korean 11. https://www.coursera.org/learn/learn-speak-korean1 12. https://www.coursera.org/learn/the-korean-alphabet-an-introduction-to-hangeul 13. https://www.udemy.com/course/complete-french-course/ 14. https://www.udemy.com/course/complete-german-course-learn-german-for-beginners/ 15. https://www.udemy.com/course/spanish-101-beginning-spanish-spanish-for-beginners/ 16. https://www.udemy.com/course/complete-japanese-course-learn-japanese-for-beginners-lvl-1/ 17. https://www.udemy.com/course/complete-korean-course-learn-korean-for-beginners-level-1/ 18. https://www.udemy.com/course/the-complete-russian-language-course/ 19. https://onlinecourses.nptel.ac.in/noc22_hs114/preview 20. https://onlinecourses.nptel.ac.in/noc22_hs85/preview 21. https://onlinecourses.nptel.ac.in/noc22_hs139/preview
Term Work (TW):	Term Work evaluation shall be for Total 25 Marks based on progress and completion of the course.

SEMESTER IV - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC401	Applications of Mathematics in Engineering – II	3 – 0 – 1	04	3 – 0 – 1	04	BS
ITC402	Computer Network and Network Design	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC403	Operating Systems	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC404	Automata Theory	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC405	Computer Organization and Architecture	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITL402	Network Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL403	Unix Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL405	Microprocessor & Microcontroller Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITPR42	PBL – Mini Project Lab II (Python-based Mini Project)	0 – 2 – 0	02 ^{\$}	0 – 1 – 0	01	PBL
ITXS45	SAT – V: Skill-Based Learning (Python Programming)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXS46	SAT – VI: Skill-Based Learning (Foreign and/or Indian Regional Languages – II)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		15 – 12 – 1	28	15 – 6 – 1	22	

*SAT can be conducted as TH or P or both as required.

^{\$}Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC401	Applications of Mathematics in Engineering – II	30	30	30	10	60	25	-	-	-	125
ITC402	Computer Network and Network Design	30	30	30	10	60	-	-	-	-	100
ITC403	Operating Systems	30	30	30	10	60	-	-	-	-	100
ITC404	Automata Theory	30	30	30	10	60	-	-	-	-	100
ITC405	Computer Organization and Architecture	30	30	30	10	60	-	-	-	-	100
ITL402	Network Lab	-	-	-	-	-	25	-	-	25	50
ITL403	Unix Lab	-	-	-	-	-	25	-	25	-	50
ITL405	Microprocessor & Microcontroller Lab	-	-	-	-	-	25	-	25	-	50
ITPR42	PBL – Mini Project Lab II (Python-based Mini Project)	-	-	-	-	-	25	-	-	25	50
ITXS45	SAT – V: Skill-Based Learning (Python Programming)	-	-	-	-	-	25	-	-	-	25
ITXS46	SAT – VI: Skill-Based Learning (Foreign and/or Indian Regional Languages – II)	-	-	-	-	-	25	-	-	-	25
Total		150	150	150	50	300	175	-	50	50	775

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, BS – Basic Science Course, PC – Professional Core Course, PBL – Project-Based Learning, SAT – Skill/Activity/Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC401	Applications of Mathematics in Engineering – II	03	-	01	04
Prerequisites:	Engineering Mathematics, Basics of Applications of Mathematics in Engineering				
Course Objectives (COBs):	1. To analyze characteristics of matrices. 2. To determine the value of line integral. 3. To study the concepts of n dimensional vector spaces and orthonormal basis. 4. To introduce concepts of probability distributions and sampling theory 5. To use the theory of Linear and Non-linear programming in engineering problems.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Determine eigenvalues, eigenvectors of matrices and study diagonalization. 2. Evaluate line integrals using Cauchy’s theorems. 3. Apply the concept of vector spaces and orthogonalization process in engineering problems of higher dimensions. 4. Use probability distribution and sampling theory in decision making problems. 5. Apply techniques of Linear Programming to solve optimization problems. 6. Solve optimization problems using techniques of Non-Linear Programming.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Linear Algebra: Theory of Matrices	Characteristic Equation, Eigenvalues and Eigenvectors, and Properties (without proof).	CO1	02	06	
	Cayley-Hamilton Theorem (without proof), Verification and Reduction of Higher Degree Polynomials.	CO1	02		
	Similarity of Matrices, Diagonalizable and Non-Diagonalizable Matrices.	CO1	02		
2. Complex Integration	Line Integral, Cauchy’s Integral theorem for Simple Connected and Multiply Connected Regions (without proof), Cauchy’s Integral Formula (without proof).	CO2	02	07	
	Taylor’s and Laurent’s Series (without proof).	CO2	03		
	Definition of Singularity, Zeroes, Poles of $f(z)$, Residues, Cauchy’s Residue Theorem (without proof).	CO2	02		
3. Linear Algebra: Vector Spaces	Vectors in n-dimensional Vector Space, Norm, Dot Product, The Cauchy-Schwarz inequality (with proof), Unit Vector.	CO3	02	06	
	Orthogonal Projection, Orthonormal Basis, Gram-Schmidt Process for Vectors.	CO3	02		
	Vector Spaces over Real-field, Subspaces.	CO3	02		
4. Probability Distribution and Sampling Theory	Probability Distribution: Poisson and Normal Distribution	CO4	03	07	
	Sampling Distribution, Test of Hypothesis, Level of Significance, Critical Region, One-tailed, and Two-tailed Test, Degree of Freedom.	CO4	02		

	Students' t-distribution (Small Sample), Test Significance of Mean and Difference between the Means of Two Samples, Chi-Square Test: Test of Goodness of Fit and Independence of Attributes, Contingency Table.	CO4	02	
5. Linear Programming Problems	Types of Solutions, Standard and Canonical of LPP, Basic and Feasible solutions, Slack Variables, Surplus Variables, Simplex Method.	CO5	02	06
	Artificial Variables, Big-M Method (Method of Penalty).	CO5	02	
	Duality, Dual of LPP and Dual Simplex Method.	CO5	02	
6. Nonlinear Programming Problems	NLPP with One Equality Constraint (Two or Three Variables) using the Method of Lagrange's Multipliers.	CO6	02	07
	NLPP with Two Equality Constraints.	CO6	02	
	NLPP with Inequality Constraint: Kuhn-Tucker Conditions.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. E. Kreyszig, Advanced Engineering Mathematics, Wiley. 2. R. Jain and S. Iyengar, Advanced Engineering Mathematics, Narosa Publication. 3. J. Brown and R. Churchill, Complex Variables and Applications, McGraw Hill.			
Reference Books:	1. T. Veerarajan, Probability, Statistics and Random Processes, McGraw Hill. 2. H. Taha, Operations Research: An Introduction, Pearson. 3. S. Rao, Engineering Optimization: Theory and Practice, Wiley. 4. D. Hira and P. Gupta, Operations Research, S. Chand and Sons.			
Useful Links:	1. https://nptel.ac.in/courses/111/108/111108066/ 2. https://nptel.ac.in/courses/111/103/111103070/ 3. https://nptel.ac.in/courses/111/104/111104071/ 4. https://nptel.ac.in/courses/111/105/111105041/ 5. https://www.coursera.org/learn/complex-analysis			
Term Work (TW):	<ul style="list-style-type: none"> Each student has to write at least 06 Assignments on entire syllabus. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as Mini Project in Applications of Mathematics – II and shall be graded depending on the performance of the students. Term work evaluation shall be for Total 25 Marks based on Assignments on Entire Syllabus and Mini Project Presentation. 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC402	Computer Network and Network Design	03	-	-	03
Prerequisites:	Fundamentals of Communication.				
Course Objectives (COBs):	<div>1. To explain the division of network functionalities into layers.</div> <div>2. To describe the types of transmission media along with data link layer concepts, design issues and protocols.</div> <div>3. To analyze the strength and weaknesses of routing protocols and gain knowledge about IP addressing.</div> <div>4. To evaluate the data transportation, issues and related protocols for end-to-end delivery of data.</div> <div>5. To examine the data presentation techniques used in presentation layer & client/server model in application layer protocols.</div> <div>6. To design a network for an organization using networking concepts.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe the functionalities of each layer of the models and compare the models.</div> <div>2. Categorize the types of transmission media and explain data link layer concepts, design issues and protocols.</div> <div>3. Analyze the routing protocols and assign IP address to networks.</div> <div>4. Explain the data transportation and session management issues and related protocols used for end-to-end delivery of data.</div> <div>5. Explain the data presentation techniques and illustrate the client/server model in application layer protocols.</div> <div>6. Apply networking concepts of IP address, routing, and application services to design a network for an organization.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Computer Networks	IT Infrastructure, Use of Computer Networks, Network Devices, Network Software, Protocol Layering.	CO1	02	04	
	Reference Models: OSI, TCP/IP, Comparison of OSI & TCP/IP.	CO1	02		
2. Physical Layer & Data Link Layer	Physical Layer: Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum, Switching: Circuit-Switched Networks, Packet Switching, Structure of a Switch.	CO2	04	10	
	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, Parity, CRC, Checksum), Elementary Data Link protocols: Stop and Wait, Sliding Window (Go Back N, Selective Repeat), Piggybacking, HDLC.	CO2	04		
	Medium Access Protocols: Random Access, Controlled Access, Channelization, Ethernet Protocol: Standard	CO2	02		

	Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, 10-Gigabit Ethernet.			
3. Network Layer	Network Layer Services, Packet Switching, Network Layer Performance, IPv4 Addressing (Classful and Classless), Subnetting, Supernetting, IPv4 Protocol, DHCP, Network Address Translation (NAT).	CO3	03	08
	Routing Algorithms: Distance Vector Routing, Link State Routing, Path Vector Routing.	CO3	02	
	Protocols – RIP, OSPF, BGP.	CO3	02	
	Next Generation IP: IPv6 Addressing, IPv6 Protocol, Transition from IPV4 to IPV6.	CO3	01	
4. Transport Layer & Session Layer	Transport Layer: Transport Layer Services, Connectionless & Connection-Oriented Protocols.	CO4	01	07
	Transport Layer Protocols: User Datagram Protocol: UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers.	CO4	04	
	Session Layer: Session Layer Design Issues, Session Layer Protocol - Remote Procedure Call (RPC).	CO4	02	
5. Presentation Layer & Application Layer	Presentation Layer: Compression: Comparison between Lossy Compression and Lossless Compression, Huffman Coding, Speech Compression, LZW, RLE, Image Compression – GIF, JPEG.	CO5	03	05
	Application Layer: Standard Client-Server Protocols: World Wide Web, HTTP, FTP, Electronic Mail, Domain Name System (DNS), SNMP.	CO5	02	
6. Network Design Concepts	Introduction to VLAN, VPN.	CO6	02	05
	Case Study to Design a Network for an Organization Meeting the following Guidelines: Networking Devices, IP Addressing: Subnetting, Supernetting, Routing Protocols to be used, Services to be used: TELNET, SSH, FTP Server, Web Server, File Server, DHCP Server and DNS Server.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. A. Tanenbaum, Computer Networks, Pearson. 2. B. Forouzan, Data Communications and Networking, McGraw Hill.			
Reference Books:	1. S. Keshav, An Engineering Approach to Computer Networks, Pearson. 2. B. Forouzan, TCP/IP Protocol Suite, McGraw Hill. 3. R. Bose, Information Theory, Coding and Cryptography, McGraw Hill. 4. K. Sayood and M. Kaufman, Introduction to Data Compression, Elsevier.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105183/ 2. https://nptel.ac.in/courses/106/105/106105080/ 3. https://www.coursera.org/learn/tcpip 4. https://www.coursera.org/learn/fundamentals-network-communications			

Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC403	Operating Systems	03	-	-	03
Prerequisites:	Computer Programming (C / C++), Basic of Hardware i.e., ALU, RAM, ROM, HDD, etc., Computer-System Organization				
Course Objectives (COBs):	1. To understand the major components of Operating System & their functions. 2. To introduce the notion of a process and its management like transition, scheduling, etc. 3. To understand basic concepts related to Inter-Process Communication (IPC) like mutual exclusion, deadlock, etc. and role of Operating System in IPC. 4. To understand the concepts and implementation of memory management policies and virtual memory. 5. To understand functions of Operating System for storage management and device management. 6. To study the need and fundamentals of special-purpose Operating System with the advent of new emerging technologies.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the basic concepts related to Operating System. 2. Describe the process management policies and illustrate the scheduling of processes by CPU. 3. Apply synchronization primitives and evaluate deadlock conditions as handled by Operating System. 4. Explain the memory allocation and management functions of Operating Systems. 5. Explain the services provided by Operating System for storage management. 6. Compare the functions of various special-purpose Operating Systems.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Fundamentals of Operating System	Introduction to Operating Systems, Operating System Structure and Operations, Functions of Operating Systems.	CO1	01	03	
	Operating System Services and Interface, System Calls and its Types, System Programs, Operating System Structure, System Boot.	CO6	02		
2. Process Management	Basic Concepts of Process, Operation on Process, Process State Model and Transition, Process Control Block, Context Switching.	CO2	04	10	
	Introduction to Threads, Types of Threads, Thread Models.	CO2	01		
	Basic Concepts of Scheduling, Types of Schedulers, Scheduling Criteria, Scheduling Algorithms.	CO2	05		
3. Process Coordination	Basic Concepts of Inter-process Communication and Synchronization, Race Condition, Critical Region and Problem, Peterson’s Solution, Synchronization Hardware	CO3	04	08	

	and Semaphores, Classic Problems of Synchronization, Message Passing.			
	Introduction to Deadlocks, System Model, Deadlock Characterization, Deadlock Detection and Recovery, Deadlock Prevention, Deadlock Avoidance.	CO3	04	
4. Memory Management	Basic Concepts of Memory Management, Swapping, Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation.	CO4	05	09
	Basic Concepts of Virtual Memory, Demand Paging, Copy-on Write, Page Replacement Algorithms, Thrashing.	CO4	04	
5. Storage Management	Basic Concepts of File System, File Access Methods, Directory Structure, File System Implementation, Allocation Methods, Free Space Management.	CO5	03	06
	Overview of Mass-Storage Structure, Disk Structure, Disk Scheduling, RAID Structure, Introduction to I/O Systems.	CO5	03	
6. Special-Purpose Operating Systems	Open-source and Proprietary Operating System, Fundamentals of Distributed Operating System, Network Operating System, Embedded Operating Systems, Cloud and IoT Operating Systems, Real-Time Operating System, Mobile Operating System, Multimedia Operating System.	CO6	02	03
	Comparison between Functions of various Special-purpose Operating Systems.	CO6	01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. A. Silberschatz, P. Galvin, G. Gagne, Operating System Concepts, Wiley. 2. W. Stallings, Operating Systems: Internal and Design Principles, Pearson. 3. A. Tanenbaum, Modern Operating Systems, Pearson.			
Reference Books:	1. N. Chauhan, Principles of Operating Systems, Oxford University Press. 2. A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, Pearson. 3. R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform.			
Useful Links:	1. https://nptel.ac.in/courses/106/106/106106144/ 2. https://onlinecourses.nptel.ac.in/noc21_cs44/preview 3. https://www.coursera.org/learn/os-power-user			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC404	Automata Theory	03	-	-	03
Prerequisites:	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.				
Course Objectives (COBs):	1. To learn fundamentals of Regular and Context Free Grammars and Languages. 2. To understand the relation between Regular Language and Finite Automata and Machines. 3. To learn how to design Automata as Acceptors, Verifiers and Translators. 4. To understand the relation between Regular Languages, Contexts Free Languages, PDA and TM. 5. To learn how to design PDA as acceptor and TM as Calculators. 6. To learn applications of Automata Theory.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain, analyze and design Regular languages, Expression and Grammars. 2. Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator. 3. Analyze and design Context Free languages and Grammars. 4. Design different types of Push down Automata as Simple Parser. 5. Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine. 6. Explain applications of various Automata.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction and Regular Languages	Languages: Alphabets and Strings, Regular Languages: Regular Expressions, Regular Languages.	CO1	03	06	
	Regular Grammars, RL and LL Grammars.	CO1	02		
	Closure Properties.	CO1	01		
2. Finite Automata	Finite Automata: FA as Language Acceptor or Verifier.	CO2	02	09	
	NFA (with and without ϵ).	CO2	01		
	DFA, RE to NFA, NFA to DFA, Reduced DFA, NFA-DFA equivalence, FA to RE.	CO2	04		
	Finite State Machines with output: Moore and Mealy Machines. Moore and Mealy M/C Conversion. Limitations of FA.	CO2	02		
3. Context Free Grammars	Context Free Languages: CFG.	CO2	03	08	
	Leftmost and Rightmost derivations, Ambiguity.	CO3	02		
	Simplification and Normalization (CNF & GNF) and Chomsky Hierarchy (Types 0 to 3).	CO3	03		
4. Push Down Automata	Push Down Automata: Deterministic (Single Stack) PDA.	CO4	04	06	
	Equivalence between PDA and CFG. Power and Limitations of PDA.	CO4	02		

5. Turing Machine	Turing Machine: Deterministic TM.	CO5	04	07
	Variants of TM, Halting problem, Power of TM.	CO5	03	
6. Applications of Automata	Applications of FA.	CO2	01	03
	Applications of CFG.	CO3	01	
	Applications of PDA.	CO4		
	Applications of TM.	CO5	01	
	Introduction to Compiler & Its phases.	CO6		
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. J. Martin, Introduction to languages and the Theory of Computation, McGraw Hill. 2. K. Mahesh, Theory of Computation: A Problem-Solving Approach, Wiley. 3. A. Aho, R. Shethi, M. Lam and J. Ullman, Compilers Principles, Techniques and Tools, Pearson.			
Reference Books:	1. J. Hopcroft, R. Motwani and J. Ullman, Introduction to Automata Theory, Languages and Computation, Pearson. 2. D. Cohen, Introduction to Computer Theory, Wiley. 3. V. Kulkarni, Theory of Computation, Oxford University Press. 4. N. Chandrashekhar, K. Mishra, Theory of Computer Science, Automata Languages & Computations, PHI. 5. J. Donovan, Systems Programming, McGraw Hill. 6. S. Agrawal, Theoretical Computer Science, Vikas Publications.			
Useful Links:	1. https://nptel.ac.in/courses/111/103/111103016/ 2. https://online.stanford.edu/courses/soe-ycautomata-automata-theory 3. http://www.jflap.org/			
Continuous Assessment (CA):	<ul style="list-style-type: none">Continuous Assessment shall be conducted for Total 40 Marks, and includes —<ul style="list-style-type: none">Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks),Internal Assessment: 10 Marks.Duration of each Test shall be 1 Hour and 15 Minutes.Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.			
End Semester Examination (ESE):	<ul style="list-style-type: none">End Semester Exam shall be conducted for Total 60 Marks.Duration of End Semester Exam shall be 02 Hours and 30 Minutes.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC405	Computer Organization and Architecture	03	-	-	03
Prerequisites:	Basics of Logic Design.				
Course Objectives (COBs):	<div>1. To conceptualize the basics of organizational and features of a digital computer.</div> <div>2. To study microprocessor architecture and assembly language programming.</div> <div>3. To study processor organization and parameters influencing performance of a processor.</div> <div>4. To analyze various algorithms used for arithmetic operations.</div> <div>5. To study the function of each element of memory hierarchy and various data transfer techniques used in digital computer.</div> <div>6. To study microcontroller architecture and C language programming.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe basic organization of computer and the architecture of 8086 microprocessor and implement assembly language programming for 8086 microprocessors.</div> <div>2. Describe different control unit design methods and conceptualize instruction level parallelism.</div> <div>3. Apply fundamentals of digital logic design to solve problem & perform various arithmetic operations using various algorithms.</div> <div>4. Describe concept of memory organization and explain the function of each element of a memory hierarchy.</div> <div>5. Explain different methods for computer I/O mechanism.</div> <div>6. Describe the architecture of 8051 microcontroller and implement C language programming for 8051 microcontrollers.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Overview of Computer Architecture & Organization	Introduction of Computer Organization and Architecture, Basic Organization of Computer and Block Level Description of the Functional Units, Evolution of Computers, Von Neumann Model, Performance Measure of Computer Architecture.	CO1	03	05	
	Architecture of 8086 Family, Instruction Set, Addressing Modes.	CO1	02		
2. Processor Organization and Architecture	CPU Architecture, Instruction Formats, Basic Instruction Cycle with Interrupt Processing. Instruction Interpretation and Sequencing.	CO2	02	07	
	Control Unit: Soft Wired (Microprogrammed) and Hardwired Control Unit.	CO2	03		
	Microinstruction Sequencing and Execution, Micro Operations, Concepts of Nano Programming, Introduction to Parallel Processing Concepts, Flynn’s Classifications, Instruction Pipelining, Pipeline Hazards.	CO2	02		

3. Data Representation and Arithmetic Algorithms	Number Systems: Introduction to Number Systems, Binary Number Systems, Signed Binary Numbers, Binary, Octal, Decimal and Hexadecimal Number and their Conversions, 1's and 2's Complement	CO3	02	09
	Basics of Digital Circuits: NOT, AND, OR, NAND, NOR, EX-OR, EX-NOR Gates, Introduction to K-Mal	CO3	03	
	Booth's Algorithm, Division of Integers: Restoring and Non-Restoring Division, Signed Division.	CO3	04	
	Floating-Point Representation: IEEE 754 Floating Point (Single & Double Precision) Number Representation.	CO3	01	
4. Memory Organization	Introduction to Memory and Memory Parameters, Classifications of Primary and Secondary Memories, Types of RAM and ROM, Allocation Policies, Memory Hierarchy and Characteristics.	CO4	03	07
	Cache Memory: Concept, Architecture (L1, L2, L3), Mapping Techniques. Cache Coherency, Interleaved and Associative Memory.	CO4	04	
5. I/O Organization	Input/Output Systems, I/O Module-Need & Functions.	CO5	02	05
	Types of Data Transfer Techniques: Programmed I/O, Interrupt Driven I/O and DMA.	CO5	03	
6. Overview of 8051 Microcontroller	Introduction to Microcontroller, Difference between Microcontroller and Microprocessor.	CO6	04	08
	Architecture of 8051 Microcontroller, Pin Diagram of 8051, Instruction Set of 8051, C Language Programming, Interfacing of Ports.	CO6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. C. Hamacher, Z. Vranesic and S. Zaky, Computer Organization, McGraw Hill. 2. W. Stallings, Computer Organization and Architecture: Designing for Performance, Pearson. 3. J. Uffenbeck, 8086/8088 family: Design Programming and Interfacing, (Pearson Education). 4. M. Mazidi, J. Mazidi and R. McKinlay, The 8051 Microcontroller & Embedded systems using Assembly and C, Pearson. 5. R. Jain, Modern Digital Electronic, McGraw-Hill Publication.			
Reference Books:	1. L. Das, Embedded systems an integrated approach, Pearson. 2. B. Govindarajulu, Computer Architecture and Organization: Design Principles and Applications. 3. J. Hayes, Computer Architecture and Organization, McGraw Hill.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105163/ 2. https://www.udemy.com/course/computer-organization-and-architecture-j/ 3. https://www.udemy.com/course/computer-fundamental-computer-architecture/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. 			

	<ul style="list-style-type: none"> • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Lab Code		Lab Name		Credits			
				TH	P	TUT	Total
ITL402		Network Lab		-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.					
Software Requirements:		TCL, NS2.35, Ubuntu Operating System, Protocol Analyzer like Wireshark.					
Prerequisites:		Computer Programming (C / C++).					
Lab Objectives (LOBs):		1. To get familiar with the basic network administration commands. 2. To install and configure network simulator and learn basics of TCL scripting. 3. To understand the network simulator environment and visualize a network topology and observe its performance. 4. To implement client-server socket programs. 5. To observe and study the traffic flow and the contents of protocol frames. 6. To design and configure a network for an organization.					
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Execute and evaluate network administration commands and demonstrate their use in different network scenarios. 2. Demonstrate the installation and configuration of network simulator. 3. Demonstrate and measure different network scenarios and their performance behavior. 4. Implement the socket programming for client server architecture. 5. Analyze the traffic flow of different protocols. 6. Design a network for an organization using a network design tool.					
Lab No.	Experiment Title					LOs Mapped	Hours
0	Lab Prerequisites.					-	02
1	Execute and analyze basic networking commands: ifconfig, ip, traceroute, tracepath, ping, netstat, ss, dig, nslookup, route, host, arp, hostname, curl or wget, mtr, whois, tcpdump.					LO1	02
2	Installation and configuring of NS-2 simulator and introduction to TCL using Hello program.					LO2	02
3	Write TCL scripts to create topologies.					LO2	02
4	Analysis of network performance for quality-of-service parameters such as packet-delivery-ratio, delay and throughput by plotting xgraph.					LO3	02
5	Implement Distance Vector Routing Protocols.					LO3	02
6	Implement Link State Routing Protocols.					LO3	02
7	Installation and configuring of Graphical Network Simulator GNS- 3.					LO2	02
8	Implement Topology in GNS - 3.					LO3	02
9	Implement Socket Programming using TCP with C/Java/python: TCP Client, TCP Server.					LO4	02
10	Implement Socket Programming using UDP with C/Java/python: UDP Client, UDP Server.					LO4	02
11	Install one of the Network Protocol Analyser Tools and Analyse the Traffic.					LO5	02
12	Network Design for an organization using the following concepts: 1. Addressing (IP Address Assignment) 2. Naming (DNS)					LO6	04

	3. Routing		
Virtual Lab Links:	1. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/ 2. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/		
Term Work (TW):	1. Term work should consist of a minimum of 08 experiments. 2. Journal must include at least 02 assignments on content of theory course “Computer Network & Network Design” and “Network Lab”. 3. Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). 4. The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.		
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).		

Lab Code		Lab Name	Credits			
			TH	P	TUT	Total
ITL403		Unix Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.				
Software Requirements:		Unix / Ubuntu, Editor, VirtualBox.				
Prerequisites:		Computer Programming (C / C++).				
Lab Objectives (LOB):		1. To understand architecture and installation of Unix Operating System. 2. To learn Unix general purpose commands and programming in Unix editor environment. 3. To understand file system management and user management commands in Unix. 4. To understand process management and memory management commands in Unix. 5. To learn basic shell scripting. 6. To learn scripting using Awk and Perl languages.				
Lab Outcomes (LO):		Upon completion of the course, the learners will be able to: 1. Explain the functioning of Unix, and use various PC OS alternatives like CPU OS Simulator, Cloud OS, etc. 2. Apply the Unix general purpose commands. 3. Apply Unix commands for system administrative tasks such as file system management and user management. 4. Apply Unix commands for system administrative tasks such as process management and memory management. 5. Implement basic shell scripts for different applications. 6. Implement advanced scripts using Awk & Perl languages and grep, sed, etc. commands for performing various tasks.				
Lab No.	Experiment Title			LOs Mapped	Hours	
0	Lab Prerequisites.			-	02	
1	a. Case Study: Brief History of Unix, Unix Architecture; Installation of Unix Operating System. b. Installation and hands-on alternates for execution of Unix utilities: VirtualBox, VMware, etc.			LO1	02	
2	Study and hands-on with various editors like Vi, Vim, nano, pico, etc.			LO1	02	
3	Execution of Unix General Purpose Utility Commands like echo, clear, exit, date, time, uptime, cal, cat, tty, man, which, history, id, pwd, whoami, ping, ifconfig, pr, lp, lpr, lpstat, lpq, lprm, cancel, mail, etc.			LO2	02	
4	a. Study of Unix file system (tree structure), file and directory permissions, single and multiuser environment. b. Execution of File System Management Commands like ls, cd, pwd, cat, mkdir, rmdir, rm, cp, mv, chmod, wc, piping and redirection, grep, tr, echo, sort, head, tail, diff, comm, less, more, file, type, wc, split, cmp, tar, find, vim, gzip, bzip2, unzip, locate, etc.			LO3	02	
5	Execution of User Management Commands like who, whoami, su, sudo, login, logout, exit, passwd, useradd/adduser, usermod, userdel, groupadd, groupmod, groupdel, gpasswd, chown, chage, chgrp, chfn, etc.			LO3	02	

6	a. Execution of Process Management Commands like ps, pstree, nice, kill, pkill, killall, xkill, fg, bg, pgrep, renice, etc. b. Execution of Memory Management Commands like free, /proc/meminfo, top, htop, df, du, vmstat, demidecode, sar, pagesize, etc.	LO4	02
7	Implementation of Scheduling Algorithms using CPU OS Simulator.	LO1, LO4	02
8	a. Study of Shell, Types of Shell, Variables and Operators b. Execute the following Scripts (at least 6): <ul style="list-style-type: none"> i) Write a shell script to perform arithmetic operations. ii) Write a shell script to calculate simple interest. iii) Write a shell script to determine the largest among three integer numbers. iv) Write a shell script to determine if a given year is leap year or not. v) Write a shell script to print the multiplication table of given numbers using while statement. vi) Write a shell script to search whether an element is present in the list or not. vii) Write a shell script to compare two strings. viii) Write a shell script to read and check if the directory / file exists or not, if not make the directory / file. ix) Write a shell script to implement a menu-driven calculator using case statements. x) Write a shell script to print following pattern: <pre>* * * * * * *</pre> xi) Write a shell script to perform operations on directory like: display name of current directory, display list of directory contents, create another directory — write contents on that and copy it to a suitable location in your home directory, etc. 	LO5	06
9	Execute the following scripts using grep / sed commands: <ul style="list-style-type: none"> i) Write a script using grep command to find the number of words character, words and lines in a file. ii) Write a script using egrep command to display a list of specific types of files in the directory. iii) Write a script using sed command to replace all occurrences of a particular word in a given file. iv) Write a script using sed command to print duplicate lines in input. 	LO5	04
10	a. Execute the following scripts using Awk / Perl languages: <ul style="list-style-type: none"> i) Write an Awk script to print all even numbers in a given range. ii) Write an Awk script to develop a Fibonacci series (take user input for number of terms). iii) Write a Perl script to sort elements of an array. b. Write a Perl script to check a number is prime or not.	LO6	02
Virtual Lab Links / <ol style="list-style-type: none"> 1. https://www.ee.iitb.ac.in/~vlabsync/ 2. http://www.ee.surrey.ac.uk/Teaching/Unix/unix2.html 			

Learning Resources:	3. https://www.hackerrank.com/domains/shell 4. S. Das, Unix Concepts and Applications, McGraw Hill. 5. R. Michael, Mastering Unix Shell Scripting, Wiley. 6. D. Ambawade, D. Shah, Linux Labs and Open-Source Technologies, Dreamtech Press. 7. Y. Kanetkar, Unix Shell Programming, BPB Publications. 8. B. Forouzan and R. Gilberg, Unix and Shell Programming, Cengage Learning.
Term Work (TW):	1. Term work should consist of a minimum of 08 experiments. 2. Journal must include at least 02 assignments on content of the theory course “Operating Systems” and “Unix Lab”. 3. Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). 4. The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical (P):	Practical Examination will be based on the experiment list for Total 25 Marks.

Lab Code		Lab Name	Credits				
			TH	P	TUT	Total	
ITL405		Microprocessor and Microcontroller Lab		-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.					
Software Requirements:		Tasm, Keil / Crossware.					
Prerequisites:		Computer Programming (C / C++).					
Lab Objectives (LOBs):		1. To get hands-on experience with Assembly Language Programming. 2. To study interfacing of peripheral devices with 8086 microprocessors. 3. To realize techniques for faster execution of instructions and improve speed of operation and performance of microprocessors. 4. To write and debug programs in TASM / hardware kits / Crossware / Keil. 5. To get hands on experience with C Language Programming with controller. 6. To study interfacing of peripheral devices with 8051 microcontrollers.					
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Execute the selected instructions to understand addressing modes of 8086. 2. Execute assembly language programs on microprocessor using arithmetic and logical instructions of 8086 microprocessors. 3. Execute assembly language programs using loop instructions of 8086 microprocessors. 4. Execute the selected instructions to understand addressing modes of 8051. 5. Implement C language programs using instruction set of 8051. 6. Implement C language programs for interfacing different devices with 8051.					
Lab No.	Experiment Title				LOs Mapped	Hours	
0	Lab Prerequisites.				-	02	
1	Simulation of selected instructions to understand the addressing modes and instruction set of 8086 microprocessors.				LO1	02	
2	Implementation of Arithmetic and Logical operations using Assembly Language Programming. a. Program to perform arithmetic operations on 16-bit data. b. Program to evaluate given logical expression. c. Convert two-digit Packed BCD to Unpacked BCD.				LO2	02	
3	Implementations of loop operations using Assembly Language Programming. a. Program to move set of numbers from one memory block to another. b. Program to count number of 1's and 0's in a given 8-bit number. c. Program to find even and odd numbers from a given list. d. Program to search for a given number.				LO3	02	
4	Implementation of String Operations using Assembly Language Programming. a. Check whether a given string is a Palindrome or not. b. Compute the factorial of a positive integer 'n' using procedure. c. Generate the first 'n' Fibonacci numbers.				LO3	02	
5	Simulation of selected instructions to understand the addressing modes and instruction set of 8051 Microcontroller.				LO4	02	

6	<p>Implementation of Arithmetic and Logical operations using C Language Programming.</p> <p>a. Program to perform arithmetic operations on 16-bit data.</p> <p>b. Program to evaluate given logical expression.</p> <p>c. Convert two-digit Packed BCD to Unpacked BCD.</p>	LO5	02
7	<p>Implementations of loop operations using C Language Programming.</p> <p>a. Program to move set of numbers from one memory block to another.</p> <p>b. Program to count number of 1's and 0's in a given 8-bit number.</p> <p>c. Program to find even and odd numbers from a given list.</p> <p>d. Program to search for a given number.</p>	LO5	02
8	<p>Interfacing of 8051 Microcontroller.</p> <p>a. Program to toggle bits of port P0, P1, P2, P3.</p> <p>b. Program to interface Stepper Motor.</p> <p>c. Program to perform serial communication.</p>	LO6	06
9	Implementation of interfacing of LCD with the 8051 Microcontroller using C language programming.	LO6	02
10	<p>Interfacing with 8051 Microcontroller.</p> <p>a. Interfacing Seven Segment Display.</p> <p>b. Interfacing Keyboard Matrix.</p> <p>c. Interfacing DAC.</p>	LO6	04
Virtual Lab Links:	http://vlabs.iitkgp.ac.in/coa/		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Computer Organization and Architecture” and “Microprocessor and Microcontroller Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical (P):	Practical examination will be based on the experiment list for Total 25 Marks.		

PBL Course Code	PBL Course Name	Credits			
		TH	P	TUT	Total
ITPR42	PBL – Mini Project Lab II (Python-based Mini Project)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Python, MySQL.				
Prerequisites:	Computer Programming (C / C++), Fundamentals of Python.				
PBL Objectives (PROBs):	<ol style="list-style-type: none"> 1. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used. 2. To practice the process of identifying the needs and converting it into a problem statement. 3. To apply engineering knowledge and modern tools/technologies for deriving solutions to the real-world problems. 4. To inculcate the process of self-learning and research. 5. To be acquainted with solving the problem in a group. 6. To improve communication, management and report-writing skills of the students. 				
PBL Outcomes (PROs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none"> 1. Identify societal / research needs, formulate problem statements, review research literature, and analyze complex engineering problems. 2. Design suitable solutions for the problems including scope, objectives, timeline, system flow, user interface, algorithms, etc. 3. Gather, analyze, and interpret data — and apply knowledge of engineering fundamentals, modern tools / technologies for development of solutions. 4. Analyze sustainability and scalability of the developed solution and its impact in terms of environmental, societal, safety, legal, cultural, health, etc. aspects. 5. Apply ethical principles, excel in written and oral communication, and engage in independent and life-long learning. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects. 				
Guidelines for Project-Based Learning (PBL):	<ol style="list-style-type: none"> 1. Students have to form a team of minimum 02 and maximum 04 members, based on their area of interest and size of project. Interdisciplinary (inter-branch) teams are encouraged. 2. Students should develop a Web / Mobile Application with a proper user interface using any suitable technology like HTML5, CSS, etc. for front end and Python at backend. 3. Students should carry out a survey and identify needs, which shall be converted into problem statement for Mini Project in consultation with Faculty Guide, Internal committee of faculties, and the Head of Department. 4. Projects should compulsorily be based on societal contribution (healthcare, agriculture, etc.) and reflecting role of engineer in the society. Students should try to take up need-based live projects so as to get exposure to communication with beneficiaries and skills for understanding client requirements. 5. Based on the idea presentation as well as discussion on feasibility, novelty, and contribution of the idea, a project definition will be finalized. 6. Students shall submit their implementation plan in the form of Gantt / PERT / CPM chart, which will cover weekly activity of the Mini project. 7. A log book is to be prepared by each group, wherein the group can record weekly work progress and the Faculty Guide can verify and record notes / comments. 				

	<ol style="list-style-type: none"> 8. Faculty Guide may give inputs to students during Mini Project activity; however, focus shall be on self-learning. 9. Students in a group shall understand the problem effectively, propose multiple solutions, and select the best possible solution in consultation with their guide. 10. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate. 11. The solution is to be validated with proper justification and report to be compiled in standard format of the Department. 12. With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, if the problem statement is huge and significant, a same problem statement can be worked upon for 02 semesters, i.e., same Minor Project in Semesters V and VI. Projects with a very large scope can also be taken forward to higher semesters, in consultation with the Head of the Department. 13. Students are encouraged to participate in Technical Paper Presentation competitions. 14. The students' group shall complete a project in all aspects including: Identification of need / problem, proposed final solution, Procurement of components / systems / data, Building prototype and testing. 15. Three reviews will be conducted for continuous assessment: one shall be for finalization of the problem and proposed solution, second shall be for evaluation of work progress, and third shall be for evaluation of implementation and testing of solutions. 16. Mini Project shall be assessed based on following parameters: <ul style="list-style-type: none"> • Attainment of Course Outcomes. • Technical efficiency and quality of developed solution. • Innovativeness in solutions. • Impact on environment. • Cost effectiveness. • Sustainability analysis. • Societal impact. • Effective use of standard engineering norms. • Contribution of an individual as member or leader. • Clarity in written and oral communication. 17. Students are encouraged to publish a paper based on the work in Conferences / Student competitions.
Useful Learning Links:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc21_cs75/preview 2. https://www.coursera.org/specializations/python 3. https://www.udemy.com/course/the-complete-python-course/
Term Work (TW):	<ul style="list-style-type: none"> • Term Work shall be granted based individual's contribution in group activity, their understanding and response to questions. • Term Work evaluation shall be for Total 25 Marks — based on the following evaluation: <ul style="list-style-type: none"> ○ Presentation in Review 1 ○ Presentation in Review 2 ○ Presentation in Review 3 ○ Project Report and Log Book
Practical & Oral (P&O):	P&O examination will be of Total 25 Marks and shall be based on the Project Demonstration, Presentation, and Report.

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXS45	SAT – V: Skill-Based Learning (Python Programming)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Python, MySQL.				
Skill Prerequisites:	Computer Programming (C / C++, Java).				
Skill Objectives (SOBs):	<div>1. To understand basics of Python including data types, operator, conditional statements, looping statements, input and output functions in Python.</div> <div>2. To understand list, tuple, set, dictionary, string, array and functions in Python.</div> <div>3. To impart knowledge of Object-Oriented Programming concepts in Python.</div> <div>4. To explain concepts of modules, packages, multithreading and exception handling.</div> <div>5. To understand knowledge of File handling, GUI & Database Programming.</div> <div>6. To learn data visualization using Matplotlib, Data Analysis using Pandas and Web Programming using Flask.</div>				
Skill Outcomes (SOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe the structure, syntax, and semantics of the Python language.</div> <div>2. Interpret advanced data types and functions in Python.</div> <div>3. Illustrate the concepts of object-oriented programming as used in Python.</div> <div>4. Develop Python applications using modules, packages, multithreading and exception handling.</div> <div>5. Create solution with suitable GUI, File Handling functionalities and suitable database operations.</div> <div>6. Develop cost-effective robust applications using the latest Python trends and technologies.</div>				
Module No. and Name	Subtopics	SOs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Basics of Python	Introduction, Features, Python building blocks – Identifiers, Keywords, Indention, Variables and Comments, Basic Data types (Numeric, Boolean, Compound).	SO1	01	03	
	Operators: Arithmetic, Comparison, Relational, Assignment, Logical, Bitwise, Membership, Identity Operators, Operator Precedence.	SO1	01		
	Control Flow Statements: Conditional Statements (if, if...else, nested if) Looping in Python (while loop, for loop, nested loops) Loop Manipulation using continue, pass, break. Input / Output Functions, Decorators, Iterators and Generators.	SO1	01		

2. Advanced Datatypes and Functions	Lists: a) Defining lists, accessing values in List, deleting Values in List, Updating Lists b) Basic List Operations c) Built-in List Functions.	SO2	01	07
	Tuples: a) Accessing values in Tuples, deleting values in Tuples and updating Tuples b) Basic Tuple Operations c) Built-in Tuple Functions.	SO2	01	
	Dictionaries: a) Accessing values in Dictionary, deleting values in Dictionary and updating Dictionary. b) Basic Dictionary Operations c) Built-in Dictionary Functions.	SO2	01	
	Sets: a) Accessing values in Set, deleting values in Set, updating Sets b) Basic Set Operations. c) Built-in Set Functions.	SO2	01	
	Strings: a) String Initialization, Indexing, Slicing, Concatenation, Membership & Immutability b) Built-in String Functions.	SO2	01	
	Arrays: a) Working with Single dimensional Arrays: Creating, Importing, Indexing, Slicing, Copying and Processing Arrays. b) Working with Multi-Dimensional Arrays using Numpy: Mathematical Operations, Matrix Operations, Aggregate and other Built-in Functions.	SO2	01	
	Functions: a) Built-in Functions in Python. b) Defining Function, Calling Function, Returning Values, Passing Parameters. c) Nested and Recursive Functions d) Anonymous Functions (Lambda, Map, Reduce, Filter).	SO2	01	
3. Object-Oriented Programming	Overview of Object-oriented Programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces.	SO3	01	03
	Inheritance: Types of Inheritance (Single, Multiple, Multi -level, Hierarchical), super() Method, Constructors in Inheritance, Operator Overloading, Method Overloading, Method Overriding.	SO3	01	
	Abstract Class, Abstract Method, Interfaces in Python.	SO3	01	
4. Modules, Packages, Multithreading and Exception Handling	Modules: Writing Modules, Importing Objects from Modules, Python Built-in Modules (e.g. Numeric and Mathematical Module, Functional Programming Module, Regular Expression Module), Namespace and Scoping.	SO4	01	04
	Packages: Creating User Defined Packages and Importing Packages.	SO4	01	
	Multi -Threading: Process Vs Thread, use of Threads, Types of Threads, Creating Threads in Python, Thread Synchronization, Deadlock of Threads.	SO4	01	
	Exception Handling: Compile Time Errors, Runtime Errors, Exceptions, Types of Exception, Try Statement, Except Block, Raise Statement, Assert Statement, User - Defined Exceptions.	SO4	01	

5. File Handling, GUI & Database Programming	File Handling: Opening File in Different Modes, Closing A File, Writing to A File, Accessing File Contents Using Standard Library Functions, Reading from A File – read (), readLine (), readLines (), Renaming and Deleting a File, File Exceptions, Pickle in Python.	SO5	01	03
	Graphical User Interface (GUI): Different GUI Tools in Python (Tkinter, Pyqt, Kivy, etc.), Working with Containers, Canvas, Frame, Widgets (Button, Label, Text, Scrollbar, Check Button, Radio Button, Entry, Spinbox, Message, etc.) Connecting GUI with Databases to Perform CRUD Operations. (On Supported Databases Like Sqlite, Mysql, Oracle, Postgresql, etc.).	SO5	02	
6. Data Visualization, Analysis and Web Programming using Python	Visualization Using Matplotlib: Matplotlib with Numpy, Working with Plots (Line Plot, Bar Graph, Histogram, Scatter Plot, Area Plot, Pie Chart, etc.), Working with Multiple Figures.	SO6	01	05
	Data Manipulation and Analysis Using Pandas: Introduction to Pandas, Importing Data into Python, Series, Data Frames, Indexing Data Frames, Basic Operations with Data Frame, Filtering, Combining and Merging Data Frames, Removing Duplicates.	SO6	02	
	Scipy: Linear Algebra Functions using Numpy & Scipy.	SO6	01	
	Web Programming: Introduction to Flask, creating a Basic Flask Application, build a Simple REST API using Flask.	SO6	01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
Text Books:	1. R. Nageswara Rao, Core Python Programming, Dreamtech Press, Wiley. 2. M. Savaliya, R. Maurya, Programming through Python, StarEdu Solutions. 3. E. Balagurusamy, Introduction to Computing and Problem-solving using Python, McGraw Hill.			
Reference Books:	1. Z. Shaw, Learn Python 3 the Hard Way, Zed Shaw's Hard Way Series. 2. M. Brown, Python: The Complete Reference, McGraw Hill. 3. P. Barry, Head First Python, 2nd Edition, O'Reilly Media.			
Useful learning Links:	1. https://docs.scipy.org/doc/numpy/user/quickstart.html 2. https://matplotlib.org/tutorials/ 3. https://pandas.pydata.org/docs/getting_started/ 4. https://www.geeksforgeeks.org/python-build-a-rest-api-using-flask/ 5. https://python-iitk.vlabs.ac.in/			
Guidelines for Skill-Based Learning (SBL):	<ul style="list-style-type: none">Programming labs shall be conducted as 02 Hours of blended theory and hands-on session.The classes will be conducted as a flipped classroom, where students have to attend class after reviewing the lessons provided to them beforehand.			

	<ul style="list-style-type: none"> • Discussion on the topics and implementation of programs involving the concepts mentioned will be performed during the assigned lab hours.
Term Work (TW):	<ul style="list-style-type: none"> • Term Work evaluation shall be for Total 25 Marks based on Practical Performance. • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXS46	SAT – VI: Skill-Based Learning (Foreign and/or Indian Regional Languages – II)	-	01	-	01
Skill Objectives (SOBs):	1. Acquire reading and writing proficiency in the target language 2. Understand the common heritage of, and diversity among, countries that speak the target language. 3. Communicate and interact effectively with citizens of the target cultures				
Skill Outcomes (SOs):	Upon completion of the course, the learners will be able to: 1. Demonstrate of communicative proficiency in the target language. 2. Write the target language in formal expository prose that impede communication. 3. Learn through MOOC online courses to adopt hybrid mode of learning.				
Guidelines for Skill-Based Learning (SBL):	Each student has to complete any one Foreign and/or Indian Language MOOC course from NPTEL / Coursera / Udemy, etc. sites referring the given suggestive list of courses, but not limited to the list as it is a learner's choice for the interested course, to be completed during the semester time frame.				
Sr. No.	Suggestive List of Courses				
1	Introduction to Japanese Language and Culture				
2	German – II and III				
3	The Psychology of Language				
4	Spanish Vocabulary: Meeting People, Cultural Experience, Sports, Travel, and the Home, Careers and Social Events, Spanish Vocabulary Project				
5	A Bridge to the World: Korean Language for Beginners, First Step Korean, Learn to Speak Korean 1, The Korean Alphabet: An Introduction to Hangeul				
6	Complete French Course: Learn French for Beginners				
7	Complete German Course: Learn German for Beginners				
8	Spanish 1-4: Beginner, Elementary, Intermediate and Advanced				
9	Complete Japanese Course: Learn Japanese for Beginners				
10	Complete Korean Course: Learn Korean for Beginners				
11	The Complete Russian Language Course				
12	Spoken Sanskrit: Basic and Intermediate Levels				
13	Applied Linguistics				
14	Fundamental Concepts in Sociolinguistics				
15	Introduction to Basic Spoken Sanskrit and Intermediate level to Basic Spoken Sanskrit				
Learning Resources (Suggestive Courses Links but not limited to these only):	1. https://onlinecourses.nptel.ac.in/noc22_hs84/preview 2. https://onlinecourses.nptel.ac.in/noc22_hs89/preview 3. https://onlinecourses.nptel.ac.in/noc22_hs123/preview 4. https://www.coursera.org/learn/spanish-vocabulary-meeting-people 5. https://www.coursera.org/learn/spanish-vocabulary-cultural-experience 6. https://www.coursera.org/learn/spanish-vocabulary-sports-travel-home 7. https://www.coursera.org/learn/spanish-vocabulary-careers 8. https://www.coursera.org/learn/spanish-vocabulary-project 9. https://www.coursera.org/learn/korean-beginners 10. https://www.coursera.org/learn/learn-korean				

	11. https://www.coursera.org/learn/learn-speak-korean1 12. https://www.coursera.org/learn/the-korean-alphabet-an-introduction-to-hangeul 13. https://www.udemy.com/course/complete-french-course/ 14. https://www.udemy.com/course/complete-german-course-learn-german-for-beginners/ 15. https://www.udemy.com/course/spanish-101-beginning-spanish-spanish-for-beginners/ 16. https://www.udemy.com/course/complete-japanese-course-learn-japanese-for-beginners-lvl-1/ 17. https://www.udemy.com/course/complete-korean-course-learn-korean-for-beginners-level-1/ 18. https://www.udemy.com/course/the-complete-russian-language-course/ 19. https://onlinecourses.nptel.ac.in/noc22_hs114/preview 20. https://onlinecourses.nptel.ac.in/noc22_hs85/preview 21. https://onlinecourses.nptel.ac.in/noc22_hs139/preview
Term Work (TW):	Term Work evaluation shall be for Total 25 Marks based on progress and completion of the course.

SEMESTER V - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC501	Internet Programming	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC502	Computer Network Security	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC503	Entrepreneurship and E-Business	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC504	Internet of Things	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC505	Department Level Elective – I	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITL501	Internet Programming Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL502	Security Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL504	IoT Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL505	Department Level Elective – I Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITL506	Business Communication & Ethics	0 – 4** – 0	04	0 – 2 – 0	02	BS
ITPR53	PBL – Minor Project Lab I (IoT with Web Application Development)	0 – 2 – 0	02 ^{\$}	0 – 1 – 0	01	PBL
ITXS57	SAT – VII: Skill-Based Learning (Aptitude / Logic Building & Competitive Programming)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXT58	SAT – VIII: Technology-Based Learning	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		15 – 18 – 0	33	15 – 9 – 0	24	

*SAT can be conducted as TH or P or both as required.

^{\$}Load of learner, not the faculty.

**02 Hours class-wise and 02 Hours batch-wise.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC501	Internet Programming	30	30	30	10	60	-	-	-	-	100
ITC502	Computer Network Security	30	30	30	10	60	-	-	-	-	100
ITC503	Entrepreneurship and E-Business	30	30	30	10	60	-	-	-	-	100
ITC504	Internet of Things	30	30	30	10	60	-	-	-	-	100
ITDLC505	Department Level Elective – I	30	30	30	10	60	-	-	-	-	100
ITL501	Internet Programming Lab	-	-	-	-	-	25	-	25	-	50
ITL502	Security Lab	-	-	-	-	-	25	-	-	-	25
ITL504	IoT Lab	-	-	-	-	-	25	-	-	25	50
ITDLL505	Department Level Elective – I Lab	-	-	-	-	-	25	-	-	-	25
ITL506	Business Communication & Ethics	-	-	-	-	-	25	25	-	-	50
ITPR53	PBL – Minor Project Lab I (IoT with Web Application Development)	-	-	-	-	-	25	-	-	25	50
ITXS57	SAT – VII: Skill-Based Learning (Aptitude / Logic Building & Competitive Programming)	-	-	-	-	-	25	-	-	-	25
ITXT58	SAT – VIII: Technology-Based Learning	-	-	-	-	-	25	-	-	-	25
Total		150	150	150	50	300	200	25	25	50	800

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, BS – Basic Science Course, PBL – Project-Based Learning, SAT – Skill / Activity / Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses and Labs (PE-DLC – I)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Advanced Database Management System and Information Retrieval (ITDLC5051)	Wireless Technology (ITDLC5052)	Computer Graphics (ITDLC5053)	Advanced Data Structures and Algorithmic Performance Analysis (ITDLC5054)
Advanced Databases and Information Retrieval Lab (ITDLL5051)	Sensor Network Lab (ITDLL5052)	Computer Graphics Lab (ITDLL5053)	Algorithmic Analysis Lab (ITDLL5054)

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC501	Internet Programming	03	-	-	03
Prerequisites:	Knowledge of Basic Programming, Basic HTML and CSS.				
Course Objectives (COBs):	1. To orient students to Web Programming fundamental. 2. To expose students to JavaScript to develop interactive web page development. 3. To design front end application using basic React. 4. To expose students to advanced concepts in React. 5. To orient students to Fundamentals of Node.js. 6. To expose students to Node.js applications using express framework.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe protocols or technologies required for various web applications. 2. Apply JavaScript to add functionality to web pages. 3. Design front-end application using basic React. 4. Design front-end applications using functional components of React. 5. Design back-end applications using Node.js. 6. Develop web based Node.js applications using Express.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Web Programming Fundamentals	Working of Web Browser, HTTP Protocol, HTTPS, DNS, TLS.	CO1	01	04	
	XML Introduction, JSON Introduction, DOM, URL, URI, REST API.	CO1	03		
2. JavaScript	Introduction to ES6, Difference Between ES5 and ES6.	CO2	02	08	
	Variables, Condition, Loops, Functions, Events, Arrow Functions.	CO2	02		
	Setting CSS Styles Using JavaScript, DOM Manipulation, Classes and Inheritance.	CO2	02		
	Iterators and Generators, Promise, Client-Server Communication, Fetch.	CO2	02		
3. React Fundamentals	Installation, Installing Libraries, Folder and File Structure, Components, Component Lifecycle, State and Props.	CO3	03	07	
	React Router and Single Page Applications, UI Design, Forms.	CO3	02		
	Events, Animations, Best Practices.	CO3	02		
4. Advanced React	Functional Components - Refs, Use effects, Hooks, Flow architecture.	CO4	03	07	
	Model - View-Controller Framework, Flux.	CO4	02		
	Bundling the Application. Web Pack.	CO4	02		
5. Node.js	Environment Setup, First App, Asynchronous Programming, Callback Concept.	CO5	03	07	

	Event Loops, REPL, Event Emitter.	CO5	01	
	Networking Module, Buffers, Streams, File System, Web Module.	CO5	03	
6. Express	Introduction, Express Router, REST API.	CO6	02	06
	Generator, Authentication, Sessions.	CO6	02	
	Integrating with React.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. V. Subramaniam, Rediscovering JavaScript, Master ES6, ES7, and ES8, Pragmatic Bookshelf. 2. A. Banks and E. Porcello, Learning React Functional Web Development with React and Redux, O'Reilly. 3. D. Bugl, Learning Redux, Packt Publication. 4. A. Mead, Learning Node.js Development, Packt Publishing. 			
Reference Books:	<ol style="list-style-type: none"> 1. E. Brown, Web Development with Node and Express, O'Reilly. 2. V. Bojinov, RESTful Web API Design with Node.js 10, Packt Publication. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://reactjs.org/tutorial/tutorial.html 2. https://react-redux.js.org/introduction/quick-start 3. https://webpack.js.org/ 4. https://www.youtube.com/watch?v=-27HAh8c0YU 5. https://www.coursera.org/specializations/website-development 6. https://onlinecourses.nptel.ac.in/noc20_cs52/preview 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC502	Computer Network Security	03	-	-	03
Prerequisites:	Basic Concepts of Computer Network, Network Design, Operating Systems.				
Course Objectives (COBs):	<div>1. To learn the basic concepts of computer and network security.</div> <div>2. To understand various cryptographic algorithms including secret key management and different authentication techniques.</div> <div>3. To learn different types of malicious software and its effect on the security.</div> <div>4. To provide knowledge of various secure communication standards including IPsec, SSL/TLS and email.</div> <div>5. To learn Network Management Security and Network Access Control techniques in Computer Security.</div> <div>6. To study different attacks on networks and infer the use of firewalls and security protocols.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Apply the fundamentals concepts of computer security and network security.</div> <div>2. Apply the cryptographic techniques using classical and block encryption methods.</div> <div>3. Describe the system security malicious software.</div> <div>4. Describe the network layer security, transport layer security and application layer security.</div> <div>5. Explain the need of Network Management Security and illustrate the need for NAC.</div> <div>6. Compare functions of an IDS and firewall for the system security.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Network Security & Cryptography	Computer Security and Network Security (Definition), CIA, Services, Mechanisms and Attacks, The OSI Security Architecture, TCP/IP Model, Network Security Model.	CO1	04	08	
	Classical Encryption Techniques (Mono-Alphabetic and Poly-Alphabetic Substitution Techniques: Vigenere Cipher, Playfair Cipher, Transposition Techniques: Keyed and Keyless Transposition Ciphers), Introduction to Steganography.	CO1	04		
2. Key Management, Distribution and User Authentication	Block Cipher Modes of Operation, Data Encryption Standard, Advanced Encryption Standard (AES), RC5 Algorithm.	CO2	03	09	
	Public Key Cryptography: RSA Algorithm. Hashing Techniques: SHA256, SHA-512, HMAC and CMAC.	CO2	03		
	Digital Signature Schemes – RSA, DSS. Remote User Authentication Protocols, Kerberos, Digital Certificate: X.509, PKI.	CO2	03		

3. Malicious Software	SPAM, Trojan Horse, Viruses, Worms, System Corruption, Attack Agents, Information Theft, Trapdoor, Key Loggers.	CO3	02	04
	Phishing, Backdoors, Rootkits, Denial of Service Attacks, Zombie.	CO3	02	
4. IP Security, Transport Level Security and Email Security	IP Level Security: Introduction to IPsec, IPsec Architecture, Protection Mechanism (AH and ESP).	CO4	02	08
	Transport Level Security: VPN, Need Web Security Considerations, Secure Sockets Layer (SSL) Architecture, Transport Layer Security (TLS), HTTPS, Secure Shell (SSH) Protocol Stack.	CO4	04	
	Email Security: Secure Email S/MIME, Screen Reader Support Enabled.	CO4	02	
5. Network Management Security and Network Access Control	Network Management Security: SNMPv2 and SNMPv3.	CO5	02	06
	NAC: Principal Elements of NAC, Principal NAC Enforcement Methods, How to Implement NAC Solutions, Use Cases for Network Access Control.	CO5	04	
6. System Security	Intrusion Detection System, Intrusion Prevention System.	CO6	01	04
	Firewall Design Principles, Characteristics of Firewalls, Types of Firewalls.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. W. Stallings, Cryptography and Network Security, Principles and Practice, Pearson. 2. B. Ferouzan, Cryptography & Network Security, McGraw Hill. 3. M. Stamp, Mark Stamp's Information Security Principles and Practice, Wiley. 4. B. Menezes, Cryptography & Network Security, Cengage Learning.			
Reference Books:	1. B. Schneier, Applied Cryptography, Protocols, Algorithms and Source Code in C, Wiley. 2. A. Kahate, Cryptography and Network Security, McGraw Hill.			
Useful Links:	1. https://nptel.ac.in/courses/106/107/106107155/ 2. https://nptel.ac.in/courses/106/105/106105031/ 3. https://nptel.ac.in/courses/106/106/106106221/ 4. https://www.rsa.com			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits				
		TH	P	TUT	Total	
ITC503	Entrepreneurship and E-Business	03	-	-	03	
Prerequisites:	Fundamentals of Technology.					
Course Objectives (COBs):	1. To distinguish entrepreneur and entrepreneurship starting and feasibility study. 2. To realize the skills required to be an entrepreneur. 3. To acquaint the students with challenges of starting new ventures. 4. To identify the right sources of fund for starting a new business. 5. To familiarize students with concept of E-business models. 6. To understand various E-business strategies.					
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the concept of entrepreneurship and its close relationship with enterprise and owner-management. 2. Explain characteristics of entrepreneurship & leadership. 3. Analyze the factors for starting a new venture and business development. 4. Analyze issues and decisions involved in financing and resourcing a business start-up. 5. Describe various e-business models. 6. Explain strategic initiatives for CRM, SCM, etc.					
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module		
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02		
1. Introduction	Concept, Meaning and Definition of Entrepreneur and Entrepreneurship, Evolution of Entrepreneurship.	CO1	01	04		
	Role of Entrepreneurship in Economic Development, Managerial vs Entrepreneurial Approach.	CO1	01			
	Classification and Types of Entrepreneurs. Characteristics and Qualities of Successful Entrepreneurs.	CO1	01			
	Women Entrepreneurs, Corporate & Social Entrepreneurship.	CO1	01			
2. Entrepreneurship Development and Leadership	Entrepreneurial Motivation: Motivating Factors, Types of Start-Ups, Characteristics of Entrepreneurial Leadership.	CO2	01	06		
	Components of Entrepreneurial Leadership: Factors Influencing Entrepreneurial Development and Motivation, Entrepreneurial Opportunities and Challenges, Entrepreneurship Process.	CO2	01			
	Types of Enterprises and Ownership Structure: Small Scale, Medium Scale and Large-Scale Enterprises.	CO2	02			
	Meaning and Definition (Evolution), Role of Small Enterprises in Economic Development, Proprietorship.	CO2	02			
	Policies Governing SMEs, Partnership, Ltd.					
	Companies and Co-operatives: Their Formation, Capital Structure and Source of Finance.					

3. New Venture Planning	Methods to Initiate Ventures: Acquisition, Advantages of Acquiring an Ongoing Venture and Examination of Key Issues.	CO3	01	07
	Developing a Marketing Plan-Customer Analysis, Sales Analysis and Competition Analysis.	CO3	03	
	Business Plan-Benefits of Drivers, Perspectives in Business Plan Preparation, Elements of a Business Plan, Business Plan Failures.	CO3	03	
4. Financing and Managing Venture	Financing Stages, Sources of Finance: Venture Capital, Criteria for Evaluating New-Venture Proposals & Capital-Process.	CO4	02	06
	Management of Venture: Objectives and Functions of Management, Scientific Management, General and Strategic Management.	CO4	02	
	Introduction to Human Resource Management: Planning, Job Analysis, Training, Recruitment and Selection.	CO4	02	
5. Overview of E-business	Concept of E-Business, Business Success Through Adoption of Technology, Information Management for Business Initiatives, Performance Improvement Through E-Business.	CO5	02	08
	Introduction to Various Collaborative Partnerships, E-Commerce: Sectors of E-Commerce, B2C, B2B and C2C Ecommerce, E-Commerce Success Factors, Clicks and Bricks in E-commerce, Collaborative Commerce.	CO5	03	
	E-Marketplace, M-Commerce, E-Government; Various E-Business Models, Challenges of the E-Business Models, Globalization of E-Business.	CO5	03	
6. Strategic Initiatives for Technology	Customer Relationship Management: The Evolution of CRM, Functional Areas of CRM, Contemporary Trends - SRM, PRM, ERM, Future Trends of CRM.	CO6	02	08
	Enterprise Resource Planning: Core and Extended ERP, Components of ERP System, Benefits and Risks of ERP Implementation.	CO6	02	
	Supply Chain Management: Meaning, Definition, Importance, and Characteristics of SCM, Elements of SCM, Push & Pull Supply Chain Model, Use of E-Business to Restructure Supply Chain, Supply Chain Management Implementation.	CO6	02	
	Procurement: Meaning and Advantages of E-Procurement, Types & Drivers of E-Procurement, Components of E-Procurement Systems, Implementation of E-Procurement.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. R. Hisrich, M. Peters, and D. Shepherd, Entrepreneurship, McGraw Hill. 2. H. David, Entrepreneurship: New venture creation, PHI.			

	3. D. Chaffey, E- Business & E- Commerce Management: Strategy, Implementation, Pearson. 4. P. Joseph, E-commerce – A Managerial Perspective, PHI.
Reference Books:	1. F. Zhao, Entrepreneurship and Innovations in E-business an Integrative Perspective, Idea Group Publications. 2. A. Stephen and H. Baltzan, Business Driven Technology, McGraw Hill. 3. D. Chaffey and T. Hemphill, Digital Business and E-commerce Management, Pearson. 4. R. Kalakota and R. Marcia, E-Business 2.0 Roadmap for Success, Pearson.
Useful Links:	1. https://nptel.ac.in/courses/110/106/110106141/ 2. https://www.coursera.org/specializations/wharton-entrepreneurship 3. https://www.udemy.com/course/the-complete-business-plan-course/ 4. https://nptel.ac.in/courses/110/105/110105083/
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC504	Internet of Things	03	-	-	03
Prerequisites:	Computer Organization & Architecture, Microprocessor & Microcontroller, Computer Networks.				
Course Objectives (COBs):	<div>1. To describe the fundamental knowledge and basic technical competence in the field of Internet of Things (IoT).</div> <div>2. To explain the different sensors, devices and application protocols for IoT and apply IoT knowledge to key industries that IoT is revolutionizing.</div> <div>3. To emphasize on Arduino board architecture to build embedded C programs with interfacing of different sensors and hardware.</div> <div>4. To emphasize on Raspberry pi board architecture to build embedded C programs with interfacing of different sensors and hardware.</div> <div>5. To develop IoT application by learn frameworks and software platforms for useful projects or products.</div> <div>6. To explore various application domains for developing IoT projects for each platform that can be undertaken by a student.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe the concepts of IoT and the Things in IoT.</div> <div>2. Emphasize interfacing and application protocols, sensors, actuators for IoT.</div> <div>3. Apply IoT knowledge to design solutions for key industries and societal problems.</div> <div>4. Examine various IoT hardware items and software platforms used in projects.</div> <div>5. Identify data management, business processes and analytics of IoT.</div> <div>6. Explain the platforms for development of small IoT applications for societal problems.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Internet of Things (IoT)	Understanding IoT Fundamentals, IoT Layer Architecture, IoT Platforms, Overview of IoT Components.	CO1	03	05	
	IoT Communication Technologies, Real Time Examples (Applications) of IoT, Challenges in IoT.	CO1	02		
2. Sensor, Actuators and Protocols	Interfacing Protocols: I2C, SPI and Serial.	CO2	02	08	
	Communication Protocol: RFID, NFC, Bluetooth, Wifi, ZigBee.	CO2	02		
	Sensors-Light Sensor, Temperature Sensor with Thermistor, Voltage Sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with Ultrasound Sensors, RTC-DS3231.	CO2	02		
	Actuators - Connecting LED, Buzzer, Switching High Power Devices with Transistors, Controlling AC Power Devices with Relays, Controlling Servo Motor,	CO2	02		

	Speed Control of DC Motor, Unipolar and Bipolar Stepper Motors.			
3. Arduino	Arduino Development Board, Architecture and Pin Diagram.	CO3	02	07
	Writing Arduino Software, Arduino Libraries, Basics of Embedded C Programming.	CO3	02	
	Interfacing Arduino with Sensors, Actuators and Peripheral Devices, Watchdog Timer.	CO3	03	
4. Raspberry Pi Hardware Interfacing	Introduction to Raspberry Pi Development Board, Architecture and Pin Diagram.	CO4	03	06
	Interfacing Raspberry Pi with Different Sensors, Actuators, Peripheral Devices, Open-Source Platforms- ThingSpeak, ThingsBoard, OpenRemote.	CO4	03	
5. Raspberry Pi Software Interfacing	Introduction to Raspbian Operating System, Setting up Python on Raspberry Pi, Python Programming Using Raspberry Pi.	CO5	03	06
	Interfacing Raspberry Pi with Blynk IO Cloud and Cayenne IO Cloud Server.	CO5	03	
6. Software Testing and Maintenance	IoT Physical Servers and Cloud Offerings, Introduction to Cloud Storage Models.	CO5	03	07
	Communication APIs Webserver – Web Server for IoT, Python Web Application.	CO5	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton and J. Henry, IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things, Pearson. 2. H. Chaouchi, The Internet of Things – Connecting Objects to the Web, Wiley. 3. M. Margolis, Arduino Cookbook, O'Reilly. 4. S. Monk, Raspberry Pi Cookbook, Software and Hardware Problems and solutions, O'Reilly. 			
Reference Books:	<ol style="list-style-type: none"> 1. Bahga and V. Madisetti, Internet of Things – Hands-On Approach, Universities Press. 2. A. McEwen & H. Cassimally, Designing the Internet of Things, Wiley. 3. D. Norris, Raspberry Pi – Projects for the Evil Genius, McGraw Hill 4. A. Tamboli, Build Your Own IoT Platform, Apress. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106/105/106105166/ 2. https://nptel.ac.in/courses/108/108/108108179/ 3. https://www.coursera.org/specializations/iot 4. https://www.coursera.org/specializations/uiuc-iot 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC5051	Advanced Databases and Information Retrieval	03	-	-	03
Prerequisites:	Database Management System.				
Course Objectives (COBs):	<div>1. To impart knowledge related to query processing and query optimization phases of a database management system.</div> <div>2. To learn advanced techniques for data management and to overview emerging data models like Temporal, Mobile, and Spatial database.</div> <div>3. To classify various Information retrieval models.</div> <div>4. To create awareness of how enterprise can organize and analyse large amounts of data by creating a Data Warehouse and to introduce students to data science and problem solving with data science and statistics.</div> <div>5. To understand the process of data extraction, transformation and loading.</div> <div>6. To evaluate the significance of various indexing and searching techniques for information retrieval.</div>				
Course Outcomes (COs):	<div>On successful completion, of course, learner will be able to:</div> <div>1. Calculate query costs and find the alternate efficient paths for query execution.</div> <div>2. Apply sophisticated access protocols to control access to the database.</div> <div>3. Describe the taxonomy of different information retrieval models.</div> <div>4. Analyze strategic data in an enterprise and to design a data Warehouse structure.</div> <div>5. Analyze data using OLAP operations for strategic decision-making process.</div> <div>6. Apply various indexing and searching techniques.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Query Processing and Optimization	Overview: Introduction, Query Processing in DBMS, Steps of Query Processing.	CO1	03	07	
	Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions.	CO1	04		
2. Advanced Data Management Techniques	Advanced Database Access Protocols: Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role-Based Access Control, Remote Database Access Protocol.	CO2	04	10	
	Advanced Database Models Like Mobile Databases, Temporal Databases, Spatial Databases, Object Oriented Database & Object Relational Database.	CO2	03		
	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in Distributed Databases.	CO2	03		
3. Data Warehousing, Dimensional	The Need for Data Warehousing; Data Warehouse Defined, Relevance of Data Warehouse in the age of Big Data, Features of a Data Warehouse.	CO4, CO5	02	09	
	Data Warehouse Architecture - Enterprise or	CO4,	02		

Modelling and OLAP	Centralized, Federated and Multitier Architectures, Data Warehouse and Data Marts, Data Warehousing Design Strategies.	CO5		
	Data Modelling - Dimensional Model, The Star Schema, Executing a Query, The Snowflake Schema; Fact Tables and Dimension Tables, Factless Fact Table; Updates to Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys.	CO4, CO5	02	
	Need for Online Analytical Processing; OLAP Operations in a Cube: Roll-up, Drill-down, Slice, Dice, Pivot; OLAP Architectures: MOLAP, ROLAP, DOLAP and HOLAP.	CO4, CO5	03	
4. ETL Process	Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction.	CO4	02	03
	Data Transformation: Tasks Involved in Data Transformation, Techniques of Data Loading.	CO4	01	
5. Information Retrieval & IR Models	Motivation, Basic Concepts, The Retrieval Process, Information System Components, Parts and Types on Information System; Definition and Objectives on Information Retrieval System.	CO3	02	06
	Modeling: Taxonomy of Information Retrieval Models, Retrieval: Adhoc and Filtering, Formal Characteristics of IR Models, Classic Information Retrieval.	CO3	02	
	Alternative Set Theoretic Models, Probabilistic Models, Structured Text Retrieval Models, Models for Browsing; Multimedia IR Models: Data Modeling.	CO3	02	
6. Indexing and Searching	Indexing and Searching Inverted Files, Other Indices for Text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries, Compression.	CO6	02	04
	Multimedia IR: Indexing and Searching - Spatial Access Methods, A Generic Multimedia Indexing Approach, One-dimensional Time Series, Two-dimensional Color Images, Automatic Feature Extraction.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. H. Korth, A. Silberchatz and S. Sudarshan: Database System Concepts, McGraw Hill. 2. R. Elmasri and S. Navathe, Fundamentals of Database Systems, Pearson. 3. P. Ponniah, Data Warehousing: Fundamentals for IT Professionals, Wiley. 4. R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw Hill. 5. R. Baeza-Yates and B. Ribeiro- Neto, Modern Information Retrieval, Addison Wesley. 6. G. Kowaski, Information Retrieval Systems: Theory and Implementation, Kluwer Academic Publisher. 			

Reference Books:	<ol style="list-style-type: none"> 1. T. Reema, Data Warehousing, Oxford University Press. 2. R. Kimball and M. Ross, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Wiley India. 3. H. Kamber, Data Mining Concepts and Techniques, Morgan Kaufmann. 4. P. Rob and C. Coronel, Database Systems Design, Implementation and Management, Thomson Learning. 5. C. Manning and P. Raghavan, Introduction to Formation Retrieval Cambridge University Press.
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106/105/106105175/ 2. https://www.coursera.org/specializations/database-systems 3. https://www.udemy.com/topic/database-management/ 4. https://www.coursera.org/learn/text-retrieval 5. https://nptel.ac.in/courses/106/101/106101007/ 6. https://www.udemy.com/course/information-retrieval-and-mining-massive-data-sets/
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC5052	Wireless Technology	03	-	-	03
Prerequisites:	Principle of Communication, Computer Network, Computer Network Security.				
Course Objectives (COBs):	1. To discuss the fundamentals of Wireless Communication. 2. To comprehend the fundamental principles of Wide Area Wireless Networking Technologies and their Applications. 3. To explain Wireless Metropolitan and Local Area Networks. 4. To describe Wireless Personal Area Networks and Ad hoc Networks. 5. To learn and analyze Wireless Network Security Standards. 6. To study the design considerations for Wireless Networks.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the basic concepts of Wireless Network and Wireless Generations. 2. Describe the various Wide Area Wireless Technologies. 3. Analyze the prevalent IEEE Standards used for implementation of WLAN and WMAN Technologies. 4. Analyze the importance of WPAN, WSN and Ad-hoc Networks. 5. Analyze various Wireless Network Security Standards. 6. Apply the design considerations for deploying the Wireless Network Infrastructure.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Fundamentals of Wireless Communication	Introduction to Wireless Communication - Advantages, Disadvantages and Applications, Multiple Access Techniques - FDMA, TDMA, CDMA, OFDMA.	CO1	02	07	
	Spread Spectrum Techniques – DSSS, FHSS.	CO1	01		
	Evolution of Wireless generations – 1G to 5G (Based on Technological Differences and Advancements), 5G – Key Requirements and Drivers of 5G Systems, Use Cases, Massive MIMO.	CO1	04		
2. Wide Area Wireless Networks	Principle of Cellular Communication – Frequency Reuse Concept, Cluster Size and System Capacity, Co-Channel Interference and Signal Quality.	CO2	03	08	
	GSM – System Architecture, GSM Radio Subsystem, Frame Structure.	CO2	01		
	GPRS and EDGE – System Architecture, UMTS – Network Architecture.	CO2	03		
	CDMA 2000 –Network Architecture, LTE – Network Architecture, Overview of LoRa & LoRa WAN.	CO2	01		
3. Wireless Metropolitan and Local Area Networks	IEEE 802.16 (WiMax) – Mesh Mode, Physical and MAC layer.	CO3	04	08	
	IEEE 802.11(Wi-Fi) – Architecture, Protocol Stack, Enhancements and Applications.	CO3	04		

4. Wireless Personal Area Networks and Ad hoc Networks	IEEE 802.15.1 (Bluetooth) – Piconet, Scatter Net, Protocol Stack, IEEE 802.15.4 (ZigBee) – LR-WPAN Device Architecture, Protocol Stack.	CO4	03	08
	Wireless Sensor Network – Design Considerations, Issues and Challenges, WSN Architecture, Applications.	CO4	02	
	Introduction of Ad hoc Networks – MANET and VANET – Characteristics, Applications, Advantages and Limitations.	CO4	02	
	Overview of E-VANET (Electrical Vehicular Ad-Hoc Networks).	CO4	01	
5. Wireless Network Security	Security in GSM, UMTS Security.	CO5	02	04
	Bluetooth Security, WEP, WPA2.	CO5	02	
6. Wireless Network Design Considerations	Cisco Unified Wireless Network.	CO6	02	04
	Designing Wireless Networks with Lightweight Access Points and Wireless LAN Controllers.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. T. Single, Wireless Communications, McGraw Hill. 2. V. Garg, Wireless Communications and Networking, Morgan Kaufmann. 3. M. Rhee, Wireless Mobile Internet Security, Wiley. 4. R. Prasad, 5G Outlook–Innovations and Applications, River Publishers. 5. D. Teare, Designing for Cisco Internetwork Solutions, CCDA, Cisco Press.			
Reference Books:	1. N. Tripathi, J. Reed, Cellular Communications: A Comprehensive and Practical Guide, Wiley. 2. T. Rappaport, Wireless Communications- Principles & Practice, PHI. 3. W. Stallings, Wireless Communications and Networks, Pearson. 4. C. Cordeiro, D. Agrawal, Adhoc & Sensor Networks Theory and Applications, World Scientific. 5. M. Nicopolitidia, G. Obaidat, I. Papadimitriou, Wireless Networks, Wiley.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc20_ee61/preview 2. https://doi.org/10.1007/978-3-642-17878-8_63 3. https://doi.org/10.1007/978-3-642-54525-2_44 4. https://lora-alliance.org/resource_hub/what-is-lorawan/ 5. https://doi.org/10.1007/s42835-021-00687-8			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC5053	Computer Graphics	03	-	-	03
Prerequisites:	Basic Knowledge of Mathematics.				
Course Objectives (COBs):	<div>1. To equip student with the fundamental knowledge and basic technical competence in the field of Computer Graphics.</div> <div>2. To emphasize on understanding of Computer Graphics Algorithms.</div> <div>3. To prepare the student for advanced are as in the field of Computer Graphics.</div> <div>4. To introduce student for professional a venues in the field of Computer Graphics.</div> <div>5. To discuss the three-dimensional viewing of computer graphics in the development of computer games, information visualization.</div> <div>6. To discuss hidden surface removal needs in computer graphics.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to-</div> <div>1. Explain the basic concepts of Computer Graphics.</div> <div>2. Explain various algorithms for basic graphics primitives.</div> <div>3. Discuss clipping algorithms on graphical objects and apply2-D geometric Transformations on it.</div> <div>4. Describe curve representation techniques using 3-D geometric transformations on graphical objects.</div> <div>5. Discuss hidden surface removal methods on graphical objects.</div> <div>6. Explain advance algorithms in Computer Graphics.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction	Definition and Representative Uses of Computer Graphics, Overview of Coordinate System, Definition of Scan Conversion, Raster Scan & Random Scan Displays.	CO1	01	02	
	Architecture of Raster Graphics System with Display Processor, Architecture of Random Scan Systems.	CO1	01		
2. Output Primitives	Scan Conversions of Point, Line and Circle: DDA Algorithm and Brenham Algorithm for Line Drawing.	CO2	03	08	
	Midpoint Algorithm for Circle, Aliasing, Antialiasing Techniques Like Pre-Filtering and Post-Filtering, Super Sampling, and Pixel Phasing.	CO2	03		
	Filled Area Primitive: Scan Line Polygon Fill Algorithm, Inside Outside Tests, Boundary Fill and Flood Fill Algorithm.	CO2	02		
3. Two-Dimensional Transformation and Clipping	Basic 2D Transformations: Translation, Scaling, Rotation, Reflection, Matrix Representation and Homogeneous Coordinates, Composite Transformation.	CO3	03	09	
	Viewing Transformation Pipeline and Window to	CO3	03		

	Viewport Coordinate Transformation, Clipping Operations: Point Clipping, Line Clipping.			
	Line Clipping Algorithms: Cohen-Sutherland, Liang-Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton.	CO3	03	
4. Three-Dimensional Transformation, Curves and Fractals	3D Transformations: Translation, Rotation, Scaling. Reflection, Types of Projection, Composite Transformations: Rotation About an Arbitrary Axis.	CO4	03	06
	Bezier Curve, B-Spline Curve. Fractal-Geometry: Fractal Dimension, Hilbert's Curve, Koch Cur.	CO4	03	
5. Hidden surface removal	Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts,	CO5	03	06
	Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms.	CO5	03	
6. Advance topics	Visible surface detection concepts, back-face detection, depth buffer method, illumination.	CO6	03	08
	Light sources, illumination methods (ambient, diffuse reflection).	CO6	02	
	Specular reflection), Color models: properties of light, XYZ, RGB, YIQ and CMY color models	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. D. Hearn and M. Baker, Computer Graphics C Version, Pearson. 2. J. Foley, A. Dam, S. Feiner, and J. Hughes, Computer Graphics Principles and Practice in C, Pearson. 3. R. Maurya, Computer Graphics, Wiley. 4. P. Andleigh and K. Thakrar, Multimedia System Design, PHI. 5. Z. Li and M. Drew, Fundamentals of Multimedia, PHI.			
Reference Books:	1. D. Rogers, Procedural Elements for Computer Graphics, McGraw Hill. 2. S. Bhattacharya, Computer Graphics, Oxford Publication. 3. K. Rao, Z. Bojkovic and D. Milovanovic, Multimedia Communication Systems: Techniques, Standards & Networks, McGraw Hill.			
Useful Links:	1. https://nptel.ac.in/courses/106/106/106106090/ 2. https://nptel.ac.in/courses/106/103/106103224/ 3. https://nptel.ac.in/courses/106/102/106102065/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC5054	Advanced Data Structures and Algorithmic Performance Analysis	03	-	-	03
Prerequisites:	Data Structures and Analysis, Knowledge of any Programming Languages like C.				
Course Objectives (COBs):	1. To learn mathematical background for analysis of algorithm. 2. To learn various advanced data structures. 3. To understand the different design approaches of algorithm. 4. To learn dynamic programming methods. 5. To understand the concept of pattern matching. 6. To learn advanced algorithms.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the different methods for analysis of algorithms. 2. Apply an appropriate advanced data structure to solve a specific problem. 3. Apply an appropriate Divide and Conquer and Greedy algorithms approach for a given problem. 4. Apply the Dynamic Programming technique to solve a given problem. 5. Apply an appropriate pattern matching algorithm for a given problem / application. 6. Apply the concepts of Optimization, Approximation and Parallel computing algorithms.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction	Fundamentals of the Analysis of Algorithms: Time and Space Complexity, Asymptotic Analysis and Notation, Average and Worst-Case Analysis.	CO1	02	04	
	Recurrences: The Substitution Method, Recursive Tree Method, Master’s Method.	CO1	02		
2. Advanced Data Structures	B Tree, B+ Tree, Red-Black Trees.	CO2	03	06	
	Heap Operations, Implementation of Priority Queue Using Heap, Topological Sort.	CO2	03		
3. Divide and Conquer and Greedy Algorithms	Introduction to Divide and Conquer, Analysis of Binary Search, Merge Sort and Quick Sort, Finding Minimum and Maximum Algorithm.	CO3	04	08	
	Introduction to Greedy Algorithms: Knapsack Problem, Job Sequencing Using Deadlines, Optimal Storage on Tape, Optimal Merge Pattern, Analysis of all These Algorithms and Problem Solving.	CO3	04		
4. Dynamic Algorithms	Introduction to Dynamic Algorithms, All Pair Shortest Path, 0/1 Knapsack, Travelling Salesman Problem.	CO4	03	07	
	Matrix Chain Multiplication, Optimal Binary Search Tree, Analysis of all Algorithms and Problem Solving.	CO4	04		
5. String Matching	Introduction, The Naïve String-Matching Algorithm, Rabin Karp Algorithm, Boyer Moore Algorithm, Knuth-Morris-Pratt Algorithm.	CO5	04	07	

	Longest Common Subsequence (LCS), Analysis of all Algorithms and Problem Solving.	CO5	03	
6. Advanced Algorithms and NP Problems	Optimization Algorithms: Genetic Algorithm (GA), Approximation Algorithms: Vertex-cover problem, Parallel Computing Algorithms: Fast Fourier Transform.	CO6	05	07
	Introduction to NP-Hard and NP-Complete Problems.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. T. Cormen, C. Leiserson, R. Rivest, C. Stein, Introduction to Algorithms, PHI. 2. H. Bhasin, Algorithms: Design and Analysis, Oxford. 3. E. Horowitz, S. Sahani, S. Rajasekaran, Fundamentals of Computer Algorithms, Universities Press. 4. P. Deshpande, O. Kakde, C and Data structures, Dreamtech Press. 			
Reference Books:	<ol style="list-style-type: none"> 1. G. Tamassia, Mount, Data Structures and Algorithms in C++, Wiley. 2. R Thareja, Data Structures using C, Oxford. 3. M. Weiss, Data Structures and Algorithm Analysis in C, Pearson. 4. R. Arora, Optimization Algorithms and Applications, Chapman and Hall 			
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106/102/106102064/ 2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-851-advanced-data-structures-spring-2012/ 3. https://www.udemy.com/course/data-structures-and-algorithms-in-java-2/ 4. https://www.coursera.org/lecture/competitive-programming-core-skills/advanced-data-structures-and-i-o-Dj3hZ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Lab Code		Lab Name		Credits			
				TH	P	TUT	Total
ITL501		Internet Programming Lab		-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.					
Software Requirements:		JDK 8 or above, NodeJS, React.					
Lab Prerequisites:		Knowledge of Java programming, Basic HTML and CSS.					
Lab Objectives (LOBs):		1. To orient students to HTML for making webpages. 2. To orient students to CSS for making responsive webpages. 3. To expose students to Bootstrap for developing dynamic and responsive webpages. 4. To expose students to JavaScript to make web pages interactive. 5. To orient students to React for developing front end applications. 6. To orient students to Node.js for developing backend applications.					
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply the appropriate HTML tags to develop a webpage. 2. Apply the appropriate CSS tags to format data on webpage. 3. Develop responsive websites using Bootstrap. 4. Use JavaScript to develop interactive web pages. 5. Develop front end applications using React. 6. Develop back-end applications using Node.js/Express.					
Lab No.	Experiment Title					LOs Mapped	Hours
0	Lab Prerequisites.					-	02
1	Create webpage to implement Elements, Attributes, Head, Body, Hyperlink, Formatting.					LO1	02
2	Create webpage to implement Images, Tables, List, Frames, Forms, Multimedia.					LO1	02
3	Create webpage to implement CSS Syntax and different properties (Inclusion, Color, Background, Fonts, Tables, lists, etc.).					LO2	02
4	Create webpage to implement CSS3 selectors, Pseudo classes, Pseudo elements.					LO2	02
5	Create responsive webpage to implement Grid system, Forms, Button, Navbar, Breadcrumb, Jumbotron using bootstrap.					LO3	02
6	Perform from the following to develop interactive web pages using JavaScript: a. Variables, Operators, Conditions, Loops, b. Functions, Events, Classes and Objects, c. Error handling, Validations, d. Arrays, String, Date.					LO4	08
7	Installation and Configuration of React.					LO5	02
8	Create the front-end application using JSX, Components, Props, State, Forms, Events, Routers, Refs, Keys of React.					LO5	02
9	Installation and Configuration Node.js/Express.					LO6	02
10	Create the back-end application using Node.js or Express (Callbacks, Event loops).					LO6	02
Virtual Lab Links:		1. https://reactjs.org/tutorial/tutorial.html 2. https://nodejs.dev/learn					

	3. https://www.youtube.com/watch?v=-27HAh8c0YU 4. https://html-iitd.vlabs.ac.in/
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of the course “Internet Programming” and “Internet Programming Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical (P):	Practical Exam will be based on the experiment list for Total 25 Marks.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
ITL502	Security Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Windows or Linux Desktop OS, Wireshark, ARPWATCH, Kismet, NetStumbler, NESSU.				
Prerequisites:	Java / Python Programming.				
Lab Objectives (LOBs):	<div>1. To apply the knowledge of symmetric cryptography to implement classical ciphers.</div> <div>2. To analyze and implement public key encryption algorithms, hashing and digital signature algorithms.</div> <div>3. To explore the different network reconnaissance tools to gather information about networks.</div> <div>4. To explore the tools like sniffers, port scanners and other related tools for analyzing.</div> <div>5. To Scan the network for vulnerabilities and simulate attacks.</div> <div>6. To set up intrusion detection systems using open-source technologies and to explore email security.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Implement classical ciphers using symmetric cryptography.</div> <div>2. Demonstrate key management, distribution and user authentication.</div> <div>3. Analyze the different network reconnaissance tools to gather information about networks.</div> <div>4. Apply tools like sniffers, port scanners and other related tools for analyzing packets in a network.</div> <div>5. Apply open-source tools to scan the network for vulnerabilities and simulate attacks.</div> <div>6. Demonstrate the network security system using open-source tools.</div>				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	Write a program for breaking the Mono-alphabetic Substitution Cipher using Frequency analysis method.	LO1		02	
2	Design and implement a product cipher using Substitution ciphers.	LO1		02	
3	Cryptanalysis or decoding Playfair, Vigenere cipher.	LO1		02	
4	Encrypt long messages using various modes of operation using AES or DES.	LO2		02	
5	Cryptographic Hash Functions and Applications (HMAC): to understand the need, design and applications of collision resistant hash functions.	LO2		02	
6	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA.	LO2		02	
7	Study the use of network reconnaissance tools like whois, dig, traceroute, nslookup to gather information about networks and domain registrars.	LO3		02	
8	Study of packet sniffer tools Wireshark: a. Observer performance in promiscuous as well as non-promiscuous mode. b. Show the packets can be traced based on different filters.	LO3		02	
9	Download, install nmap and use it with different options to scan open ports, perform OS fingerprinting, ping scan, TCP port scan, UDP port scan, etc.	LO4		02	
10	Study of malicious software using different tools: a) Keylogger attack using a keylogger tool.	LO5		04	

	b) Simulate DOS attack using Hping or other tools. c) Use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities.		
11	Study of Network security by a) Set up IPSec under Linux. b) Set up Snort and study the logs.	LO6	02
12	Explore the GPG tool to implement email security.	LO6	02
Virtual Lab Links:	http://cse29-iiith.vlabs.ac.in/		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Computer Network Security” and “Security Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
ITL504	IoT Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above, Arduino Board, Raspberry Pi Board, Sensors, Actuators.				
Software Requirements:	Arduino IDE, Raspbian Operating System, ThingSpeak.				
Prerequisites:	Embedded C and Python Programming.				
Lab Objectives (LOBs):	<div>1. To address the real-world problems and find the required solution.</div> <div>2. To design the problem solution as per the requirement analysis done.</div> <div>3. To study the basic concepts of programming/ hardware/ emulator for Raspberry Pi/ Arduino/ ARM Cortex/ Intel Galileo etc.</div> <div>4. To fabricate and implement the mini project intended solution for project-based learning.</div> <div>5. To build and test the mini project successfully.</div> <div>6. To improve the team building, communication and management skills of the students.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Conduct a survey of several available literatures in the preferred field of study.</div> <div>2. Identify the requirements for the societal problems to solve using IoT.</div> <div>3. Create the IoT solution based on hardware requirements and by coding, emulating and testing.</div> <div>4. Evaluate the performance and sustainability of the developed IoT systems.</div> <div>5. Prepare report and present the findings of the study conducted in the preferred domain.</div> <div>6. Demonstrate an ability to work in teams and manage the conduct of the research study.</div>				
Guidelines for Experiments:	<div><div>• The Mini Project work is to be conducted by a group of three students.</div><div>• Each group will be associated with a subject in-charge. The group should meet with the faculty during laboratory hours and the progress of work discussed must be documented.</div><div>• The students may do survey for different application using Raspberry pi and Arduino etc. topics for the mini project.</div><div>• Each group will identify the hardware and software requirement for their mini project problem statement.</div><div>• Prototype/ Design your own circuit board using Raspberry pi and Arduino.</div><div>• Installation, configure and manage your Raspberry pi and Arduino boards.</div><div>• Work with operating system and do coding to for input devices on board.</div><div>• The project assessment for term work will be done at least two times.</div><div>• Create and interface using web to publish or remotely access the data on Internet.</div><div>• Each group along with the faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.</div><div>• Each group may present their work in various project competitions and paper presentations.</div><div>• A detailed report is to be prepared as per guidelines given by the concerned faculty.</div></div>				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	Conduction of a survey of several available literatures in the preferred field of study.	LO1		02	

2	Finalizing problem definition (IoT data analytics areas).	LO2	02
3	Getting started with Arduino-Board, Installation of Arduino IDE, Basic programs using Arduino-Uno.	LO3	02
4	Study of different types of Sensors and Interfacing of sensors to Arduino Uno and Arduino Nano Board.	LO3	02
5	Study of NODE MCU, installation of software and driver. Programming of node MCU.	LO3	04
6	Study of Raspberry Pi, Installation of Raspbian OS, Programming.	LO4	02
7	Sending data on ThingSpeak/ Open-source platforms and do analysis of data.	LO4	04
8	Deriving outcome of problem definition using required board and test the results.	LO4	04
9	Report writing of Project, with publication on GIT/ blog/ website.	LO5	02
10	Presentation of work in project competition/ paper presentation.	LO6	02
Virtual Lab Links:	<ol style="list-style-type: none"> 1. https://learniot.kjsiet.in/ 2. https://www.arduino.cc/ 3. https://www.iot4smes.eu/en/raspberrypi_simulator.aspx 4. https://www.labcenter.com/visualdesigner/raspberry-pi/ 		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of course “IoT Programming” and “IoT Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical & Oral (P&O):	<ul style="list-style-type: none"> • P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks). 		

Lab Code		Lab Name	Credits			
			TH	P	TUT	Total
ITDLL5051		Advanced Databases and Information Retrieval Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.				
Software Requirements:		Ubuntu 19.04, Python, PostgreSQL.				
Prerequisites:		Database Management Systems, SQL Lab.				
Lab Objectives (LOBs):		1. To introduce advanced concepts of transaction management and recovery techniques. 2. To impart knowledge related to query processing and query optimizer phases of a database management system. 3. To introduce advanced database models like distributed databases. 4. To create awareness of how enterprise can organize and analyse large amounts of data by creating a data warehouse. 5. To learn the fundamentals of information retrieval system. 6. To classify various Information retrieval models.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply query optimization techniques to evaluate the query costs. 2. Implement data fragmentation in distributed databases. 3. Study data warehouse tool and create data warehouse. 4. Execute OLAP operations to take strategic decisions. 5. Understand the search engine evaluation methods. 6. Evaluate text processing techniques and operations in information retrieval system.				
Lab No.	Experiment Title				LOs Mapped	Hours
0	Lab Prerequisites.				-	02
1	Implementation of Query Optimization Techniques and evaluation of the cost of the query.				LO1	04
2	a. Implementation of distributed database. b. Study of Pentaho, Teradata etc. Data Warehouse tools.				LO2, LO3	02
3	Identification of problem and data for Data Warehouse for design of Star Schema, Snowflake Schema for the same.				LO3	02
4	Implementation of Data Warehouse for the identified problem.				LO3	02
5	Implementation of OLAP queries for Data Warehouse created.				LO3, LO4	02
6	Analyse different search engine techniques and Search Engine Optimization (SEO).				LO5	02
7	Implementation of Web Scrapper.				LO6	02
8	Retrieving RBG value from image and analyze it.				LO6	02
9	Reading content from CSV and removes common contents from sentence.				LO6	02
10	Removing extra whitespaces, removes special characters, lowercase all texts.				LO6	02
11	Implementation to split given sentence into words using word tokenizer.				LO6	02
12	Implementation of Mini project based on IR or Data Warehouse.				LO3, LO6	02
Virtual Lab Links:		http://vlabs.iitb.ac.in/bootcamp/labs/dbms/exp8/index.php				

<p>Term Work (TW):</p>	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of course “Advanced Database Management System and Information Retrieval” and “Advanced Databases and Information Retrieval Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
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Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
ITDLL5052	Sensor Network Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above, Sensors –DHT11/22, PIR, MQ2/MQ3, HC-SR04, Moisture sensor, Arduino Uno/Mega board, RPi Board, Wireless Radio Modules- Zigbee RF module, Bluetooth Module (HC-05), Mobile Phone with Bluetooth antenna, Others-Breadboard, wires, power supplies, USB cables, buzzers, LEDs, LCDs.				
Software Requirements:	Windows or Linux Desktop OS Arduino IDE, XCTU Configuration and test utility software, CupCarbon IOT simulator, Tinkercad Simulation Software, Contiki/Cooja, Internet connection.				
Prerequisites:	Introduction to 8086, 8051 and Python Programming.				
Lab Objectives (LOBs):	<ol style="list-style-type: none">1. To learn various communication technologies, Microcontroller boards and sensors.2. To design the problem solution as per the requirement analysis done using sensors and technologies.3. To study the basic concepts of programming/sensors/ emulators.4. To design and implement the mini project intended solution for project-based earning.5. To build, test and report the mini project successfully.6. To improve the team building, communication and management skills of the students.				
Lab Outcomes (LOs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none">1. Analyze various wireless communication technologies based on the range of communication, cost, propagation delay, power and throughput.2. Analyze the literature survey of sensors used in real world wireless applications.3. Demonstrate the simulation of WSN using the Network Simulators (Contiki/ Tinker CAD/ Cup carbon etc.).4. Develop the project successfully by hardware/sensor requirements, coding, emulating and testing.5. Apply the findings of the study conducted in the preferred domain.6. Demonstrate the ability to work in teams and manage the conduct of the research study.				
Guidelines for Experiments:	<ul style="list-style-type: none">• The Mini Project work is to be conducted by a group of three students.• Each group will be associated with a subject in-charge. The group should meet with the faculty during laboratory hours and the progress of work discussed must be documented.• The students may do survey for different application using Raspberry pi and Arduino etc. topics for the mini project.• Each group will identify the hardware and software requirement for their mini project problem statement.• Prototype/ Design your own circuit board using Raspberry pi and Arduino.• Installation, configure and manage your Raspberry pi and Arduino boards.• Work with operating system and do coding to for input devices on board.• The project assessment for term work will be done at least two times.• Create and interface using web to publish or remotely access the data on Internet.• Each group along with the faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.• Each group may present their work in various project competitions and paper presentations.• A detailed report is to be prepared as per guidelines given by the concerned faculty.				

Lab No.	Experiment Title	LOs Mapped	Hours
0	Lab Prerequisites.	-	02
1	Study of various wireless communication technologies like IEEE 802.15.1, IEEE 802.15.4 and IEEE 802.11.	LO1	02
2	a. Study of various types of sensors and display devices (e.g. DHT-11/22, HC-SR04, MFRC 522, PIR Sensor) and demonstration of their interfacing using Arduino/ Raspberry pi. b. Implementation of Smart industrial process monitoring and control system.	LO2	04
3	a. Installation and testing the simulation tools (eg. TinkerCad/ Cupcarbon/ ContikiCooja). b. Study of Amazon Web Service Platform and transfer data.	LO3	02
4	a. Study of interfacing of Arduino/ Raspberry pi with Wireless Technologies (e.g. HC-05, XBee S2C by Digi, ESP controller). b. To monitor sensor data and generate notification based on event triggering.	LO4	02
5	Interfacing using Mobile/Web to publish or remotely access the data on the Internet.	LO4	02
6	Mini Project: a. Study of remote access technologies with respect to the selected project. b. Design, configure, testing the Mini Project c. Report submission.	LO4, LO5, LO6	14
Useful Learning Links:	1. https://www.digi.com/resources/documentation/digidocs/90001526/tasks/t_download_and_install_xctu.htm 2. https://www.arduino.cc/en/software 3. http://cupcarbon.com/		
Term Work (TW):	<ul style="list-style-type: none"> Term work should consist of a minimum of 04 experiments and Mini Project. Journal must include at least 02 assignments on content of theory of the course “Wireless Technology” and “Sensor Network Lab”. Term work evaluation shall be for Total 25 Marks (Experiments and Mini Project: 20 Marks, Assignments: 05 Marks). The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL5053		Computer Graphics Lab	-	01	-	01
Hardware Requirements:		PC i3 Processor or above.				
Software Requirements:		Turbo C / Borland C / Online C Compiler.				
Prerequisites:		C Programming.				
Lab Objectives (LOBs):		1. To explain students with the fundamental knowledge and basic technical competence in the field of Computer Graphics. 2. To emphasize on understanding of Computer Graphics Algorithms. 3. To prepare the student for advanced areas in the field of Computer Graphics. 4. To introduce students for professional avenues in the field of Computer Graphics. 5. To discuss the three-dimensional viewing of computer graphics in the development of computer games, information visualization. 6. To discuss hidden surface removal needs in computer graphics.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Implement the basic concepts of Computer Graphics like line, circle, etc. 2. Implement 2-D geometric transformations on graphical objects and use various clipping algorithms on graphical objects. 3. Implement 3-D geometric transformations and curve representation techniques. 4. Implement complex pictures with the help of fractals. 5. Implement line elimination methods and Area-Coherence Algorithms. 6. Implement back-face detection and depth buffer method algorithms in computer graphics.				
Lab No.	Experiment Title			LOs Mapped		Hours
0	Lab Prerequisites.			-		02
1	Implement DDA line drawing algorithm: Dotted, dashed and thick lines.			LO1, LO2		02
2	Implement Brashenham line drawing algorithm- Dotted, dashed and thick lines.			LO1, LO2		02
3	Draw circle using Mid-point circle algorithm: Generate shapes like sine wave, spiral curve etc.			LO1, LO2		02
4	Implement any seed Fill polygon filling algorithm.			LO3		02
5	Implement any line clipping algorithm and Polygon Clipping Algorithms			LO3		02
6	Implement a program to perform 2D Transformation (Translation, Rotation, Scaling). With the help of matrix multiplication, with the help of equation.			LO4		02
7	Implement a program to perform translation, rotation and scaling on a cube. (3D Transformation) Implement basic 3D transformation on a cube.			LO4		02
8	Implement Bezier curve segments. (Generation of 2D curves).			LO3		02
9	Implement any Fractal (Koch/Hilbert).			LO4		04
10	Implement any hidden Line Elimination Methods			LO5		02
11	Implement any hidden Surface and Hidden Line methods.			LO5		02
12	Implement back-face detection, depth buffer method.			LO6		02

13	Implement illumination methods (ambient, diffuse reflection).	LO6	02
Virtual Lab Links:	1. http://vlabs.iitb.ac.in/vlabs-dev/labs/cglab/index.php 2. http://cse18-iiith.vlabs.ac.in/		
Term Work (TW):	<ul style="list-style-type: none"> Term work should consist of a minimum of 08 experiments. Journal must include at least 02 assignments on content of theory of the course “Computer Graphics” and “Computer Graphics Lab”. Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical & Oral (P&O):	<ul style="list-style-type: none"> Practical & Oral Examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral 10 Marks). 		

Lab Code		Course Name		Credits			
				TH	P	TUT	Total
ITDLL5054		Algorithm Analysis Lab		-	01	-	01
Hardware Requirements:		PC i3 Processor or above.					
Software Requirements:		Turbo / Borland C Compiler / Online C Compiler / JDK / Python.					
Prerequisites:		C Programming / Java / Python.					
Lab Objectives (LOBs):		1. To learn mathematical background for analysis of algorithm. 2. To learn various advanced data structures. 3. To understand the different design approaches of algorithm. 4. To learn dynamic programming methods. 5. To understand the concept of pattern matching. 6. To learn advanced algorithms.					
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply the different methods for analysis of algorithms. 2. Implement appropriate advanced data structures to solve specific problems. 3. Implement appropriate divide and conquer and greedy algorithms approaches for a given problem. 4. Implement the dynamic programming techniques to solve a given problem. 5. Implement appropriate pattern matching algorithms for a given problem / application. 6. Apply the concepts of optimization, approximation and parallel computing algorithms.					
Lab No.	Experiment Title			LOs Mapped		Hours	
0	Lab Prerequisites.			-		02	
1	Implement the following using array as data structure and analyze its time complexity: a. Merge sort b. Heap sort			LO1		04	
2	Implement Optimal Binary Search Tree problem and analyze its time complexity.			LO1		02	
3	Find Minimum Cost Spanning Tree of a given undirected graph using: a. Kruskal’s algorithm / b. Prim’s algorithm.			LO2		02	
4	Implement Dijkstra’s algorithm and analyze its time complexity.			LO2		02	
5	Implement 0/1 Knapsack problem using Greedy Method.			LO3		02	
6	Implement N Queen's problem using Back Tracking.			LO3		02	
7	Implement Matrix Chain Multiplication and analyze its time complexity.			LO4		02	
8	Implement any scheme to find the optimal solution for the Traveling Sales Person problem and then solve the same problem instance using any approximation algorithm and determine the error in the approximation.			LO4		02	
9	Implement Longest Common Subsequence problem and analyze its time complexity.			LO5		02	
10	Implement following string-matching algorithms and analyze time complexities: a. Naïve / b. Rabin Karp c. Knuth Morris Pratt			LO5		02	
11	Implement Vertex-cover problem using Dynamic Programming.			LO6		02	

12	Case studies - Identification of suitable algorithm / approach for optimization of solution to real-world problem.	LO6	02
Virtual Lab Links:	1. https://www.vlab.co.in/broad-area-computer-science-and-engineering 2. https://cs413daa.wixsite.com/algorithms/virtual-lab		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Advanced Data Structures and Algorithmic Performance Analysis” and “Algorithm Analysis Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
ITL506	Business Communication & Ethics	-	02	-	02
Hardware Requirements:	PC i3 Processor or above.				
Software Requirements:	Language Laboratory Software: ODLL (Oréll Digital Language Lab)				
Prerequisites:	Fundamental knowledge of Professional Communication Skills as acquired in Semester II.				
Lab Rationale:	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student’s interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.				
Lab Objectives (LOBs):	<div>1. To discern and develop an effective style of writing important technical/business documents.</div> <div>2. To investigate possible resources and plan a successful job campaign.</div> <div>3. To comprehend the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.</div> <div>4. To develop creative and impactful presentation skills.</div> <div>5. To analyze personal traits, interests, values, aptitudes and skills.</div> <div>6. To understand the importance of integrity and develop a personal code of ethics.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Plan and prepare effective business/technical documents which will in turn provide a solid foundation for their future managerial roles.</div> <div>2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.</div> <div>3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.</div> <div>4. Deliver persuasive and professional presentations.</div> <div>5. Develop creative thinking and interpersonal skills required for effective professional communication.</div> <div>6. Apply codes of ethical conduct, personal integrity and norms of organizational behavior.</div>				
Module No. and Name	Subtopics	LOs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Lab Outline	Prerequisite Concepts and Course Introduction.	-	01	01	
1. Advanced Technical Writing: Project / Problem Based Learning	Classification of Reports: Classification on the basis of Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long).	LO1, LO6	01	06	
	Parts of a Long Formal Report: Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter).	LO1, LO6	01		

	Language and Style of Reports: Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Proofreading Through Plagiarism Checkers.	LO1, LO6	01	
	Definition, Purpose & Types of Proposals: Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals).	LO1, LO6	01	
	Parts of a Proposal: Elements, Scope and Limitations, Conclusion.	LO1, LO6	01	
	Technical Paper Writing: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format.	LO1, LO6	01	
2. Employment Skills	Cover Letter & Resume: Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resumes (Chronological, Functional & Combination).	LO2, LO4	01	06
	Verbal Aptitude Test: Modelled on CAT, GRE, GMAT exams.	LO2, LO4	01	
	Group Discussions: Purpose of a GD, Parameters of Evaluating a GD.	LO2, LO4	01	
	Types of GDs (Normal, Case-based & Role Plays).	LO2, LO4	01	
	GD Etiquettes.	LO2, LO4	01	
	Personal Interviews: Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual.	LO2, LO4	01	
3. Business Meetings	Conducting Business Meetings: Types of Meetings, Meeting Etiquettes.	LO3, LO6	01	02
	Documentation: Notice, Agenda, Minutes.	LO3, LO6	01	
4. Technical / Business Presentations	Effective Presentation Strategies: Defining Purpose, Analyzing Audience, Location and Event Gathering, Selecting & Arranging Material.	LO4, LO2	01	02
	Structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation.	LO4, LO2	01	
5. Interpersonal Skills	Emotional Intelligence.	LO5, LO6	01	08
	Motivation.	LO5, LO6	01	
	Assertiveness.	LO5, LO6	01	
	Time Management.	LO5, LO6	02	
	Stress Management.	LO5,	02	

		LO6		
	Start-up Skills: Financial Literacy, Risk Assessment, Data Analysis (E.g. Consumer Behavior, Market Trends, etc.).	LO5, LO6	01	
6. Corporate Ethics	Intellectual Property Rights: Copyrights, Trademarks, Patents.	LO6	01	02
	Case Studies: Cases related to Business / Corporate Ethics.	LO5, LO6	01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01

Activity No.	Activity Title	Lab Hours / Activity
1	Test of English as Foreign Language (TOEFL)	02
2	Group Discussion (Practice Session) – I	02
3	Group Discussion (Practice Session) – II	02
4	Final Group Discussion – I	02
5	Final Group Discussion – II	02
6	English Aptitude Test	02
7	Resume Writing	02
8	Mock Interview	02
9	Role Play Techniques for Interpersonal Skills	02
10	Project Report Presentation – I	02
11	Project Report Presentation – II	02
12	Technical Proposal	02
13	Corporate Ethics/Role Play/Case Studies	02
14	Business Meetings: Case Studies/Role Play	02

Text Books:	1. S. Kumar & P. Lata, Communication Skills Workbook, Oxford University Press. 2. C. Bovée, and J. Thill, Business Communication Today. Upper Saddle River, Pearson.
Reference Books:	1. V. Arms, Humanities for the Engineering Curriculum: With selected chapters from Olsen/Huckin: Technical Writing and Professional Communication, McGraw Hill. 2. J. Butterfield, Verbal Communication: Soft Skills for a Digital Workplace, Cengage Learning. 3. L. Masters, H. Wallace, and L. Harwood, Personal Development for Life and Work, Cengage Learning. 4. S. Robbins, T. Judge, and T. Campbell, Organizational Behavior, Pearson. 5. M. Raman, S. Sharma, Technical Communication, Principles and Practice. Oxford University Press. 6. A. Ram, Place Mentor - Tests of Aptitude for Placement Readiness. Oxford University Press.
Useful Learning Links:	1. Interview techniques (How to answer tell me about yourself) - https://www.youtube.com/watch?v=m5kR7TPAkSw 2. The 4 types of team members you can hire - https://www.youtube.com/watch?v=5bYYFfbSqc 3. Every Meeting Ever - https://www.youtube.com/watch?v=K7agiXFFQJU 4. TOEFL listening skill - https://www.youtube.com/watch?v=jSUh0Civuv4 5. MBA interview - https://www.youtube.com/watch?v=cwW9QBNUwCw

	6. How to write a successful CV - https://www.youtube.com/watch?v=U0JAfqEak2c
Term Work (TW):	<ul style="list-style-type: none"> • Term work shall consist of a minimum of 08 assignments. • Term work evaluation shall be for Total 25 Marks based on Assignments (15 Marks) and Book Report (10 Marks). • The final certification and acceptance of term work will be based on attendance, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Oral (O):	Oral examination will be based on a Group Discussion (GD) and the Project/Book Report Presentation for Total 25 Marks (GD: 10 Marks and Presentation: 15 Marks).
Guidelines:	<ul style="list-style-type: none"> • The main body of the project/book report should contain a minimum 25 pages (excluding front and back matter). • The group size for the final report presentation should not be less than 05 students or exceed 07 students. • There will be an end–semester presentation based on the book report.

PBL Course Code	PBL Course Name	Credits			
		TH	P	TUT	Total
ITPR53	PBL – Minor Project Lab I (IoT with Web Application Development)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above, IoT Components.				
Software Requirements:	JDK 8 or above, Node.js, React.				
Prerequisites:	Web Programming, IoT.				
PBL Objectives (PROBs):	<ol style="list-style-type: none"> 1. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used. 2. To practice the process of identifying the needs and converting it into a problem statement. 3. To apply engineering knowledge and modern tools/technologies for deriving solutions to the real-world problems. 4. To inculcate the process of self-learning and research. 5. To be acquainted with solving the problem in a group. 6. To improve communication, management and report-writing skills of the students. 				
PBL Outcomes (PROs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none"> 1. Identify societal / research needs, formulate problem statements, review research literature, and analyses complex engineering problems. 2. Design suitable solutions for the problems including scope, objectives, timeline, system flow, user interface, algorithms, etc. 3. Gather, analyse, and interpret data — and apply knowledge of engineering fundamentals, modern tools / technologies for development of solutions. 4. Analyze sustainability and scalability of the developed solution and its impact in terms of environmental, societal, safety, legal, cultural, health, etc. aspects. 5. Apply ethical principles, excel in written and oral communication, and engage in independent and life-long learning. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects. 				
Guidelines for Project-Based Learning (PBL):	<ol style="list-style-type: none"> 1. Students have to form a team of minimum 02 and maximum 04 members, based on their area of interest and size of project. Interdisciplinary (inter-branch) teams are encouraged. 2. Students should develop a Web Application using a suitable technology and interfacing with IoT. 3. Students should carry out a survey and identify needs, which shall be converted into problem statement for Minor Project in consultation with Faculty Guide, Internal committee of faculties, and the Head of Department. 4. Projects on societal contribution (healthcare, agriculture, etc.) are preferred. Students should try to take up need-based live projects so as to get exposure to communication with beneficiaries and skills for understanding client requirements. 5. Based on the idea presentation as well as discussion on feasibility, novelty, and contribution of the idea, a project definition will be finalized. 6. Students shall submit their implementation plan in the form of Gantt / PERT / CPM chart, which will cover weekly activity of the Mini project. 7. A log book is to be prepared by each group, wherein the group can record weekly work progress and the Faculty Guide can verify and record notes / comments. 8. Faculty Guide may give inputs to students during Mini Project activity; however, focus shall be on self-learning. 				

	<p>9. Students in a group shall understand the problem effectively, propose multiple solutions, and select the best possible solution in consultation with their guide.</p> <p>10. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.</p> <p>11. The solution is to be validated with proper justification and report to be compiled in standard format of the Department.</p> <p>12. With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, if the problem statement is huge and significant, a same problem statement can be worked upon for 02 semesters, i.e., same Minor Project in Semesters V and VI. Projects with a very large scope can also be taken forward to higher semesters, in consultation with the Head of the Department.</p> <p>13. Students are encouraged to participate in Technical Paper Presentation competitions.</p> <p>14. The students' group shall complete a project in all aspects including: Identification of need / problem, proposed final solution, Procurement of components / systems / data, Building prototype and testing.</p> <p>15. Three reviews will be conducted for continuous assessment: one shall be for finalization of the problem and proposed solution, second shall be for evaluation of work progress, and third shall be for evaluation of implementation and testing of solutions.</p> <p>16. Minor Project shall be assessed based on following parameters:</p> <ul style="list-style-type: none"> • Attainment of Course Outcomes. • Technical efficiency and quality of developed solution. • Innovativeness in solutions. • Impact on environment. • Cost effectiveness. • Sustainability analysis. • Societal impact. • Effective use of standard engineering norms. • Contribution of an individual as member or leader. • Clarity in written and oral communication. <p>17. Students are encouraged to publish a paper based on the work in Conferences / Student competitions.</p>
Useful Learning Links:	<ol style="list-style-type: none"> 1. https://www.coursera.org/projects/build-a-full-website-using-wordpress 2. https://www.coursera.org/specializations/website-development 3. https://www.coursera.org/specializations/full-stack-react 4. https://www.coursera.org/specializations/web-design 5. https://www.udemy.com/course/ux-web-design-master-course-strategy-design-development/ 6. https://onlinecourses.swayam2.ac.in/cec21_lb01/preview
Term Work (TW):	<ul style="list-style-type: none"> • Term Work shall be granted based individual's contribution in group activity, their understanding and response to questions. • Term Work evaluation shall be for Total 25 Marks — based on the following evaluation: <ul style="list-style-type: none"> ○ Presentation in Review 1 ○ Presentation in Review 2 ○ Presentation in Review 3 ○ Project Report and Log Book
Practical & Oral (P&O):	P&O examination will be of Total 25 Marks and shall be based on the Project Demonstration, Presentation, and Report.

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXS57	SAT – VI: Skill-Based Learning (Aptitude / Logic Building and Competitive Programming)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Turbo C, JDK, Python, MySQL.				
Skill Prerequisites:	Knowledge of Elementary Mathematics (HSC level), Knowledge of Basic English Grammar (SSC level), Knowledge of Basic Programming Languages.				
Skill Objectives (SOBs):	<div>1. To create the basic awareness about how to prepare for recruitment process.</div> <div>2. To introduce the students to computational skills required to appear for recruitment tests.</div> <div>3. To introduce the students to programming skills required to appear for recruitment tests/ project /coding competitions.</div>				
Skill Outcomes (SOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Solve problems that require Quantitative Ability.</div> <div>2. Solve problems that Logical, Verbal and Non-Verbal Reasoning Skills.</div> <div>3. Solve campus placements aptitude papers covering Quantitative Ability, Logical Reasoning and Verbal Ability.</div> <div>4. Solve basic problems of Competitive Programming.</div> <div>5. Solve advanced problems for Competitive Programming including Data Structures, Code Optimization, etc.</div> <div>6. Solve campus placements papers covering Competitive Programming and Competitive Programming competition problem statements.</div>				
Module No. and Name	Subtopics	SOs Mapped	Hours / Subtopic	Total Hours / Module	
1. Basics of Quantitative Abilities	Problems on Number System, HCF and LCM, Algebra, Profit & Loss, Average & Allegation / Mixture.	SO1, SO3	02	04	
	Problems on Ratio and Proportion, Percentage, Time and Work, Geometry Mensuration.	SO1, SO3	02		
2. Arithmetic Quantitative Abilities	Problems on Ages, Permutation and Combination, Probability, Time and Distance.	SO1, SO3	02	04	
	Problems on Simple and Compound Interest, Boats & Stream, Pipes & Cisterns, Height & Distance.	SO1, SO3	02		
3. Logical, Verbal and Non-Verbal Reasoning	Analytical, Puzzles, Blood relationship, Data Interpretation, Data sufficiency, Logical Deductions, Logical Sequence of Words.	SO2, SO3	02	04	
	Logical Venn Diagrams, Statement and Arguments, Statement and Assumptions, Statement and Conclusions.	SO2, SO3	02		
4. Programming Techniques	Introduction to Competitive Programming, Programming Contests, Platforms for Competitive Programming Practice, Language Features.	SO4, SO6	02	04	

	Different approaches to solve programming problems.	SO4, SO6	02	
5. Data Structures, Analysis and Optimization	Code Optimization, Programming Questions with Time Complexity.	SO5, SO6	03	06
	Dynamic Programming Problems, Sorting, Searching	SO5, SO6	03	
6. Advanced Data Structures and Mathematical Problems	Intermediate Algorithms: String Manipulation, Bit Manipulation, Intermediate Data Structures: Trees, Set, Map, Heap, Graph.	SO5, SO6	03	06
	Greedy Algorithms, Game Theory, Tries, Segment Trees, Suffix Tree, Suffix Array, Graph Colouring.	SO5, SO6	03	
Text Books:	1. A. Sharma, How to Prepare for Quantitative Aptitude for CAT, McGraw Hill. 2. R. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand. 3. R. Aggarwal, A Modern Approach to Verbal & Non-Verbal Reasoning, S. Chand. 4. A. Laaksonen, Guide to Competitive Programming Learning and Improving Algorithms through Contests, Springer.			
Reference Books:	1. S. Skiena, The Algorithm Design Manual, Springer. 2. T. Cormen, Introduction to Algorithms, PHI. 3. S. Halim, F. Halim, S. Effendy, Competitive Programming 4 - Book 1: The Lower Bound of Programming Contests in the 2020s.			
Useful Learning Links:	1. https://onlinecourses.nptel.ac.in/noc21_cs99/preview 2. https://unacademy.com/a/i-p-c-beginner-track 3. https://www.coursera.org/learn/competitive-programming-core-skills 4. https://www.coursera.org/learn/computational-thinking-problem-solving 5. https://www.faceprep.in/c/competitive-programming/ 6. https://www.geeksforgeeks.org/competitive-programming-a-complete-guide/ 7. https://www.hackerrank.com/ 8. https://www.codechef.com/ 9. https://codeforces.com/ 10. https://www.codingninjas.com/codestudio 11. https://practice.geeksforgeeks.org/ 12. https://leetcode.com/problemset/all/			
Term Work (TW):	Term Work evaluation shall be for Total 25 Marks (Quiz / Mini-challenge: 10 Marks and Active Participation: 15 Marks) <ul style="list-style-type: none">Quiz / Mini-challenge: Evaluation shall be conducted for every module. The average of all quizzes / mini-challenges shall be considered for assigning the marks.Active Participation: Marks will be awarded based on students' participation in SBL sessions; presenting/showcasing learned skills through Events / Competitions / Trainings / Internships, etc.; Submission of Report / Progress of problem solving on various platforms; Achievements / Recognitions, etc.			

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXT58	SAT – VIII: Technology-Based Learning	-	01	-	01
Prerequisites:	Basic Engineering and Technology courses.				
TBL Objectives (TOBs):	<div><div></div><div>1 To acquire competency in emerging areas of technology.</div><div>2 To create a mindset for life-long learning required to persist technological shifts and be abreast with the market trends.</div><div>3 To facilitate learning at self-paced schedules.</div><div>4 To boost time management ability and self-discipline.</div><div>5 To provide opportunities of strengthening digital footprints by showcasing the additional proficiency acquired as well as improve connectivity and networking.</div><div>6 To enhance employment and entrepreneurial opportunities requiring specialization.</div></div>				
TBL Outcomes (TOs):	<div><div></div><div>Upon completion of the course, the learners will be able to:</div><div>1. Explain concepts of the emerging technology learned through the pursued course.</div><div>2. Describe social, ethical, and legal issues surrounding the learned technology.</div><div>3. Demonstrate professionalism and skills of digital age learning and working.</div><div>4. Demonstrate knowledge in entrance exams for higher technical education, placement interviews, and other avenues.</div><div>5. Analyze real-world case studies in society/industry for applicability of sustainable technological solutions.</div><div>6. Apply the acquired knowledge in developing technology-based solutions to real-world problems or other projects at hand.</div></div>				
Guidelines for Technology-Based Learning (TBL):	<div><div></div><div>1. Learners should enroll for an online course based on their area of interest concerning emerging areas of technology in consultation with Faculty Supervisor nominated by the Head of Department.</div><div>2. The course duration should be of minimum 04 weeks.</div><div>3. Students should watch all the videos of the course to learn the course in-depth and entirety.</div><div>4. Students should solve weekly assignments that are to be submitted online within the prescribed deadline.</div><div>5. Students should register and appear for the course certification exam on scheduled date and time.</div><div>6. Students should submit the certificate of course completion to the Faculty Supervisor.</div><div>7. Faculty Supervisor shall monitor students’ participation and progress at every stage — from course enrolment to certification.</div></div>				
Useful Learning Links:	<div><div></div><div>1. https://swayam.gov.in</div><div>2. https://www.nptel.ac.in</div><div>3. https://www.coursera.org</div></div>				
Term Work (TW):	Term Work evaluation shall be for Total 25 Marks based on progress and completion of the course.				

SEMESTER VI - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC601	Data Mining & Business Intelligence	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC602	Web X.0	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC603	Advanced Software Engineering and Project Management	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC604	Artificial Intelligence and Data Science – I	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC605	Department Level Elective – II	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITL601	Data Mining & Business Intelligence Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL602	Web Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL603	DevOps Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL605	Department Level Elective – II Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITPR64	PBL – Minor Project Lab II (AI-based Minor Project)	0 – 2 – 0	02 ^{\$}	0 – 1 – 0	01	PBL
ITXS69	SAT – IX: Skill-Based Learning (Mobile Application Development)	0 – 2* – 0	02	0 – 1 – 0	01	SAT
ITXT610	SAT – X: Technology-Based Learning	0 – 2* – 0	02	0 – 1 – 0	01	SAT
Total		15 – 14 – 0	29	15 – 7 – 0	22	

*SAT can be conducted as TH or P or both as required.

^{\$}Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC601	Data Mining & Business Intelligence	30	30	30	10	60	-	-	-	-	100
ITC602	Web X.0	30	30	30	10	60	-	-	-	-	100
ITC603	Advanced Software Engineering and Project Management	30	30	30	10	60	-	-	-	-	100
ITC604	Artificial Intelligence and Data Science – I	30	30	30	10	60	-	-	-	-	100
ITDLC605	Department Level Elective – II	30	30	30	10	60	-	-	-	-	100
ITL601	Data Mining & Business Intelligence Lab	-	-	-	-	-	25	-	-	25	50
ITL602	Web Lab	-	-	-	-	-	25	-	25	-	50
ITL603	DevOps Lab	-	-	-	-	-	25	25	-	-	50
ITDLL605	Department Level Elective – II Lab	-	-	-	-	-	25	-	-	-	25
ITPR64	PBL – Minor Project Lab II (AI-based Minor Project)	-	-	-	-	-	25	-	-	25	50
ITXS69	SAT – IX: Skill-Based Learning (Mobile Application Development)	-	-	-	-	-	25	-	-	-	25
ITXT610	SAT – X: Technology-Based Learning	-	-	-	-	-	25	-	-	-	25
Total		150	150	150	50	300	175	25	25	50	775

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, PBL – Project-Based Learning, SAT – Skill/Activity/Technology-Based Learning (Exposure Course), CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses and Labs (PE-DLC – II)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Big Data Analytics (ITDLC6051)	IoT Data Analytics (ITDLC6052)	Image Processing (ITDLC6053)	Cloud Computing and Services (ITDLC6054)
Big Data Analytics Lab (ITDLL6051)	IoT Data Analytics Lab (ITDLL6052)	Image Processing Lab (ITDLL6053)	Cloud Computing and Virtualization Lab (ITDLL6054)

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC601	Data Mining & Business Intelligence	03	-	-	03
Prerequisites:	Database Management Systems.				
Course Objectives (COBs):	<div>1. To introduce the concept of data warehouse data mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage.</div> <div>2. To enable students to effectively identify sources of data and process it for data mining.</div> <div>3. To make students well versed in all data mining algorithms, methods of evaluation.</div> <div>4. To impart knowledge of tools used for data mining.</div> <div>5. To provide knowledge on how to gather and analyze large sets of data to gain useful business understanding.</div> <div>6. To impart skills that can enable students to approach business problems analytically identifying opportunities to derive business value from data.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe of the importance of data warehousing and data mining and the principles of business intelligence.</div> <div>2. Perform exploratory analysis and pre-processing of the data to be used for mining.</div> <div>3. Apply the appropriate classification techniques and measure their performance.</div> <div>4. Apply the appropriate clustering techniques and measure their performance.</div> <div>5. Apply the appropriate frequent paten mining techniques and measure their performance.</div> <div>6. Apply BI to solve practical problems: Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Data Warehousing and Mining	DWH Characteristics, OLAP Operation, OLTP vs OLAP.	CO1	02	04	
	KDD Process, Kind of Patterns to be Mined, Technologies Used, Data Mining Applications.		02		
2. Data Exploration and Data Pre-processing	Types of Attributes, Statistical Description of Data, Measuring Data Similarity and Dissimilarity.	CO2	03	07	
	Need of Data Pre-processing, Data Cleaning, Data Integration, Data Reduction: Attribute Subset Selection, Histograms, Clustering, Sampling, Data Cube Aggregation, Data Transformation and Data Discretization: Normalization, Binning, Histogram Analysis.	CO2	04		
3. Classification	Basic Concepts, Decision Tree Induction: Attribute Selection Measures, Tree Pruning, Bayesian Classification: Naïve Bayes Classifier.	CO3	05	07	

	Prediction: Structure of Regression Models, Simple Linear Regression.	CO3	01	
	Accuracy and Error Measures, Precision, Recall, Holdout, Random Sampling, Cross Validation, Bootstrap.	CO3	01	
4. Clustering and Outlier Detection	Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K-Medoids, Hierarchical Methods: Agglomerative, Divisive, Density-Based Methods: DBSCAN.	CO4	05	08
	Introduction to Outliers, Types, Challenges; Outlier Detection Methods: Supervised, Semi-Supervised, Unsupervised, Proximity-based, Clustering-based.	CO4	03	
5. Frequent Pattern Mining	Basic Concepts: Market Basket Analysis, Frequent Itemset, Closed Itemset, Association Rules, Frequent Itemset.	CO5	02	07
	Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from Frequent Itemset, Improving the Efficiency of Apriori, Pattern Growth Approach for Mining Frequent Itemset, Mining Frequent Itemset using Vertical Data Formats.	CO5	04	
	Introduction to Advance Pattern Mining: Mining Multilevel Association Rules and Multidimensional Association Rules.	CO5	01	
6. Business Intelligence	Need of Business Intelligence, Business Intelligence Architectures, Definition of Decision Support System.	CO1, CO6	02	06
	Development of a Business Intelligence System using Data Mining for Business Applications like Fraud Detection, Recommendation System.	CO6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. J. Han, M. Kamber, Data Mining Concepts and Techniques, Morgan Kaufmann. 2. P. Tan, M. Steinbach, V. Kumar, Introduction to Data Mining, Pearson. 3. P. Ponniah, Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, Wiley. 4. G. Shmueli, N. Patel, P. Bruce, Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner, Wiley.			
Reference Books:	1. M. Berry, G. Linoff, Data Mining Techniques, Wiley. 2. V. Pudi, R. Krishna, Data Mining, Oxford Higher Education. 3. C. Vercellis, Business Intelligence: Data Mining and Optimization for Decision Making, Wiley.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105174/ 2. https://www.coursera.org/specializations/data-warehousing 3. https://www.coursera.org/learn/business-intelligence-tools 4. https://www.coursera.org/learn/business-intelligence-data-analytics			

Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC602	Web X.0	03	-	-	03
Prerequisites:	Java Programming, Python Programming, Javascript, HTML, and CSS.				
Course Objectives (COBs):	1. To understand the digital evolution of web technology. 2. To learn Type Script and understand how to use it in web application. 3. To empower the use of Angular to create web applications that depend on the Model-View-Controller Architecture. 4. To gain expertise in a leading document-oriented NoSQL database, designed for speed, scalability, and developer agility using MongoDB. 5. To build web applications quickly and with less code using Flask framework. 6. To gain knowledge of Rich Internet Application Technologies.				
Couse Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the basic concepts related to web analytics and semantic web. 2. Apply TypeScript to eliminate bugs in code and enable you to scale your code. 3. Apply Angular framework to build dynamic, responsive single-page web applications. 4. Apply MongoDB for frontend and backend connectivity using REST API. 5. Apply Flask web development framework to build web applications with less code. 6. Describe Rich Internet Application using proper choice of Framework.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to WebX.0	Web Analytics 2.0: Introduction to Web Analytics, Web Analytics 2.0, Clickstream Analysis, Optimal strategy to choose your web analytics tool.	CO1	03	05	
	Web3.0 and Semantic Web: Characteristics of Semantic Web, Components of Semantic Web, Semantic Web Stack, N-Triples and Turtle, Ontology, RDF and SPARQL.	CO1	02		
2. TypeScript	Overview, TypeScript Internal Architecture, TypeScript Environment Setup.	CO2	01	06	
	TypeScript Types, variables and operators, Decision Making and loops.	CO2	02		
	TypeScript Functions, TypeScript Classes and Objects, TypeScript Modules.	CO2	03		
3. Introduction to Angular	Overview of Angular, Angular vs Angular JS, Setting up Local Environment.	CO3	01	09	
	Components: Overview, Component Lifecycle, View Encapsulation, Component Interaction, Component Styles, Sharing data between parent & child components	CO3	02		
	Directives: Attribute Directives, Structural directives	CO3	01		
	Routing & Navigation: Basic Routing, Frontend routing vs Backend routing (advantages and disadvantages)	CO3	01		
	Templates: Introduction, Text Interpolation, Template	CO3	02		

	Statements, Property binding, Event binding, Two way binding.			
	Forms: Introduction to forms, Reactive Forms, Validations	CO3	01	
	Testing Angular applications: Introduction to ng test, Testing components, Debugging tests.	CO3	01	
4. MongoDB and Building REST API using MongoDB	MongoDB: Understanding MongoDB, MongoDB Data Types, Administering User Accounts, Configuring Access Control.	CO4	02	09
	Adding the MongoDB Driver to Node.js, Connecting to MongoDB from Node.js, Accessing and Manipulating MongoDB Documents from Node.js.	CO4	03	
	REST API: Examining the rules of REST APIs, Evaluating API patterns, handling typical CRUD functions (create, read, update, delete).	CO4	02	
	Using Express and Mongoose to interact with MongoDB.	CO4	02	
5. Flask	Flask Environment Setup, App Routing, URL Building, Flask HTTP Methods, Flask Request Object, Flask cookies, File Uploading in Flask	CO5	03	05
	Flask cookies, File Uploading in Flask	CO5	02	
6. Rich Internet Application	AJAX: Introduction and Working.	CO6	01	05
	Developing RIA using AJAX Techniques: CSS, HTML, DOM, XML HTTP Request, JavaScript, PHP	CO6	02	
	Introduction to Open-Source Frameworks and CMS for RIA: Django, Drupal, Joomla.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. B. Cherny, Programming TypeScript- Making Your Javascript Application Scale, O'Reilly Media Inc. 2. A. Bretz and C. Ihrig, Full Stack JavaScript Development with MEAN, SitePoint Pty. Ltd. 3. S. Holmes, C. Harber, Getting MEAN with Mongo, Express, Angular, and Node, Manning Publications. 4. M. Grinberg, "Flask Web Development: Developing Web Applications with Python", O'Reilly. 5. Dr. D. Shah, Advanced Internet Programming, StarEdu Solutions.			
Reference Books:	1. Y. Fain and A. Moiseev, TypeScript Quickly, Manning Publications. 2. S. Fenton, Pro TypeScript: Application - Scale Javascript Development, Apress 3. B. Dayley, B. Dayley, C. Dayley, Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications, 2nd Edition, Addison-Wesley Professional			
Useful Links:	1. https://onlinecourses.swayam2.ac.in/cec21_lb01/preview 2. https://www.coursera.org/lecture/single-page-web-apps-with-angularjs 3. https://www.udemy.com/course/learning-mongodb-schema-indexes-and-queries			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. 			

	<ul style="list-style-type: none"> • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC603	Advanced Software Engineering and Project Management	03	-	-	03
Prerequisites:	Fundamentals of Software Engineering.				
Course Objectives (COBs):	1. To provide the knowledge of advanced concepts in software engineering discipline. 2. To describe software designing methods. 3. To understand IT project management. 4. To describe risk and software configuration management for quality software solutions. 5. To understand design, the architecture of software systems in various architectural styles and patterns. 6. To provide the knowledge of distributed software engineering.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain Agile Software Engineering. 2. Explain Software design methods. 3. Explain concepts of IT Project Management. 4. Describe risk and software configuration management. 5. Design various architectural styles and patterns of software systems. 6. Explain concepts of Distributed Software Engineering.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Software Engineering Models and Agile Development	Capability Maturity Model (CMM), V-model, Incremental Models.	CO1	02	07	
	Evolutionary Process Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban Model.	CO1	05		
2. Software Design Engineering	Design Process & Quality, Design Concepts, The Design Model, Design Decisions, Views, Patterns, Application Architectures	CO2	04	07	
	User Interface Design: The Golden Rules, Interface Design Steps & Analysis, Design Evaluation.	CO2	03		
3. IT Project Management	Management Spectrum, 3Ps (People, Product and Process) Process and Project Metrics.	CO3	01	07	
	Introduction to 4 P’s, W ⁵ HH Principle, Need for Project Management, Project Life Cycle and ITPM, Project Feasibility.	CO3	03		
	RFP, PMBOK Knowledge areas, Business case, Project Planning, Project charter and Project scope, WBS.	CO3	03		
4. Risk Management & Configuration Management	Risk Identification, Risk Assessment, Risk Projection, Risk management process, RMMM	CO4	03	08	
	Software Configuration Management, SCM Repositories, SCM Process.	CO4	02		
	Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR),	CO4	03		

	Walkthrough, Dynamics Testing.			
5. Designing Architectures	Design Process, Architectural Conception, Refined Experience in Action: Styles and Architectural Patterns.	CO5	03	04
	Architectural Conception in Absence of Experience, Putting it all Together: Design Processes Revisited	CO5	03	
6. Introduction to Distributed Software Engineering	Motivations for Micro Services, Types of Micro Services, Small and focused Loosely coupled Micro Services.	CO6	03	06
	Comparing Micro Services and Monolithic Architectures, Benefits from Micro Services, Challenges with Monolithic Architecture.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. R. Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill. 2. R. Mall, Fundamentals of Software Engineering, PHI. 3. T. Jach, Marchewka, Information Technology Project Management, Wiley. 4. N. Taylor, N. Medvidovic, E. Dashofy, Software Architecture: Foundations, Theory, and Practice, Wiley. 5. L. Bass, P. Clements, R. Kazman, Software Architecture in Practice, Pearson.			
Reference Books:	1. P. Jalote, An Integrated Approach to Software Engineering, Narosa Publication. 2. I. Sommerville, Software Engineering, Addison-Wesley.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc20_cs68/preview 2. https://www.coursera.org/specializations/software-development-lifecycle 3. https://www.youtube.com/watch?v=wEr6mwquPLY 4. https://nptel.ac.in/courses/110104073			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC604	Artificial Intelligence and Data Science - I	03	-	-	03
Prerequisites:	Mathematics Fundamentals, Data Structures and Analysis.				
Course Objectives (COBs):	<div>1. To introduce the students with different issues involved in trying to define and simulate intelligence.</div> <div>2. To familiarize the students with specific, well known Artificial Intelligence methods, algorithms and knowledge representation schemes.</div> <div>3. To introduce students’ different techniques which will help them build simple intelligent systems based on AI/IA concepts.</div> <div>4. To introduce students to data science and apply ML methods to solve real world problems with data science and statistics.</div> <div>5. To introduce students Security and Privacy of Machine Learning.</div> <div>6. To introduce evaluation and optimization in AI & ML.</div>				
Course Outcomes (COs):	<div>On successful completion, of course, learner/student will be able to:</div> <div>1. Explain the building blocks of AI as presented in terms of intelligent agents.</div> <div>2. Apply an appropriate method and knowledge-representation scheme for solving real-world problems.</div> <div>3. Choose appropriate search method and formalize the problem.</div> <div>4. Apply problem-solving concepts with data science as well as machine learning to tackle them from a statistical perspective for real-world problems.</div> <div>5. Apply appropriate Security and Privacy of Machine Learning.</div> <div>6. Explain the concept of Evaluation and Optimization.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Artificial Intelligence	Introduction: Introduction to AI, AI Techniques, Problem Formulation.	CO1	01	03	
	Intelligent Agents: Structure of Intelligent Agents, Types of Agents, Agent Environments PEAS Representation for an Agent.	CO1	02		
2. Search Techniques	Uninformed Search Techniques: Uniform Cost Search, DFS, BFS, Depth Limited Search, Iterative Deepening.	CO2	03	08	
	Bidirectional Search. Informed Search Methods: Heuristic functions, Best First Search.	CO2	01		
	A*, Hill Climbing, Simulated Annealing, Constraint Satisfaction.	CO2	01		
	Problem Solving: Crypto-Arithmetic Problem, Water Jug, Graph Colouring.	CO2	01		
	Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning, Comparing Different Techniques.	CO2	02		
3. Knowledge Representation	Knowledge and Reasoning: A Knowledge Based Agent, WUMPUS WORLD Environment, Propositional Logic.	CO3	02	07	

using First Order Logic	First Order Predicate Logic, Forward and Backward Chaining, Resolution, Planning as an Application of a Knowledge Based Agent.	CO3	03	
	Concepts of Partial Order Planning, Hierarchical Planning and Conditional Planning.	CO3	02	
4. Introduction to DS and ML	Introduction and Evolution of Data Science, Benefits and Uses of Data Science, Data Science tasks, Data Science Vs. Business Analytics versus Big Data.	CO4	02	03
	Data Analytics, Lifecycle, Roles in Data Science Projects.	CO4	01	
	Introduction to Machine Learning, Types of Machine Learning: Supervised (Logistic Regression, Support Vector Machine).	CO4	03	04
	Issues in Machine Learning, Application of Machine Learning Steps in Developing a Machine Learning Application.	CO4	02	
5. Security and Privacy in Machine Learning	Adversarial Machine Learning, Classifying Attacks, The Importance of Adversarial ML, Adversarial training, FGSM, Security Vulnerabilities in Machine Learning Algorithms, Attack Technique: Model Poisoning, Evasion Attack	CO5	03	08
	Privacy in Machine Learning, Differential privacy, Properties of differential privacy,	CO5	03	
	Distillation as a Defense, Obfuscated Gradients, Resistance to Adversarial Attacks	CO5	02	
6. Evaluation and Optimization	Optimization: Global and Local Optima; Unconstrained Optimization: Necessary and Sufficient Conditions for Optima, Gradient Descent Methods, Constrained Optimization, KKT Conditions, Introduction to Non-Gradient Techniques, Introduction to Least Squares Optimization.	CO6	03	05
	Swarm Intelligence: Particle swarm optimization: Principles of bird flocking and fish schooling, Evolution of PSO, Operating principles, PSO algorithm	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Pearson. 2. E. Rich, K. Knight and S. Nair, Artificial Intelligence, McGraw Hill. 3. H. Seltman, Experimental Design and Analysis, Carnegie Mellon University. 4. E. Alpaydm, Introduction to Machine Learning, MIT Press. 5. M. Nielsen, Neural Networks and Deep Learning, Determination Press.			
Reference Books:	1. D. Khemani, A First Course in Artificial Intelligence, McGraw Hill. 2. G. Lugar, AI-Structures and Strategies for Complex Problem Solving, Pearson. 3. D. Dietrich, Data Science & Big Data Analytics, EMC Education Services, Wiley. 4. T. Mitchell, Machine Learning, McGraw Hill.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105077/ 2. https://www.coursera.org/specializations/data-science-statistics-machine-learning 3. https://www.udemy.com/course/complete-machine-learning-and-data-science-zero-to-			

	<u>mastery/</u>
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC6051	Big Data Analytics	03	-	-	03
Prerequisite:	Database Management System.				
Course Objectives (COBs):	<div>1. To provide an overview of an exciting growing field of Big Data Analytics.</div> <div>2. To discuss the challenges traditional data mining algorithms, face when analyzing Big Data.</div> <div>3. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL, MapReduce.</div> <div>4. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.</div> <div>5. To introduce to the students several types of big data like Social Media, Web Graphs and Data Streams.</div> <div>6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Explain the motivation for big data systems and identify the main sources of Big Data in the real world.</div> <div>2. Explain the frameworks like Hadoop, NoSQL to efficiently store, retrieve and process Big Data Analytics.</div> <div>3. Describe several Data Intensive tasks using the Map Reduce Paradigm.</div> <div>4. Apply several newer algorithms for Clustering Classifying and finding associations in Big Data.</div> <div>5. Apply algorithms to analyze Big Data like Streams, Web Graphs and Social Media data.</div> <div>6. Discuss complex real-world problems in various applications like Recommender Systems, Social Media applications, Page Ranking, etc.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Big Data	Introduction to Data Mining, Database System and Algorithms, Introduction to Big Data, Big Data Characteristics, Types of Big Data, Traditional versus Big Data Business Approach.	CO1	02	03	
	Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications.	CO1	01		
2. Big Data Frameworks	Introduction to Hadoop, Core Hadoop Components, Hadoop Ecosystem.	CO2	01	08	
	Overview of Pig, Hive, HBase, Sqoop, Databricks Architecture Overview, Workspace to Access Databricks Assets, Interfaces, Introduction to Apache Spark- Requirements, Spark Interfaces, Apache Spark Application, Databricks Datasets, Notebooks, Data Management, Computational	CO2	05		

	Management, Model Management, Authentication and Authorization.			
	NoSQL Data Architecture Patterns: Key-Value Stores, Graph Stores, Column Family (Bigtable) Stores, Document Stores, Mongo DB.	CO2	02	
3. MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures.	CO3	02	09
	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce.	CO3	03	
	Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.	CO3	03	
	Illustrating use of MapReduce with use of real-life databases and applications.	CO3	01	
4. Mining Big Data Streams	The Stream Data Model: A DataStream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.	CO5	02	07
	Sampling Data in a Stream: Sampling Techniques. Filtering Streams: The Bloom Filter.	CO5	01	
	Counting Distinct Elements in a Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements. Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk Motwani Algorithm, Query Answering in the DGIM Algorithm.	CO5	04	
5. Big Data Mining Algorithms	Frequent Pattern Mining: Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu, The SON Algorithm and MapReduce.	CO4	03	06
	Clustering Algorithms: Canopy Clustering, Clustering with MapReduce.	CO4	01	
	Classification Algorithms: Parallel Decision Trees, Parallel SVM, One Nearest Neighbor.	CO4	02	
6. Big Data Analytics Applications	Link Analysis: Page Rank Definition, Structure of the Web, Dead Ends, Using Page rank in a Search Engine, Efficient computation of Page Rank: Page Rank Iteration Using MapReduce, Topic Sensitive Page Rank, Link Spam, Hubs and Authorities, HITS Algorithm.	CO4, CO6	03	06
	Mining Social- Network Graphs: Social Networks as Graphs, Types, Clustering of Social Network Graphs, Direct Discovery of Communities, Counting Triangles using MapReduce.	CO4, CO6	02	
	Recommendation Engines: A Model for	CO4,	01	

	Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	CO6		
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. R. Shankarmani and M. Vijayalakshmi, Big Data Analytics, Wiley Publications. 2. A. Rajaraman and J. Ullman, Mining of Massive Datasets, Cambridge University Press. 3. D. McCreary and A. Kelly, Making Sense of NoSQL – A Guide for Managers and the Rest of Us, Manning Press. 4. A. Holmes Hadoop in Practice, Manning Press, Dreamtech Press. 5. K. Chodorow and M. Dirolf, MongoDB: The Definitive Guide Paperback, O'Reilly. 			
Reference Books:	<ol style="list-style-type: none"> 1. B. Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley. 2. V. Prajapati, Big Data Analytics with R and Hadoop, Paperback, Packt Publishing. 3. T. White, Hadoop: The Definitive Guide, O'Reilly. 4. S. Tiwari, Professional NoSQL, Paperback, Dreamtech Press. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106/104/106104189/ 2. https://www.coursera.org/learn/big-data-essentials 3. https://www.coursera.org/learn/introduction-to-data-analytics 4. https://www.udemy.com/course/data-analysis-with-pandas/ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC6052	IoT Data Analytics	03	-	-	03
Prerequisites:	Computer Networks, Fundamentals of Internet of Things and Data Analytics.				
Course Objectives (COBs):	1. To understand the significance of the Internet of Things Data Analytics. 2. To equip principals, networking technology and security in IoT. 3. To explore the security, surveillance and energy conservation in smart homes. 4. To learn analytics techniques for predictions in smart farming. 5. To study monitoring and tracking methods of data analysis in smart healthcare. 6. To discuss the architecture, operation, and business benefits of smart travelling.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the concepts of IoT and IoT Data Analytics. 2. Apply the design protocols of IoT in addition to protecting the privacy and trust of a network. 3. Analyze and evaluate the use of IoT Analytics in smart homes. 4. Analyze solutions for Smart farming using IoT Data Analytics. 5. Analyze solutions for Smart Healthcare using IoT Data Analytics. 6. Analyze solutions for Smart Travelling using IoT Data Analytics.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Data Science and IoT	Fundamentals of Data Analytics, Devices and Gateways, Local and Wide Area Networking.	CO1	02	08	
	IoT Data Types, IoT Data Collection, Storage, Processing and Analytics, Data Management in IoT, IoT Analytics.	CO1	03		
	AI and IoT Ecosystem, Cloud-Based IoT Analytics, IoT and Big Data, Challenges in IoT Data Analytics Applications.	CO1	03		
2. Design Principles of IoT	Design Principles for Connected Devices, IoT System Layers and Design Standardization.	CO2	03	05	
	Networking Technology in IoT, Security, Privacy and Trust in IoT.	CO2	02		
3. IoT Data Analytics in Smart Homes	Introduction, IoT Data Analytics Techniques integrated with Image Processing and Artificial Intelligence for: Security and Surveillance.	CO3	03	05	
	Energy Conservation, Recent Research in IoT Data Analytics for Smart Homes.	CO3	02		
4. IoT Data Analytics in Smart Agriculture	Introduction, IoT Data Analytics Techniques integrated with Image Processing and Artificial Intelligence for: Weather Prediction, Demand Pricing, Disease Prediction, Crop Yield Prediction.	CO4	05	08	
	Recent Research in IoT Data Analytics for Smart Farming.	CO4	03		

5. IoT Data Analytics in Smart Healthcare	Introduction, IoT Data Analytics Techniques integrated with Image Processing and Artificial Intelligence for: Remote Health Monitoring, Remote Medical Assistance, Data Assortment, Transfer and Analysis, Tracking and Alerts.	CO5	05	08
	Recent Research in IoT Data Analytics for Smart Healthcare.	CO5	03	
6. IoT Data Analytics in Smart Travelling	Introduction and need of Smart Travelling, IoT Data Analytics Techniques Integrated with Image Processing and Artificial Intelligence for: Self-Driving Cars, Travel Route Optimization, Smart Traffic Management.	CO6	03	05
	Recent Research in IoT Data Analytics for Smart Travelling.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton and J. Henry, IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things, Pearson. 2. H. Chaouchi, The Internet of Things – Connecting Objects to the Web, Wiley.			
Reference Books:	1. A. Bahga and V. Madisetti, Internet of Things – Hands-On Approach, Universities Press. 2. A. McEwen & H. Cassimally, Designing the Internet of Things, Wiley. 3. D. Norris, Raspberry Pi – Projects for the Evil Genius, McGraw Hill. 4. A. Tamboli, Build Your Own IoT Platform, Apress.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105195/ 2. https://nptel.ac.in/courses/108/108/108108098/ 3. https://www.coursera.org/specializations/internet-of-things 4. https://www.coursera.org/learn/aws-iot-developing-and-deploying-an-internet-of-things			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC6053	Image Processing	03	-	-	03
Prerequisites:	Fundamentals of Computer Graphics and Computer Programming, Understanding of Applications of Mathematics in Engineering.				
Course Objectives (COBs):	1. To learn fundamental concepts of a digital image processing system. 2. To explain concepts of image enhancement techniques. 3. To learn various image transforms. 4. To understand compression techniques and morphological concepts. 5. To learn various segmentation techniques, and object descriptors.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the fundamental concepts of image processing. 2. Demonstrate basic knowledge of spatial and frequency domain techniques including the histogram modeling with different image enhancement techniques. 3. Implement the actual needs of image transforms such as discrete cosine transform frequency domain techniques. 4. Analyze the basic algorithms used for image processing and image compression. 5. Apply morphological image processing operations. 6. Contrast image segmentation and representation.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Image processing	Image Fundamentals: Image Definition, Steps and Components of Image Processing, Image Sensing and Acquisition, Image Sampling and Quantization, Overview of Convolution and Correlation.	CO1	03	05	
	Relationship Between Pixels: Adjacency, Connectivity and Distance.	CO1	02		
2. Image Enhancement	Point Processing Techniques: Image Negative, Bit Plane Slicing, Gray Level Slicing, Contrast Stretching, Clipping, Thresholding, Dynamic Range Compression, Expressions, their Evaluation and Conversions.	CO2	04	08	
	Mask Processing Techniques: Filtering in Spatial Domain, Average Filter, Weighted Average Filter, Median Filter.	CO2	02		
	Histogram Processing: Histogram Equalization.	CO2	02		
3. Image Transforms	Discrete Fourier Transform: Transform Pair 1-D and 2-D, Transform Matrix, Properties, Filtering in Frequency Domain (High Pass, Low Pass and Homo-Morphic filters).	CO3	04	07	
	Other Discrete Transforms: Discrete Cosine Transform type-2, Discrete Hadamard Transform, Discrete Haar Transform.	CO3	03		
	Entropy, Redundancy and Types, Compression	CO4	01	07	

4. Image Compression	Ratio, Compression Methods.			
	Lossless Compression: Run-Length Encoding, Huffman Coding, LZW Coding, Lossless Predictive Coding.	CO4	03	
	Lossy Compression: Fidelity Criterion, Improved Gray scale Quantization, Symbol-Based Coding, Bit-Plane Coding, Vector Quantization.	CO4	03	
5. Image Segmentation and Representation	Basic Morphological Methods: Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation.	CO5	03	05
	Advanced Morphological Methods: Skeletonization, Thinning, Thickening, Pruning, Boundary Extraction.	CO5	02	
6. Morphological Image Processing	Image Segmentation: Point, Line and Edge Detections Methods, Hough Transform, Graph Theoretic Method, Region Based Segmentation (Region Growing, Region Splitting and Splitting and Merging).	CO6	04	07
	Image Representation: Chain Codes, Shape Number, Polygon Approximation, Statistical Moments.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. R. Gonzalez and R. Woods, Digital Image Processing, Pearson. 2. S. Jayaraman, S. Esakkirajan and T. Veerakumar, Digital Image Processing, McGraw Hill. 3. S. Sridhar, Digital Image Processing, Oxford University Press. 4. A. K. Jain, Fundamentals of Digital Image Processing, PHI.			
Reference Books:	1. J. Proakis and D. Manolakis, Digital Signal Processing Principles, Algorithms and Applications, PHI. 2. W. Pratt, Digital Image Processing, Wiley. 3. M. Sonka, Digital Image Processing and Computer Vision, Thomson Publication. 4. K. Castleman, Digital Image Processing, PHI.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc21_ee78/preview 2. https://www.coursera.org/projects/image-processing-with-python 3. https://www.udemy.com/course/matlabipt/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC6054	Cloud Computing and Services	03	-	-	03
Prerequisite:	Computer Network, Operating System				
Course Objectives (COBs):	<div>1. Understand and analyze the basics of cloud computing, service models, deployment models and architecture.</div> <div>2. Define and understand the concept of virtualization and related technologies.</div> <div>3. Understand the different cloud computing services and their relevance’s.</div> <div>4. Describe the various services provided by Amazon Web Services cloud platform.</div> <div>5. Understand and analyze the functionality of Openstack cloud platform & Severless computing.</div> <div>6. Describe the aspects of Security & Privacy in cloud computing.</div>				
Couse Outcomes (COs):	<div>On successful completion, of course, learner/student will be able to:</div> <div>1. Explain the basics concepts of cloud computing like service models, deployment models and its architecture.</div> <div>2. Describe and apply virtualization in cloud computing.</div> <div>3. Use and analyze different cloud computing services.</div> <div>4. Understand and apply various services provided by Amazon Web Services cloud platform.</div> <div>5. Discuss the functionality of Openstack cloud platform & Severless computing.</div> <div>6. Recognize and examine the security and privacy concerns in cloud computing.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Concepts of Computer Network, Network Security and Operating System	-	02	02	
1. Introduction to Cloud Computing	Introduction to Cloud Computing, Need For Cloud Computing and its Components, Cloud & Other Similar Configurations, Cloud Types: NIST and Cloud Cube Model, Characteristics of Cloud Computing.	CO1	03	05	
	Deployment Models, Service Models, Advantages and Disadvantages of Cloud Computing.	CO1	02		
2. Virtualization	Characteristics of Virtualized Environment, Structures of Virtualization, Implementation Levels of Virtualization, Mechanisms of Virtualization, Pros and Cons of Virtualization.	CO2	02	06	
	Virtualization versus Cloud Computing, Xen and KVM Architecture, Comparison Between Different Virtualization Platforms. Virtualization for CPU, Memory and I/O Devices, Hardware Support for Virtualization in Intel X86 Processor, CPU Virtualization, Memory Virtualization and I/O Virtualization, Virtualization in Multicore Processors.	CO2	04		
3. Cloud Computing Services	SPI Model of Cloud computing, Everything as a Service (XaaS): Database as a Service, Storage as a Service, Security as a Service, Collaboration as a Service, Monitoring as a Service, Network as a Service, Disaster	CO3	04	08	

	Recovery as a service, Identity management as a Service, Analytics as a Service and Backup as a Service.			
	Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non-relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys.	CO3	04	
4. Amazon Web Service Cloud Platform	Introduction to the AWS Cloud, AWS core services by categories. Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier.	CO4	05	07
	Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups. CloudWatch: Introduction, CloudWatch Metrics, CloudWatch Alarms.	CO4	02	
5. Openstack Cloud platform & Serverless Computing	Open Source Cloud Platform: Introduction To Openstack Cloud Platform, Components and Modes of Operations, Architecture of Openstack Cloud Platform. Mobile Cloud Computing: Definition, Architecture, Benefits and Challenges of Mobile Cloud Computing.	CO5	04	07
	Serverless Computing: Introduction, Working With Serverless Environment, Basics of Serverless Events and Functions, AWS Lambda.	CO5	03	
6. Cloud Security & Privacy	What is Security in Cloud Computing, Why is It Required, Different Types of Security in Cloud, Attacks, and Vulnerabilities, IaaS Security, PaaS Security, SaaS Security, Trust Boundary, Audit and Reporting.	CO6	02	06
	Introduction to Identity and Access Management (IAM), IAM Challenges, IAM Definition, IAM Architecture and Practice, Relevant IAM Standards and Protocols for Cloud Services.	CO6	02	
	Privacy: What Is Privacy? What Are the Key Privacy Concerns in the Cloud? Legal and Regulatory Implications: Laws and Regulations, Governance, Risk, and Compliance (GRC).	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. B. Sosinsky, Cloud computing Bible, Wiley. 2. K. Jayaswal, J. Kallalurchi, D. Houde, D. Shah, Cloud Computing Black Book, Dreamtech Press 3. R. Buyya, Mastering Cloud Computing, McGraw Hill. 4. J. Baron, AWS certified solution Architect, Cybex.			

	<ol style="list-style-type: none"> 5. T. Mather, S. Kumaraswamy, and S. Latif, Cloud Security and Privacy, O'Reilly. 6. R. Krutz, R. Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley.
Reference Books:	<ol style="list-style-type: none"> 1. K. Hwang, G. Fox, J. Dongarra, Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Morgan Kaufmann. 2. J. Hurwitz, Cloud Computing for Dummies, Wiley. 3. G. Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly. 4. J. Vecca, Cloud computing security: foundation and challenges, CRC Press.
Useful Links:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc22_cs20/preview 2. https://www.udemy.com/course/intro-to-cloud-computing/ 3. https://www.coursera.org/courses?languages=en&query=cloud%20computing
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITL601	Data Mining and Business Intelligence Lab	-	01	-	01
Hardware Requirements:	PC i3 Processor or above.				
Software Requirements:	WEKA, Python, Scilab, R.				
Prerequisites:	Object Oriented Programming Concepts, Database Concepts.				
Lab Objectives (LOBs):	<div>1. To introduce the concept of data mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage.</div> <div>2. To enable students to effectively identify sources of data and process it for data mining.</div> <div>3. To make students well versed in all data mining algorithms, methods, and tools.</div> <div>4. To learn how to gather and analyse large sets of data to gain useful business understanding.</div> <div>5. To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.</div> <div>6. To identify and compare the performance of business.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Identify sources of data for mining, design a Data Warehouse schema, and perform data exploration.</div> <div>2. Organize and prepare the data needed for data mining algorithms in terms of attributes and class inputs, training, validating, and testing files.</div> <div>3. Implement the appropriate data mining methods like classification, clustering or association mining on large data sets using open-source tools like WEKA.</div> <div>4. Implement various data mining algorithms from scratch using languages like Python / Java / R, etc.</div> <div>5. Analyze and compare performance of some available BI packages.</div> <div>6. Apply BI to solve practical problems: Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.</div>				
Lab No.	Experiment Title			LOs Mapped	Hours
0	Lab Prerequisites.			-	02
1	Designing Star and Snowflake Schema.			LO1	02
2	Exploration of WEKA and implementation of the following Data Mining tasks using WEKA: <div>a. Data Exploration</div> <div>b. Data Preprocessing</div>			LO1, LO2	02
3	Implementation of Data Preprocessing using Python / Scilab: <div>a. Data Cleaning</div> <div>b. Handling Missing Data</div> <div>c. Data Transformation, etc.</div>			LO1, LO2	04
4	Implementation of Data Visualization and Statistical Data Analysis using Python / Scilab: <div>a. Plotting Bar Charts, Histograms, Scatter Plots, etc.</div> <div>b. Implementation of Chi-square test, correlation analysis, etc.</div>			LO1, LO2	04
5	Perform, evaluate, and compare using open-source tools like WEKA: <div>a. Classification Algorithms</div>			LO3	02

	b. Clustering Algorithms c. Frequent Pattern Mining Algorithms		
6	Implement and evaluate any Classification Algorithm using Python / R / Scilab.	LO4	02
7	Implement and evaluate any Clustering Algorithm using Python / R / Scilab.	LO4	02
8	Implement and evaluate any Frequent Pattern Mining Algorithm using Python / R / Scilab.	LO4	02
9	Detailed study of BI Tools such as: Pentaho, Tableau, QlikView, PowerBI.	LO5	02
10	<p>Business Intelligence Mini Project: Each group to be assigned one case study with implementation and a BI report must be prepared outlining the following steps:</p> <p>a) Problem Definition, identification of Data Mining task is needed.</p> <p>b) Identification and use of standard Data Mining dataset available for the problem. Some sources for data mining datasets are: WEKA, Kaggle, UCI Machine Learning Repository, etc.</p> <p>c) Implementation of appropriate data mining algorithm.</p> <p>d) Interpretation and visualization of the results.</p> <p>e) Explanation of the BI decision that is to be taken as a result of mining.</p>	LO6	04
Virtual Lab Links:	<ol style="list-style-type: none"> 1. https://cse20-iiith.vlabs.ac.in/ 2. https://www.iiitm.ac.in/DAVirtualLab/ 3. http://cse06-iiith.virtual-labs.ac.in/ 4. http://cse22-iiith.vlabs.ac.in/ 		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “Data Mining and Business Intelligence” and “Data Mining and Business Intelligence Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and 10 Marks).		

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITL602	Web Lab	-	01	-	01
Hardware Requirements:	PC with configuration: Intel Core i3/i5/i7, 4 GB RAM				
Software Requirements:	Angular IDE, Visual Studio Code, Notepad++, Python Editors, MySQL, XAMPP, MongoDB, JDK				
Lab Prerequisites:	HTML/HTML5, CSS/CSS3, JavaScript, Python				
Lab Objectives (LOBs):	1. Open-Source Tools for Web Analytics and Semantic Web. 2. Programming in TypeScript for designing Web Applications. 3. Angular Framework for Single Page Web Applications. 4. AJAX for Rich Internet Applications. 5. REST API and MongoDB for Frontend and Backend Connectivity. 6. Flask Framework for building web applications.				
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Apply open-source tools for web analytics and semantic web apps development and deployment. 2. Apply the basic concepts of TypeScript for designing web applications. 3. Implement Single Page Applications using Angular Framework. 4. Develop Rich Internet Applications using AJAX. 5. Create REST Web services using MongoDB. 6. Design web applications using Flask.				
Lab No.	Experiment Title	LOs Mapped		Hours	
0.	Lab Prerequisites.	-		02	
1	Study Any 2 tools in each 1. Study web analytics using open-source tools like Matomo, Open Web Analytics, AWStats, Countly, Plausible. 2. Study Semantic Web Open-Source Tools like Apache TinkerPop, RDFLib, Apache Jena, Protégé, Sesame.	LO1		02	
2	Perform Any 3 from the following 1. Small code snippets for programs like Hello World, Calculator using TypeScript. 2. Inheritance example using TypeScript 3. Access Modifiers example using TypeScript 4. Building a Simple Website with TypeScript	LO2		06	
3	Perform Any 2 from the following 1. Create a simple HTML web page Project using Angular Framework and apply ng-controller, ng-model and expressions. 2. Events and Validations in Angular. (Create functions and add events, adding HTML validators, using \$valid property of Angular, etc.) 3. Create an application for like Students Record using Angular	LO3		04	
4	Perform Any 2 from the following 1. Write a JavaScript program for a AJAX. 2. Write a program to use AJAX for user validation using and to show the result on the same page below the submit button.	LO4		06	

	3. Design and develop small web application using AJAX, HTML and JSP.		
5	Perform Any 1 from the following 1. Build a RESTful API using MongoDB. 2. Build a TypeScript REST API using MongoDB.	LO5	02
6	Perform Any 3 from the following 1. Design Feedback Form using Flask. 2. Design Weather App using Flask. 3. Design Portfolio Website using Flask. 4. Create a complete Machine learning web application using React and Flask.	LO6	06
Virtual Lab Links:	https://html-iitd.vlabs.ac.in/		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 8-12 experiments • Journal must include at least 02 assignments on content of theory of the course “WEB X.0” and “Web Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical (P):	Practical examination will be based on the experiment list for Total 25 Marks.		

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITL603		DevOps Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.				
Software Requirements:		Linux / Windows Operating System, Virtual Box / VMware.				
Other Requirements:		Internet Connection for Installing Additional Packages, GitHub account, DockerHub account.				
Prerequisites:		Operating System, Linux Administration, Java / Web Application Programming, and Software Engineering.				
Lab Objectives (LOBs):		<div>1. To understand DevOps practices which aims to simplify Software Development Life Cycle.</div> <div>2. To be aware of different Version Control tools like GIT, CVS or Mercurial.</div> <div>3. To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment.</div> <div>4. To be familiarized with selenium tool, which is used for continuous testing of applications deployed.</div> <div>5. To use Docker to Build, ship and manage applications using containerization.</div> <div>6. To understand the concept of Infrastructure as a code and install and configure Ansible tool and to understand Kubernetes architecture.</div>				
Lab Outcomes (LOs):		<div>Upon completion of the course, the learners will be able to:</div> <div>1. Use Version Control for developing application.</div> <div>2. Use Jenkins to Build and deploy Software Applications on production environment.</div> <div>3. Perform Automated Testing.</div> <div>4. Build Containerized Application.</div> <div>5. Use Software Configuration, Provisioning & Monitoring Tools.</div> <div>6. Build Application using of Serverless Computing & Microservice.</div>				
Lab No.	Experiment Title			LOs Mapped		Hours
0	Lab Prerequisites.			-		02
1	Create a Sample Web Page & Upload Source Code on GitHub & Perform different Git Operation. (Study of DevOps, Benefits of DevOps, Version Control System / Source Code Management, Install GitLab and Create a GitHub, Account, Get Familiar with the Concept of Minimum Viable Product (MVP) & Cross-Functional Teams, Git Cheat-Sheet).			LO1		02
2	Create a Jenkins CI/CD pipeline with GitLab Integration Pipeline. (Installation of Gitlab, Introduction to CI/CD, Learn different Stage of Development Commit, Build, Test, Deploy, Installation of GitLab).			LO1, LO2		02
3	Create Jenkins Pipeline for Building Python Project. (Jenkins Master-Slave Architecture and Scale Your Jenkins Standalone Implementation by Implementing Slave Nodes).			LO1, LO2		02
4	Install & Configure Docker. (Docker Architecture and Container Life Cycle, Execute Docker Commands to Manage Images and Interact with Containers, Container and Various Operations Performed on it, Container Life Cycle, Understanding Images			LO1, LO3		02

	and Containers, Create and Implement Docker Images using Docker file, Container Lifecycle and Working with Containers).		
5	Build Docker Image for deploying any Web/Python/Java Application.	LO1, LO3	02
6	Implementation using Ansible: a. Install & Configure Ansible. b. Install LAMP/MEAN using Ansible Playbook. (Study about need of Ansible, YAML Syntax, Playbook).	LO1, LO3, LO4	02
7	Install & Configure Container Orchestration Tools Kubernetes. (Kubernetes Cluster Architecture, Kubctl Commands, Pod Creation).	LO1, LO5	04
8	Deployment of any Web Application on Kubernetes.	LO1, LO5	02
9	To Perform Monitoring service using Nagios/Prometheus/Splunk	LO1, LO6	02
10	Write AWS Lambda Function to Build Python/Java/HTML Application.	LO1, LO6	02
11	Use of AWS/AZURE/GCP Platform to create CI/CD Pipeline.	LO1, LO6	02
12	Perform Automation Testing using Selenium. (Introduction to Selenium, Selenium Architecture, Selenium Web Driver).	LO1, LO6	02
Virtual Lab Links:	1. http://vlabs.iitkgp.ernet.in/se/		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Advanced Software Engineering and Project Management” and “DevOps Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Oral (O):	Oral examination will be based on the experiment list for Total 25 Marks.		

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL6051		Big Data Analytics Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above, 8 GB RAM				
Software Requirements:		Virtual Machine, Hadoop Frame work, NoSQL and MongoDB Compilers.				
Lab Prerequisite:		Java, Python.				
Lab Objectives (LOBs):		1. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL. 2. To impart knowledge of MapReduce paradigm to solve complex problems MapReduce. 3. To introduce several new algorithms for big data mining like classification, clustering and finding frequent patterns. 4. To introduce to the students several types of big data like social media, web graphs and data streams. 5. To identify various sources of big data. 6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Demonstrate an ability to use Big Data Frameworks like Hadoop and Apache Spark in data bricks. 2. Develop an application using tools like Hive, Pig, NoSQL and MongoDB for Big Data Applications. 3. Implement a scalable algorithm for large Datasets using Map Reduce techniques. 4. Implement algorithms for Clustering, Classifying and finding associations in Big Data. 5. Implement algorithms to analyze Big data like streams, web graphs and social media data and construct recommendation systems. 6. Apply the knowledge of Big Data gained to fully develop BDA applications for real life applications.				
Lab No.	Experiment Title				LOs Mapped	Hours
0.	Lab Prerequisites.				-	02
1	Case study and Installation of Hadoop Ecosystem.				LO1	02
2	Implementation of HDFS Commands.				LO1	02
3	Creation of Hadoop Cluster.				LO2	02
4	a. Installation of NoSQL Database: MongoDB. b. Implementation of NoSQL queries on MongoDB.				LO2	04
5	Implementation of word count program using MapReduce technique.				LO3	02
6	Implement Matrix Multiplication and Joins using MapReduce technique.				LO3	02
7	Implement Classification using MapReduce technique.				LO4	02
8	Implement PageRank using MapReduce technique.				LO5	02
9	Implementation of Data Processing and Analytics using Databricks.				LO1, LO6	04
10	Mini Project OR Implementation of Big Data Applications (Analytics on data streams/ Social Network Analysis Algorithms/ Web Graph Algorithms/ Recommendation Engines).				LO5, LO6	04
Virtual Lab		http://cse20-iiith.vlabs.ac.in/				

Links:	
Term Work:	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Big Data Analytics” and “Big Data Analytics Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLL6052	IoT Data Analytics Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above, Arduino Board, Raspberry Pi Board, Sensors, Actuators.				
Software Requirements:	Arduino IDE, Raspbian Operating System, Tinkercad, ThingSpeak, API, Python-Matplotlib.				
Prerequisites:	Python Programming				
Lab Objectives (LOBs):	<div>1. To learn basics of IoT data analytics components.</div> <div>2. To create solution for storing the incoming data from the deployed IoT infrastructure.</div> <div>3. To create way for accessing that data through APIs.</div> <div>4. To visualize the data using different visualization diagrams and UI elements.</div> <div>5. To create informative dashboards using these visualizations.</div> <div>6. To present final solution with data analysis and remarks.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Analyze the fundamentals of IoT and IoT Data Analytics with restoring and pre-processing data.</div> <div>2. Perform data analytics using EDA.</div> <div>3. Apply suitable algorithms for development of IoT Data Analytics solutions for societal problems.</div> <div>4. Demonstrate data visualization using various tools.</div> <div>5. Make report and present the findings of the study conducted in the preferred domain.</div> <div>6. Demonstrate an ability to work in teams and manage the conduct of the research study.</div>				
Guidelines:	Students should choose an application from Healthcare/ Agriculture/ Environment/ Smart Homes, etc. or the societal application developed in IoT Lab for performing experiments of this lab.				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	Restoration of data in CSV file from IoT prototype and gather corresponding data from non-IoT devices.	LO1		02	
2	Pre-processing and integration of IoT data and non-IoT data.	LO1		02	
3	Analysis of data using Exploratory Data Analytics (EDA).	LO2		02	
4	Study and comparison of suitable Data Analytics algorithms for Time-Series data, Image data, etc.	LO3		02	
5	Implementation of suitable Data Analytics algorithms for Time Series data, image data, etc.	LO3		04	
6	Introduction and working of Analytical Dashboard- PowerBI, Google Dashboard.	LO4		02	
7	Implementation of user interface dashboard for data visualization.	LO4		04	
8	Deriving outcome of problem definition using required board and test the results.	LO5		02	
9	Report writing of Project, with publication on GIT/ blog/ website.	LO6		02	
10	Presentation of work in project competition/ paper presentation.	LO6		04	
Virtual Lab Links:	<div>1. https://www.coursera.org/specializations/developing-industrial-iot</div> <div>2. https://www.coursera.org/learn/iiot-google-cloud-platform</div>				

	3. https://www.datacamp.com/courses/analyzing-iot-data-in-python 4. https://www.iot4smes.eu/en/raspberrypi_simulator.aspx
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of “IoT Data Analytics” and “IoT Data Analytics Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLL6053	Image Processing Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	MATLAB, Open CV, Python.				
Prerequisites:	Fundamentals of Computer Graphics and Computer Programming, Applications of Mathematics in Engineering – I, Applications of Mathematics in Engineering – II.				
Lab Objectives (LOBs):	<div>1. To understand the roles of Image Processing and introduces the major research domains in the field of image processing.</div> <div>2. To describe Image Enhancement techniques for improving the quality of digital image as a pre-processing operation.</div> <div>3. To explain the Image Transform techniques and its selection for Enhancement, Compression, Representation and Description.</div> <div>4. To learn the impacts and effects of image Compression techniques for effective storage and retrieval of information.</div> <div>5. To illustrate how to shape and reshape a given object in an image using Morphological techniques over binary and gray scale images.</div> <div>6. To apply Image Segmentation techniques in order to describe image objects using image representation concept.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Apply the fundamental concepts of image processing.</div> <div>2. Demonstrate the basic knowledge of Image Enhancement techniques including the Histogram modeling.</div> <div>3. Implement the actual needs of Image Transforms techniques such as Discrete Fourier Transform and Discrete Cosine Transform.</div> <div>4. Categorize the basic algorithms used for image Compression in image processing.</div> <div>5. Apply basic morphological techniques to shape and reshape a given object.</div> <div>6. Interpret image Segmentation and Representation techniques.</div>				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	Implementation of the following basic image processing operations: a) Sampling and Quantization. b) Spatial Resolution and Intensity Resolution.	LO1		02	
2	Implementation of the following point processing operations: a. Image Negative. b. Gray Level Slicing with or without background. c. Power Law Transformations.	LO2		02	
3	Implementation of Histogram equalization.	LO2		02	
4	Implementation of the following image enhancement techniques in Spatial domain: a. Smoothing. b. Sharpening.	LO2		04	
5	Implementation of image noise removal result analysis using: a. Averaging filter.	LO2		02	

	b. Median filter.		
6	Implementation of 2D Discrete Fourier Transform and Inverse Transform using built in functions.	LO3	02
7	Implementation of Low Pass and High Pass filter in Frequency domain.	LO3	02
8	Implementation of edge detection in 2-directions using the following edge detection operators: a. Robert operator. b. Prewitt operator. c. Sobel operator.	LO6	02
9	Implementation of image compression using any of the following lossless techniques: a. Huffman. b. RLE. c. LZW.	LO4	02
10	Implementation of the basic Morphological operations.	LO5	04
11	Implementation of Chain code to identify boundary in image in image segmentation.	LO6	02
Virtual Lab Links:	https://cse19-iiith.vlabs.ac.in/		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “Image Processing” and “Image Processing Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLL6054	Cloud Computing and Virtualization Lab	-	01	-	01
Hardware Requirements:	PC i3 processor or above				
Software Requirements:	Programming Languages, Ubuntu 18.04				
Lab Prerequisite:	C Programming / JAVA / Python, Basic of Networking				
Lab Objectives (LOBs):	<div>1. To make students familiar with key concepts of virtualization.</div> <div>2. To make students familiar with various deployment models of cloud such as private, public, hybrid and community.</div> <div>3. To understand the using and adopting appropriate type of cloud for their application.</div> <div>4. To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.</div> <div>5. Apply the different service models for the application.</div> <div>6. To make students familiar with security and privacy issues in cloud computing and how to address them.</div>				
Lab Outcomes (LOs):	<div>On successful completion, of course, learner/student will be able to:</div> <div>1. Implement different types of virtualization techniques.</div> <div>2. Analyze various cloud computing service models and implement them to solve the given problems.</div> <div>3. Design and develop real world web applications and deploy them on commercial cloud(s).</div> <div>4. Explain major security issues in the cloud and mechanisms to address them.</div> <div>5. Explore various commercially available cloud services and recommend the appropriate one for the given application.</div> <div>6. Implement the concept of containerization.</div>				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	To study and implement Hosted Virtualization & Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi.	LO1		02	
2	To study and implement Infrastructure as a Service using AWS/Microsoft Azure/Google cloud platform.	LO2		02	
3	Design and develop Web Application on AWS/GCP/Azure.	LO3		04	
4	To study and implement Security as a Service on AWS/Azure.	LO4		04	
5	To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud.	LO4		02	
6	To study and implement Virtual Private Network using AWS/GCP/Azure.	LO4		02	
7	To study and implement Storage as a Service using AWS/Azure Storage.	LO5		02	
8	To study and launch AWS/GCP/Azure instance using terraform.	LO6		04	
9	To study and monitor logs of AWS/GCP/Azure.	LO6		04	
Virtual Lab Links:	<div>1. https://phoenixnap.com/kb/ubuntu-install-kvm/</div> <div>2. NIST Cloud Computing Security Reference Architecture</div>				

	<ol style="list-style-type: none"> 3. https://docs.citrix.com/en-us/xenserver/7- 1/install.html 4. https://docs.aws.amazon.com 5. https://docs.microsoft.com/en-us/azure 6. https://docs.docker.com/get-started/ 7. https://kubernetes.io/docs/home/
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Cloud Computing” and “Cloud Computing and Virtualization Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.

PBL Course Code	PBL Course Name	Credits			
		TH	P	TUT	Total
ITPR64	PBL – Minor Project Lab II (AI-based Minor Project)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Python, MySQL, Node.js, React				
Prerequisites:	Java Programming, Python Programming, Web Programming.				
PBL Objectives (PROBs):	<ol style="list-style-type: none"> 1. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used. 2. To practice the process of identifying the needs and converting it into a problem statement. 3. To apply engineering knowledge and modern tools/technologies for deriving solutions to the real-world problems. 4. To inculcate the process of self-learning and research. 5. To be acquainted with solving the problem in a group. 6. To improve communication, management and report-writing skills of the students. 				
PBL Outcomes (PROs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none"> 1. Identify societal / research needs, formulate problem statements, review research literature, and analyse complex engineering problems. 2. Design suitable solutions for the problems including scope, objectives, timeline, system flow, user interface, algorithms, etc. 3. Gather, analyse, and interpret data — and apply knowledge of engineering fundamentals, modern tools / technologies for development of solutions. 4. Analyze sustainability and scalability of the developed solution and its impact in terms of environmental, societal, safety, legal, cultural, health, etc. aspects. 5. Apply ethical principles, excel in written and oral communication, and engage in independent and life-long learning. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects. 				
Guidelines for Project-Based Learning (PBL):	<ol style="list-style-type: none"> 1. Students have to form a team of minimum 02 and maximum 04 members, based on their area of interest and size of project. Interdisciplinary (inter-branch) teams are encouraged. 2. Students should develop an Artificial Intelligence-based Web Application. 3. Students should carry out a survey and identify needs, which shall be converted into problem statement for Minor Project in consultation with Faculty Guide, Internal committee of faculties, and the Head of Department. 4. Projects on societal contribution (healthcare, agriculture, etc.) are preferred. Students should try to take up need-based live projects so as to get exposure to communication with beneficiaries and skills for understanding client requirements. 5. Based on the idea presentation as well as discussion on feasibility, novelty, and contribution of the idea, a project definition will be finalized. 6. Students shall submit their implementation plan in the form of Gantt / PERT / CPM chart, which will cover weekly activity of the Mini project. 7. A log book is to be prepared by each group, wherein the group can record weekly work progress and the Faculty Guide can verify and record notes / comments. 8. Faculty Guide may give inputs to students during Mini Project activity; however, focus shall be on self-learning. 				

	<p>9. Students in a group shall understand the problem effectively, propose multiple solutions, and select the best possible solution in consultation with their guide.</p> <p>10. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.</p> <p>11. The solution is to be validated with proper justification and report to be compiled in standard format of the Department.</p> <p>12. With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, if the problem statement is huge and significant, a same problem statement can be worked upon for 02 semesters, i.e., same Minor Project in Semesters V and VI. Projects with a very large scope can also be taken forward to higher semesters, in consultation with the Head of the Department.</p> <p>13. Students are encouraged to participate in Technical Paper Presentation competitions.</p> <p>14. The students' group shall complete a project in all aspects including: Identification of need / problem, proposed final solution, Procurement of components / systems / data, Building prototype and testing.</p> <p>15. Three reviews will be conducted for continuous assessment: one shall be for finalization of the problem and proposed solution, second shall be for evaluation of work progress, and third shall be for evaluation of implementation and testing of solutions.</p> <p>16. Minor Project shall be assessed based on following parameters:</p> <ul style="list-style-type: none"> • Attainment of Course Outcomes. • Technical efficiency and quality of developed solution. • Innovativeness in solutions. • Impact on environment. • Cost effectiveness. • Sustainability analysis. • Societal impact. • Effective use of standard engineering norms. • Contribution of an individual as member or leader. • Clarity in written and oral communication. <p>17. Students are encouraged to publish a paper based on the work in Conferences / Student competitions.</p>
Useful Learning Links:	<p>1. https://www.udemy.com/course/artificial-intelligence-projects-with-python-handson-2-in-1/</p> <p>2. https://www.codechef.com/problems/DSPCXI11</p>
Term Work (TW):	<ul style="list-style-type: none"> • Term Work shall be granted based individual's contribution in group activity, their understanding and response to questions. • Term Work evaluation shall be for Total 25 Marks — based on the following evaluation: <ul style="list-style-type: none"> ○ Presentation in Review 1 ○ Presentation in Review 2 ○ Presentation in Review 3 ○ Project Report and Log Book
Practical & Oral (P&O):	P&O examination will be of Total 25 Marks and shall be based on the Project Demonstration, Presentation, and Report.

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXS69	SAT – IX: Skill-Based Learning (Mobile Application Development)	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Flutter, AJAX, Android SDK.				
Skill Prerequisites:	C & Java Programming.				
Skill Objectives (SOBs):	<div>1. To learn the basics of the Flutter framework.</div> <div>2. To develop the App UI by incorporating widgets, layouts, gestures, and animation.</div> <div>3. To create a production ready Flutter App by including files and firebase backend service.</div> <div>4. To learn the essential technologies, and Concepts of PWAs to get started as quickly and efficiently as possible.</div> <div>5. To develop responsive web applications by combining AJAX development techniques with the jQuery JavaScript library.</div> <div>6. To understand how service workers operate and also learn to test and deploy PWA.</div>				
Skill Outcomes (SOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Understand cross platform mobile application development using Flutter framework.</div> <div>2. Design interactive Flutter App by using widgets, layouts, gestures and animation.</div> <div>3. Analyze and build production ready Flutter App by incorporating backend services and deploying on Android / iOS.</div> <div>4. Understand various PWA frameworks and their requirements.</div> <div>5. Develop a responsive user interface by applying PWA design techniques.</div> <div>6. Develop and analyse PWA features and deploy it over app hosting solutions.</div>				
Module No. and Name	Subtopics	SOs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisites and Course Introduction	-	02	02	
1. Basics of Flutter Programming	Introduction of Flutter, Understanding Widget Lifecycle Events, Dart Basics, Widget Tree and Element Tree.	SO1	01	02	
	Basics of Flutter installation, Flutter Hello World App.	SO1	01		
2. Developing Flutter UI: Widgets, Layouts, Gestures, Animation	Using Common Widgets: SafeArea, AppBar, Column, Row, Container, Buttons, Text, Richtext, Form, Images and Icon, Building Layouts: High Level View of Layouts, Creating the Layout, Types of Layout Widgets.	SO2	02	06	
	Applying Gestures: Setting Up Gesture Detector, Implementing the Draggable and Drag target Widgets, Using the Gesture Detector for Moving and Scaling Adding Animation to an App: Using Animated Container, Using Animated CrossFade, Using	SO2	02		

	Animated Opacity, Using Animation Controller, Using Staggered Animation.			
	Creating An App's Navigation: Using the Navigator, Using the Named Navigator Route, Using the Bottom Navigation Bar, Using the Tab Bar and Tab Bar View.	SO2	02	
3. Creating Production Ready Apps	Working with files: Including Libraries in your Flutter App, including a File with your App, Reading / Writing to files, Using JSON.	SO3	01	04
	Using Firebase with Flutter: Adding the Firebase and Firestore Backend, Configuring the Firebase Project, Adding a Cloud Firestore Database and Implementing Security.	SO3	02	
	Testing and Deploying of Flutter Application: Widget Testing, Deploying Flutter Apps on Android / iOS.	SO3	01	
4. Introduction to Progressive Web App	Introduction to Progressive Web App, Why Progressive Web App, Characteristics of PWA, PWAs and Hybrid Apps versus Mobile Apps.	SO4	01	02
	PWA Requirements: HTTPS, Service Workers, and Web App Manifest, PWA Framework Tools, Use Cases.	SO4	01	
5. Creating Responsive UI	Creating Responsive UI using JQuery Mobile / Material UI / Angular UI / React UI, Understanding the Concept of Responsive Web Design, Comparing Responsive, Fluid, and Adaptive Web.	SO5	02	06
	Keys to Great Progressive Web App UX, Responsive Design – The Technicalities.	SO5	02	
	Flexible Grid-Based Layout, Flexible Images and Video, Smart Use of CSS Splitting the Website Behavior (Media Queries).	SO5	02	
6. Web App Manifest & Service Workers	Web App Manifest, Using an App Manifest to Make your App Installable, Understanding App Manifest Properties, Simulating the Web App on an Emulator, Installing the Web App - Prerequisites, Understanding manifest.json	SO6	02	05
	Service Workers: Making PWAs work Offline with Service Workers, Introduction to Service Workers, Service Workers Lifecycle (Registration, Installation and Activation), Implement Service Workers Features (Events), Handling Cached Content, Enabling Offline Functionality, Serving Push Notifications, Loading Cached Content for New Users, Background Synchronization, Using IndexedDB in the Service Worker, Geo-fencing.	SO6	02	
	Deploy a PWA to GitHub Pages as a free SSL enabled static app hosting solution, Initializing the PWA as a Git repository, Testing with Lighthouse, Deploying via GitHub Pages.	SO6	01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01

Text Books:	<ol style="list-style-type: none"> 1. M. Napoli, Beginning Flutter a Hands-on Guide to App Development, Wiley. 2. R. Payne, Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, Apress. 3. C. Love, Progressive Web Application Development by Example: Develop Fast, Reliable, and Engaging User Experiences for the Web, Packt Publishing. 4. T. Ater, Building Progressive Web Apps, O'Reilly. 5. H. Majid, Progressive Web Apps with Angular: Create Responsive, Fast and Reliable PWAs using Angular, Apress.
Reference Books:	<ol style="list-style-type: none"> 1. E. Windmill, Flutter in Action, Manning Publications. 2. P. Mainkar, S Giordano, Google Flutter Mobile Development Quick Start Guide, Packt Publishing. 3. J. Wargo, Learning Progressive Web Apps: Building Modern Web Apps Using Service Workers, Addison Wesley.
Useful Learning Links:	<ol style="list-style-type: none"> 1. https://flutter.dev/docs/reference/tutorials 2. https://www.tutorialspoint.com/flutter/index.htm 3. https://www.javatpoint.com/flutter 4. https://www.tutorialspoint.com/jquery_mobile/jqm_panel_responsive.htm 5. https://www.w3schools.com/css/css_rwd_intro.asp 6. https://developers.google.com/web/updates/2015/12/getting-started-pwa 7. https://www.w3schools.com/react/ 8. https://angular.io/docs 9. https://flaviocopes.com/service-workers/
Guidelines for Skill-Based Learning (SBL):	<ul style="list-style-type: none"> • Programming labs shall be conducted as 02 Hours of blended theory and hands-on session. • The classes will be conducted as a flipped classroom, where students have to attend class after reviewing the lessons provided to them beforehand. • Discussion on the topics and implementation of programs involving the concepts mentioned will be performed during the assigned lab hours.
Term Work (TW):	<ul style="list-style-type: none"> • Term Work evaluation shall be for Total 25 Marks based on Practical Performance. • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.

Exposure Course Code	Exposure Course Name	Credits			
		TH	P	TUT	Total
ITXT610	SAT – X: Technology-Based Learning	-	01	-	01
Prerequisites:	Basic Engineering and Technology courses.				
TBL Objectives (TOBs):	<ol style="list-style-type: none">1. To acquire competency in emerging areas of technology.2. To create a mindset for life-long learning required to persist technological shifts and be abreast with the market trends.3. To facilitate learning at self-paced schedules.4. To boost time management ability and self-discipline.5. To provide opportunities of strengthening digital footprints by showcasing the additional proficiency acquired as well as improve connectivity and networking.6. To enhance employment and entrepreneurial opportunities requiring specialization.				
TBL Outcomes (TOs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none">1. Explain concepts of the emerging technology learned through the pursued course.2. Describe social, ethical, and legal issues surrounding the learned technology.3. Demonstrate professionalism and skills of digital age learning and working.4. Demonstrate knowledge in entrance exams for higher technical education, placement interviews, and other avenues.5. Analyze real-world case studies in society/industry for applicability of sustainable technological solutions.6. Apply the acquired knowledge in developing technology-based solutions to real-world problems or other projects at hand.				
Guidelines for Technology-Based Learning (TBL):	<ol style="list-style-type: none">1. Learners should enroll for an online course based on their area of interest concerning emerging areas of technology in consultation with Faculty Supervisor nominated by the Head of Department.2. The course duration should be of minimum 04 weeks.3. Students should watch all the videos of the course to learn the course in-depth and entirety.4. Students should solve weekly assignments that are to be submitted online within the prescribed deadline.5. Students should register and appear for the course certification exam on scheduled date and time.6. Students should submit the certificate of course completion to the Faculty Supervisor.7. Faculty Supervisor shall monitor students’ participation and progress at every stage — from course enrolment to certification.				
Useful Learning Links:	<ol style="list-style-type: none">1. https://swayam.gov.in2. https://www.nptel.ac.in3. https://www.coursera.org				
Term Work (TW):	Term Work evaluation shall be for Total 25 Marks based on progress and completion of the course.				

SEMESTER VII - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC701	Artificial Intelligence and Data Science - II	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITC702	Internet of Everything	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC703	Department Level Elective – III	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITDLC704	Department Level Elective – IV	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ILC705	Institute Level Elective – I	3 – 0 – 0	03	3 – 0 – 0	03	OE-ILC
ITL701	Artificial Intelligence and Data Science Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL702	IoE Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL704	Department Level Elective – IV Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITPR75	PBL – Major Project A	0 – 06 – 0	06*	0 – 3 – 0	03	PBL
Total		15 – 12 – 0	27	15 – 6 – 0	21	

*Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC701	Artificial Intelligence and Data Science - II	30	30	30	10	60	-	-	-	-	100
ITC702	Internet of Everything	30	30	30	10	60	-	-	-	-	100
ITDLC703	Department Level Elective – III	30	30	30	10	60	-	-	-	-	100
ITDLC704	Department Level Elective – IV	30	30	30	10	60	-	-	-	-	100
ILC705	Institute Level Elective – I	30	30	30	10	60	-	-	-	-	100
ITL701	Artificial Intelligence and Data Science Lab	-	-	-	-	-	25	-	-	25	50
ITL702	IoE Lab	-	-	-	-	-	25	-	-	25	50
ITDLL704	Department Level Elective – IV Lab	-	-	-	-	-	25	-	-	25	50
ITPR75	PBL – Major Project A	-	-	-	-	-	25	-	-	50	75
Total		150	150	150	50	300	100	-	-	125	725

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, OE-ILC – Open Elective - Institute Level Elective Course, PBL – Project-Based Learning, CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses & Labs (PE-DLC – III & PE-DLC – IV)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Reinforcement Learning (ITDLC7031)	Advanced Computer Networks (ITDLC7032)	Multimedia Systems (ITDLC7033)	Software Testing & Quality Assurance (ITDLC7034)
Machine Learning and Deep Learning (ITDLC7041)	Ethical Hacking and Digital Forensics (ITDLC7042)	Computer Vision (ITDLC7043)	UI/UX Design Specializations (ITDLC7044)
Machine Learning and Deep Learning Lab (ITDLL7041)	Digital Forensics Lab (ITDLL7042)	Computer Vision Lab (ITDLL7043)	UI/UX Design Lab (ITDLL7044)

Open Electives - Institute Level Elective Courses (OE-ILC – I)

Courses
Product Lifecycle Management (ILC7051)
Reliability Engineering (ILC7052)
Management Information System (ILC7053)
Design of Experiments (ILC7054)
Operations Research (ILC7055)
Cyber Security and Laws (ILC7056)
Disaster Management & Mitigation Measures (ILC7057)
Energy Audit and Management (ILC7058)
Development Engineering (ILC7059)

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC701	Artificial Intelligence and Data Science - II	03	-	-	03
Prerequisites:	Applications of Mathematics in Engineering, Data Structures.				
Course Objectives (COBs):	1. To understand recent trends in the field of AI and DS. 2. To understand data visualization and analyze data using different graphs. 3. To demonstrate data visualization using advanced charts like Google charts, D3.js. 4. To demonstrate cognitive skills of Artificial Intelligence. 5. To introduce to the Soft Computing techniques like Neural Network, Fuzzy Logic and Genetic Algorithm. 6. To understand and implement applications using concepts of AI and DS.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the recent trends in the field of AI and DS. 2. Analyze data by plotting various graphs. 3. Implement data visualizations using advanced charts for Machine Learning applications. 4. Explain the process of building a cognitive application. 5. Develop solutions to complex real-world problems using Soft Computing techniques. 6. Develop applications using concepts of AI and DS.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Trends in AI and DS	Structured and Unstructured Data, AI for Text, Video, Audio, Spatial, Image, Graph, etc. based applications.	CO1	04	04	
2. Data Visualization and EDA	Need for Exploratory Data Analysis, Key factors of data visualization, Exploring the Visual Data Spectrum: charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Exploring advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts, Infographics).	CO2	03	06	
	Acquiring and Visualizing Data from Text Files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data (Building a table, Using Semantic Table, Configuring the columns), Assuring Maximum readability (Styling your table, Increasing readability, Adding dynamic Highlighting), Including computations, Using data tables library, relating data table to a chart.	CO2	03		
3. Data Visualization Programmatically	Google Charts, Google Charts API, Chart Animations.	CO3	02	08	
	D3.js: Making Selections, Changing Selection’s Attribute, Loading and Filtering External Data, Data Formats Usable with D3, Creating a Server to Upload Data, D3’s Function for Loading Data, Dealing with Asynchronous Requests, Loading and Formatting Large Data Sets	CO3	03		

	Making Charts Interactive and Animated: Data Joins, Updates and Exits, Interactive Buttons, Updating Charts, Adding Transactions, Using Keys	CO3	03	
4. Cognitive Computing	Foundations of Cognitive Computing, Design Principles for Cognitive Systems, Natural Language Processing in support of a Cognitive System.	CO4	02	06
	Representing knowledge in Taxonomies and Ontologies, Applying advanced Analytics to Cognitive Computing, The process of building a Cognitive application.	CO4	04	
5. Introduction to Soft Computing	Soft computing vs Hard computing, Components and Applications of Soft Computing.	CO5	01	06
	Introduction to Genetic Algorithm, Biological background, Operations in Genetic Algorithm.	CO5	02	
	Introduction to Fuzzy sets, Properties of Fuzzy sets, Operations on Fuzzy sets, Fuzzy Membership Functions, Fuzzy Relations with Operations and its properties, Fuzzy composition: Max-Min Composition, Max-Product Composition, Defuzzification Methods.	CO5	03	
6. Applications of AI and DS	Recommendation Systems – Model for Recommendation Systems, Utility Matrix, Content-Based Recommendations, Discovering Features of Documents, Collaborative Filtering.	CO6	03	09
	Social Network Graphs – Clustering of Social Network Graphs, Partitioning of Graphs, and Finding Overlapping Communities.	CO6	03	
	Time Series - Naïve Forecasts, Smoothing Methods: Introduction, Moving Average, Simple Exponential Smoothing, Advanced Exponential Smoothing, Regression Based Forecasting, Autocorrelation and ARIMA Models.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	1. C. Wilke, Fundamentals of Data Visualization, O’ Reilly Media. 2. L. Kanal, Search in Artificial Intelligence, Springer. 3. J. Hurwitz, Cognitive Computing and Big Data Analytics, Wiley. 4. S. Deepa, Principles of Soft Computing, Wiley.			
Reference Books:	1. B. Uma, Introduction to Data Science Practical Approach with R and Python, Wiley. 2. J. Krohn, Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence, Pearson. 3. P. Joshi, Artificial Intelligence with Python, Packt.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc20_cs46/preview 2. https://www.udemy.com/course/complete-data-visualization-in-python/ 3. https://www.coursera.org/learn/python-visualization			

Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC702	Internet of Everything	03	-	-	03
Prerequisites:	Internet of Thing, Wireless Technology.				
Course Objectives (COBs):	1. To understand levels of the IoT architectures. 2. To correlate the connection of smart objects and IoT access technologies. 3. To Interpret edge to cloud protocols. 4. To explore data analytics and data visualization on IoT Data. 5. To explore IoT applications. 6. To explore attacks and threats in IoE				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Differentiate between the levels of the IoT architectures. 2. Analyze the IoT access technologies. 3. Illustrate various edge to cloud protocol for IoT. 4. Apply IoT analytics and data visualization. 5. Analyze and evaluate IoT applications. 6. Analyze the attacks and threats in IoE.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction and IoE Architecture	Introduction of IoE, Drivers Behind New Network Architectures: Scale, Security, Constrained Devices and Networks, Data, Legacy Device Support. Architecture: The IoT World Forum (IoTWF) Standardized Architecture: Layer 1-7, IT and OT Responsibilities in the IoT Reference Model, Additional IoT Reference Models.	CO1	03	07	
	A Simplified IoT Architecture, The Core IoT Functional Stack:: Layer 1-3, Analytics Versus Control Applications, Data Versus Network Analytics Data Analytics Versus Business Benefits, Smart Services,	CO1	02		
	IoT Data Management and Compute Stack: Fog Computing, Edge Computing, The Hierarchy of Edge, Fog, and Cloud.	CO1	02		
2. Principles of Connected Devices and Protocols in IoE	RFID and Near-Field Communication, Bluetooth Low Energy (BLE) roles, Li Fi, WPAN standard: 802.15 standards: Bluetooth, IEEE 802.15.4, Zigbee, Z-wave, Narrow Band IoT,	CO2	03	06	
	Internet Protocol and Transmission Control Protocol, 6LoWPAN, WLAN and WAN, IEEE 802.11, Long-range Communication Systems and Protocols: Cellular Connectivity-LTE, LTE-A, LoRa and LoRaWAN.	CO2	03		

3. Edge to Cloud Protocol	HTTP WebSocket, Platforms, HTTP Complex Flows: IoT Patterns: Real-time Clients, MQTT, MQTT-SN.	CO3	03	07
	Constrained Application Protocol (CoAP), Streaming Text Oriented Message Protocol (STOMP), Advanced Message Queuing Protocol (AMQP), Comparison of Protocols.	CO3	04	
4. IoE and Data Analytics.	Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud, Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets,	CO4	03	06
	Managing Data Lakes, Data Retention Strategy, Visualization and Dashboarding: Designing visual analysis for IoT data, creating a dashboard, creating and visualizing alerts.	CO4	03	
5. IoE Application Design	Prototyping for IoT and M2M, Case Studies: Home Automation (Smart lighting, Home intrusion detection), Cities (Smart Parking), Environment (Weather Monitoring, Weather Reporting Bot, Air Pollution Monitoring, Forest Fire Detection, Agriculture (Smart Irrigation), Smart Library.	CO5	05	08
	Introduction to I-IoT, Use Cases of the I-IoT, IoT and I-IoT Similarities and Differences, Introduction to Internet of Behaviour (IoB).	CO5	03	
6. IoE Security	Phases of IoT System, Internet of Things as Interconnections of Threats: Phase attacks.	CO6	03	05
	Attacks as per Architecture, Attacks based on Components.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. A. Bahga and V. Madisetti, Internet of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020 2. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, J. Henry, IoT Fundamentals 3. Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO. 4. A. Minter, P.Bhaga and V. Madisetti, Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices. Internet of Things (A Hands-on-Approach), Wiley. 5. G. Veneri , A. Capasso, “Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0”, Packet 6. A. Minter, Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices., Packet 			
Reference Books:	<ol style="list-style-type: none"> 1. S. Greengard, The Internet of Things, MIT Press. 2. H. Chabanne, RFID and the Internet of Things, Wiley. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/108/108/108108179/ 2. https://nptel.ac.in/courses/106/105/106105195/ 3. https://www.coursera.org/specializations/uiuc-iot 4. https://www.coursera.org/specializations/internet-of-things 5. https://owasp.org/www-project-internet-of-things/ 			

Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7031	Reinforcement Learning	03	-	-	03
Prerequisites:	Artificial Intelligence , Mathematics				
Course Objectives (COBs):	<div>1. Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning.</div> <div>2. Introduce to statistical learning techniques where an agent explicitly takes actions and interacts with the world.</div> <div>3. Implement in code common RL algorithms.</div> <div>4. Describe multiple criteria for analyzing RL algorithms & evaluate algorithms on these metrics: e.g. regret, sample complexity, computational complexity, empirical performance, convergence, etc.</div> <div>5. Know how to implement dynamic programming as an efficient solution approach to an industrial controlproblem.</div> <div>6. Explore solutions to the Exploration-Exploitation Dilemma.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Explain RL tasks and the core principles behind the RL, including policies,value functions, deriving Bellman equations.</div> <div>2. Discuss tabular methods to solve classical control problems.</div> <div>3. Apply Markov Decision Processes to solve real-world problems.</div> <div>4. Understand the dynamic programming for policy Evaluation.</div> <div>5. Implement reinforcement learning problems based on averaging sample returns using Monte Carlo method.</div> <div>6. Explain current advanced techniques and applications in RL.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Reinforcement Learning	Reinforcement Learning: Key features and Elements of RL,Types of RL, rewards.	CO1	03	06	
	Reinforcement Learning Algorithms: Q-Learning, StateAction Reward State Action (SARSA).	CO1	03		
2. Bandit Problems and online learning	An n-Armed Bandit Problem, Action-Value.	CO2	02	07	
	MethodsTracking a Nonstationary Problem.	CO2	02		
	Optimistic Initial Values Upper-Confidence-Bound Action Selection Gradient Bandits, Thomson Learning Algorithm.	CO2	03		
3. Markov Decision Processes	The Agent–Environment Interface, Goals and Rewards.	CO3	02	07	
	Returns, Markov properties, MarkovDecision Process	CO3	02		
	Value Functions and Optimal Value Functions.	CO3	03		
4. Dynamic Programming	Policy Evaluation (Prediction), Policy Improvement.	CO4	02	07	
	PolicyIteration, Value Iteration.	CO4	02		

	Asynchronous Dynamic Programming, Generalized Policy Iteration.	CO4	03	
5. Monte Carlo Methods and Temporal-Difference Learning	Monte Carlo Prediction.	CO5	02	07
	Monte Carlo Estimation of Action Values, Monte Carlo Control.	CO5	02	
	TD Prediction, TD control using Q-Learning.	CO5	03	
6. Applications and Case Studies	Elevator Dispatching, Dynamic Channel Allocation.	CO6	03	05
	Job-Shop Scheduling.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. R. Sutton and A. Barto, Reinforcement Learning: An Introduction. 2. A. Palmas, A. Petre, E. Ghelfi, The Reinforcement Learning Workshop: Learn how to Apply Cutting-edge Reinforcement Learning Algorithms to a Wide Range of Control Problems, Packt. 3. P. Winder, Reinforcement Learning Industrial Applications with Intelligent Agents, O'Reilly. 4. Dr. Engr S.M.F. Akhtar, Practical Reinforcement Learning, Packt. 			
Reference Books:	<ol style="list-style-type: none"> 1. M. Lapan, Deep Reinforcement Learning Hands-On, AlphaGo Zero. 2. C. Szepesvári, Algorithms for Reinforcement Learning, Morgan & Claypool. 3. Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, Pearson. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc19_cs55/preview 2. https://www.coursera.org/specializations/reinforcement-learning 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7032	Advanced Computer Networks	03	-	-	03
Prerequisites:	Computer Networks.				
Course Objectives (COBs):	<div>1. To make learners aware about advances in computer networking technologies.</div> <div>2. To give overview of advance internet, QoS based and management protocols.</div> <div>3. To study the internet routing protocols.</div> <div>4. To introduce issues related to traffic engineering and capacity planning.</div> <div>5. Study the concept of network management.</div> <div>6. To analyze the software defined network and traditional network.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe the advanced data communication technologies.</div> <div>2. Explain packet switching protocols such as X.25, X.75.</div> <div>3. Analyse the issues of advanced internet routing protocols and also QoS-based protocols.</div> <div>4. Analyse issues of traffic requirements and perform capacity planning.</div> <div>5. Apply protocols for the management of the network.</div> <div>6. Compare OpenFlow controllers and switches with other traditional networks.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Data Communications	Defining Data Communication needs, Transmission Hierarchy.	CO1	02	04	
	Optical Networks: SONET/SDH Standard, Architecture, Format, Hardware, Configuration, Advantages.	CO1	02		
2. Protocols and Interfaces	Introduction to TCP/IP: Issues in IPV4, IPV6 protocol.	CO2	02	08	
	Mature Packet Switching Protocols: ITU Recommendation X.25, User Connectivity, Theory of Operations, Network Layer Functions.	CO2	03		
	X.75 Internetworking Protocol, Advantages and Drawbacks.	CO2	03		
3. Advance Routing Protocols	Internet Routing Protocols: OSPF, RIP, BGP Multicast Routing: Reverse Path Broadcasting, Internet Group Management Protocol, Reverse Path Multicasting, Discrete Vector Multicasting protocol.	CO3	03	10	
	IP Forwarding Architectures, Overlay Model: Classical IP over ATM and LANE.	CO3	02		
	Multiprotocol Label Switching MPLS Fundamentals of Labels, Label Stack, VC Merging, Label Distribution Protocol, Explicit routing for Traffic Engineering.	CO3	02		
	Integrated Services, RSVP, Differentiated Services.	CO3	01		
	Multimedia Over Internet: RTP, Session Control Protocol H.323.	CO3	02		

4. Traffic Engineering	Requirement Definition: User requirement Traffic Sizing, Traffic Characteristics, Protocols, Time and Delay Considerations.	CO4	04	08
	Traffic Engineering and Capacity planning: Throughput Calculation, Traffic Engineering Basics, Traditional Traffic Engineering and Queued Data and Packet Switched Packet Modelling, Queuing Disciplines(M/M/1), Design Parameters for Peak: Delay or Latency, Availability and Reliability.	CO4	04	
5. Network Management	Network Management: SNMP Concept and Format.	CO5	02	04
	Management Components: SMI, MIB.	CO5	02	
6. Software Define Network	Understanding SDN and Open flow: SDN, SDN Building Blocks, OpenFlow Messages, Controller to Switch, Symmetric and Asynchronous Messages.	CO6	02	05
	Implementing OpenFlow Switch, OpenFlow Controllers, POX and NOX, Open Flow in Cloud Computing.	CO6	02	
	Case Study: How SDN Changed Traditional Enterprise Network Design.	CO6	01	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	1. M. Gallo and W. Hancock, Computer Communications and Networking Technologies, Cengage Learning. 2. Leon-Garcia, Communication Networks, McGraw Hill. 3. D. L. Spohn, Data Network Design, McGraw Hill. 4. B. Forouzan, TCP/IP Protocol Suite, McGraw Hill. 5. W. Stallings, High-Speed Networks and Internets, Pearson. 6. S. Azodolmolky, Software Defined Networking with Open Flow, Packt Publishing.			
Reference Books:	1. A. Tanenbaum, Computer Networks, PHI. 2. T. Lammle, Cisco Certified Network Analyst Study Guide, Wiley. 3. D. Comer, Internetworking with TCP/IP, Pearson. 4. J. Kurose, K.W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, Addison Wesley.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105183/ 2. https://www.coursera.org/learn/tcpip			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7033	Multimedia Systems	03	-	-	03
Prerequisites:	Computer Graphics.				
Course Objectives (COBs):	1. To learn and understand technical aspect of Multimedia Systems. 2. To understand the standards available for different audio, video and text applications. 3. To Design and develop various Multimedia Systems applicable in real time. 4. To learn various multimedia authoring systems. 5. To understand various networking aspects used for multimedia applications. 6. To develop multimedia application and analyze the performance of the same.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the technical aspect of Multimedia Systems. 2. Explain various file formats for audio, video and text media. 3. Explain various Multimedia Systems applicable in real time. 4. Explain interactive multimedia software. 5. Describe various networking protocols for multimedia applications. 6. Explain multimedia system design and its issues.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Multimedia Systems	Multimedia Elements, Multimedia Systems Architecture, Evolving Technologies for Multimedia Systems, Defining Objects for Multimedia Systems, Multimedia Data Interface Standards.	CO1	03	06	
	The Need for Data Compression, Multimedia Applications Including Digital Libraries, System Software, Streaming Videos and its Applications.	CO1	03		
2. Compression and Decompression	Types of Compression, Image Compression Schemes, Video Compression, Audio Compression, Rich-Text Format. TIFF File Format.	CO2	04	08	
	Resource Interchange File Format (RIFF), MIDI File Format, JPEG DIB File Format for Still and Motion Images, JPEG Still Image.	CO2	04		
3. Multimedia Application Design	Multimedia Application Classes, Types of Multimedia Systems, Virtual Reality Design.	CO1, CO2, CO3	03	06	
	Components of Multimedia Systems, Multimedia Database Issues and Solutions, Organizing Multimedia Databases.	CO1, CO2, CO3	03		
4. Multimedia Authoring, User Interface Design	Multimedia Authoring Systems, Hypermedia Application Design Considerations, User Interface Design.	CO4	03	06	
	Information Access, Object Display and Playback Issues.	CO4	03		

5. Distributed Multimedia Systems	Components of a Distributed Multimedia System, Distributed Client-Server Operation, Middleware in Distributed Workgroup Computing, Multi-server Network Topologies.	CO4, CO5	03	06
	Distributed Multimedia Databases, Managing Distributed Objects, Application Workflow Design Issues, Distributed Application Design Issues.	CO4, CO5	03	
6. System Design: Methodology and Considerations	Fundamental Design Issues, Determining Enterprise Requirements, Examining Current Architecture and Feasibility, Performance Analysis.	CO5, CO6	03	07
	Designing for Performance Multimedia System Design, System Extensibility, Multimedia Systems Design Example.	CO5 CO6	04	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	1. P. Andleigh and K. Thakrar, Multimedia Systems Design, Pearson. 2. Z. Li and M. Drew, Fundamentals of Multimedia, Springer. 3. K. Roa, Z. Bojkovic and D. Milovanovic, Introduction to Multimedia Communication, Application, Middleware, Networking, Wiley.			
Reference Books:	1. M. Burke, Organization of Multimedia Resources: Principles and Practice of Information Retrieval, Routledge. 2. P. Andleigh and K. Thakrar, Multimedia Systems Design, Pearson.			
Useful Links:	1. https://nptel.ac.in/courses/117/105/117105083/# 2. https://www.coursera.org/lecture/internet-of-things-multimedia/multimedia-computing-and-classification-KRa30			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7034	Software Testing and Quality Assurance	03	-	-	03
Prerequisites:	Software Engineering				
Course Objectives (COBs):	<div>1. To learn the basic software debugging methods.</div> <div>2. To study white box testing methods and techniques.</div> <div>3. To study black box testing methods and techniques.</div> <div>4. To impart knowledge of designing test plans.</div> <div>5. To demonstrate notions of normalization for database design.</div> <div>6. To study different testing tools.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to-</div> <div>1. Describe the reason for bugs and analyze the principles in software testing to prevent and remove bugs.</div> <div>2. Explain various test processes for quality improvement.</div> <div>3. Describe how to manage the test process.</div> <div>4. Explain the software testing techniques in commercial environment.</div> <div>5. Describe web-based systems and traditional testing.</div> <div>6. Describe software quality management standards.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Testing Methodology	Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing versus Exhaustive.	CO1	03	09	
	Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology.	CO1	03		
	Verification and Validation, Verification Requirements, Verification of High-Level Design, Verification of Low-Level Design, Validation.	CO1	03		
2. Testing Techniques	Dynamic Testing: Black Box Testing: Boundary Value Analysis, Equivalence Class Testing, State Table-Based Testing, Cause-Effect Graphing Based Testing.	CO2	03	09	
	White Box Testing Techniques: Need, Logic Coverage Criteria, Basis Path Testing, Graph Matrices, Loop Testing, Data Flow Testing.	CO2	02		
	Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing.	CO2	02		
	Regression Testing: Progressive versus Regressive, Regression Testing Produces Quality Software, Regression Testability, Objectives of Regression Testing, Regression Testing Types.	CO2	02		

3. Managing the Test Process	Test Management: Test Organization, Structure and of Testing Group, Test Planning, Detailed Test Design and Test Specification.	CO3	03	06
	Software Metrics: Need, Definition and Classification of Software Matrices.	CO3	03	
4. Test Automation	Automation and Testing Tools: Need, Categorization, Selection and Cost in Testing Tool, Guidelines for Testing Tools.	CO4	02	07
	Selenium Basic Terminology, Selenium Features, Selenium, Web Driver, Web Driver Architecture, Web Driver Features.	CO4	03	
	Case Study on JIRA.	CO4	02	
5. Testing for Specialized Environment	Agile Testing, Agile Testing Life Cycle, Testing in Scrum Phases, Challenges in Agile Testing.	CO5	02	05
	Testing Web based Systems: Web Based System, Web Technology Evaluation, Traditional Software and Web-Based Software, Challenges in Testing for Web-Based Software, Testing Web-based Testing.	CO5	03	
6. Quality Management	Software Quality Management, McCall's Quality Factors and Criteria.	CO6	02	03
	ISO 9126 Quality Characteristics, ISO 9000:2000, Software Quality Management.	CO6	01	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	1. N. Chahuan, Software Testing Principles and Practices Oxford Higher Education. 2. N. Kshirasagar and T. Priyadarshi, Software Testing and Quality Assurance Theory and Practice, Wiley.			
Reference Books:	1. E. William, Effective Methods for Software Testing, Wiley.			
Useful Links:	1. https://www.coursera.org/learn/introduction-software-testing 2. https://www.coursera.org/specializations/software-testing-automation 3. https://onlinecourses.nptel.ac.in/noc19_cs71/preview 4. https://www.udemy.com/course/becoming-a-software-tester/ 5. https://onlinecourses.nptel.ac.in/noc20_cs19/preview			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7041	Machine Learning and Deep Learning	03	-	-	03
Prerequisites:	Fundamentals of Data Mining and Fundamentals of Mathematics.				
Course Objectives (COBs):	1. To understand the fundamentals concepts of Machine Learning. 2. To understand the functioning of Neural Networks. 3. To understand need and apply concepts of Ensemble Learning. 4. To design Convolutional Neural Network for real-life application. 5. To design Recurrent Neural Network for real-life applications. 6. To understand advanced concepts in Deep Learning.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the Machine Learning components and challenges. 2. Apply Ensemble methods for performance enhancement of Machine Learning algorithms and analyze their performance. 3. Explain the concepts of Neural Networks, its algorithms, applications, and limitations. 4. Apply Convolutional Neural Networks for real-world applications. 5. Apply Recurrent Neural Networks for real-world applications. 6. Apply advanced techniques in Deep Learning.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Machine Learning Fundamentals	Introduction to Machine Learning (ML): Applications, Data, Types.	CO1	01	07	
	Designing a Machine Learning Model: Project Setup, Data Pipeline, Modeling, Serving.	CO1	03		
	Probability Theory: Random Variables, Distributions, Maximum Likelihood Estimation, Bias and Variance.	CO1	02		
	Overfitting and Underfitting, Challenges Motivating Deep Learning.	CO1	01		
2. Ensemble Learning	Introduction of Ensemble Methods, Need and Usefulness in Enhancing ML Algorithms, Bagging, Boosting.	CO2	03	06	
	Random Forest, Incremental Learning.	CO2	02		
	Performance Evaluation Metrics of ML Algorithms.	CO2	01		
3. Basic Neural Networks	Biological Neuron, Introduction to Neural Networks, Basic Architecture, Types of Neural Networks.	CO3	01	06	
	Activation Functions, Single Layer Perceptron and Multilayer Perceptron, Multilayer Feed Forward Network (FFN).	CO3	02		
	Backpropagation Algorithm, Variations in Standard Backpropagation, Vanishing Gradient Problem, Exploding Gradient Problem.	CO3	03		

4. Convolutional Neural Networks	Introduction to Convolutional Neural Networks (CNN), Components, ReLU Layer, Training a Convolutional Network.	CO4	02	07
	Case Studies of Convolutional Architectures: AlexNet, GoogLeNet, ResNet, The Effects of Depth, Pre-trained Models.	CO4	03	
	Applications of CNN.	CO4	02	
5. Recurrent Neural Networks	Introduction to Recurrent Neural Networks (RNN), Architecture, RNN versus CNN, RNN versus FNN.	CO5	02	07
	Training Recurrent Networks and Challenges Thereof, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRUs).	CO5	03	
	Applications of Recurrent Neural Networks.	CO5	02	
6. Advanced Topics in Deep Learning	Attention Mechanisms, Autoencoders, Generative Adversarial Networks (GANs), Training a GAN, Comparison with Variational Autoencoders (VAE).	CO6	03	06
	Using GANs for Generating Image Data, Conditional GANs, Evaluating Generative Models.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	1. S. Rose, L. Kumar, D Renuka, Deep Learning using Python, Wiley. 2. I. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press. 3. T. Mitchell, Machine Learning, McGraw Hill.			
Reference Books:	1. C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer. 2. J. Han, M. Kamber, Data Mining Concepts and Techniques, Morgan Kaufmann. 3. M. Nielsen, Neural Networks and Deep Learning, Determination Press.			
Useful Links:	1. http://neuralnetworksanddeeplearning.com/ 2. https://www.coursera.org/specializations/deep-learning 3. https://onlinecourses.nptel.ac.in/noc20_cs62/preview 4. https://onlinecourses.nptel.ac.in/noc22_cs29/preview			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7042	Ethical Hacking and Digital Forensics	03	-	-	03
Prerequisites:	Computer Networks, Computer Network Security.				
Course Objectives (COBs):	1. To remember the concept of cybercrime and principles behind ethical hacking. 2. To explore the fundamentals of digital forensics, digital evidence and incident response. 3. To learn the tools and techniques required for computer forensics. 4. To understand the network attacks and tools and techniques required to perform network forensics. 5. To learn how to investigate attacks on mobile platforms. 6. To generate a forensics report after investigation.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the concept of cybercrime and its effect on the outside world. 2. Explain the way of attacks with different types. 3. Analyze different tools and methods used in cybercrimes. 4. Describe IT law in various legal issues. 5. Analyze different aspects of cyber law. 6. Apply Information Security Standards compliance during software design and development.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Cybercrime and Ethical Hacking	Introduction to Cybercrime, Types of Cybercrime, Classification of Cybercriminals, Role of Computer in Cybercrime, Prevention of Cybercrime.	CO1	03	07	
	Ethical Hacking, Goals of Ethical Hacking, Phases of Ethical Hacking, Difference between Hackers, Crackers and Phreakers, Rules of Ethical Hacking.	CO1	04		
2. Digital Forensics Fundamentals	Introduction to Digital Forensics, Need and Objectives of Digital Forensics, Types of Digital Forensics, Process of Digital Forensics, Benefits of Digital Forensics, Chain of Custody, Anti Forensics.	CO2	03	06	
	Digital Evidence and its Types, Rules of Digital Evidences.	CO2	01		
	Incident Response, Methodology of Incident Response, Roles of CSIRT in Handling Incident.	CO2	02		
3. Computer Forensics Fundamentals	Introduction to Computer Forensics, Evidence Collection (Disk, Memory, Registry, Logs, etc.).	CO3	03	08	
	Evidence Acquisition, Analysis and Examination (Window, Linux, Email, Web, Malware).	CO3	03		
	Challenges in Computer Forensics, Tools used in Computer Forensics.	CO3	02		

4. Network Forensics Fundamentals	Introduction, Evidence Collection and Acquisition (Wired and Wireless), Analysis of Network Evidences (IDS, Router).	CO4	05	08
	Challenges in Network Forensics, Tools used in Network Forensics.	CO4	03	
5. Mobile Forensics Fundamentals	Introduction, Evidence Collection and Acquisition.	CO5	02	06
	Analysis of Evidences, Challenges in Mobile Forensics, Tools used in Mobile Forensics.	CO5	04	
6. Report Generation Fundamentals	Goals of Report, Layout of an Investigative Report.	CO6	02	04
	Guidelines for Writing a Report, Sample for Writing a Forensic Report.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	1. J. Sammons, The Basics of Digital Forensics: The Premier for Getting Started in Digital Forensics, Syngress. 2. N. Jain and D. Kalbande, Digital Forensic: The Fascinating World of Digital Evidences, Wiley. 3. J. Luttgens, M. Pepe and K. Mandia, Incident Response and Computer Forensics, McGraw Hill.			
Reference Books:	1. S. Chaudhuri and M. Chatterjee, Digital Forensics, Staredu. 2. B. Nelson, A. Phillips and C. Steuart, Guide to Computer Forensics and Investigations, Course Technology. 3. D. Littlejohn Shinder Michael Cross, Scene of the Cybercrime: Computer Forensics Handbook, Syngress Publishing.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105217/ 2. https://nptel.ac.in/courses/106/105/106105162/ 3. https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks 4. https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7043	Computer Vision	03	-	-	03
Prerequisites:	Image Processing, Artificial Intelligence.				
Course Objectives (COBs):	1. To review image processing techniques for computer vision. 2. To understand shape and region analysis. 3. To understand Hough Transform and its applications to detect lines, circles, ellipses. 4. To understand three-dimensional image analysis techniques. 5. To understand motion analysis. 6. To implement computer vision algorithms for real-world problems.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain and apply fundamental image processing techniques required for computer vision. 2. Analyze shapes and regions using suitable algorithms. 3. Apply Hough Transform for line, circle, and ellipse detections. 4. Describe and analyze 3D vision techniques. 5. Describe motion analysis. 6. Describe applications using computer vision techniques.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Image Processing Foundation	Review of Image Processing Techniques, Comparison between Image Processing and Computer Vision.	CO1	02	04	
	Corner and Interest Point Detection, Texture And Co-Occurrence Matrix.	CO1	02		
2. Shapes and Regions	Binary Shape Analysis, Connectedness, Object Labelling and Counting, Size Filtering, Distance Functions, Skeletons and Thickening and Thinning, Hole Filling.	CO2	04	08	
	Deformable Shape Analysis, Boundary Tracking Procedures, Active Contours, Shape Models and Shape Recognition, Centroidal Profiles, Handling Occlusion, Boundary Length Measures, Boundary Descriptors, Fourier Descriptors, Region Descriptors.	CO2	04		
3. Hough Transforms	Line Detection, Hough Transform (HT) for Line Detection, Foot-of-Normal Method, Line Localization, Line Fitting, RANSAC for Straight Line Detection, HT Based Circular Object Detection, Accurate Centre Location, Speed Problem, Ellipse Detection.	CO3	04	07	
	Case study: Human Iris Location, Hole Detection, Generalized Hough Transform (GHT), Spatial Matched Filtering, GHT for Ellipse Detection, Object Location, GHT for Feature Collation.	CO3	03		

4. 3D Vision	Methods For 3D Vision, Projection Schemes, Shape from Shading, Photometric Stereo, Shape from Texture, Shape from Focus.	CO4	04	08
	Active Range Finding, Surface Representations, Point-Based Representation, Volumetric Representations, 3D Object Recognition, 3D Reconstruction, SIFT Algorithms.	CO4	04	
5. Introduction to Motion	Triangulation, Bundle Adjustment, Translational Alignment, Parametric Motion.	CO5	03	06
	Spline-Based Motion, Optical Flow, Layered Motion.	CO5	03	
6. Applications and Case studies	Implementation of Application Like Face Recognition, Specific Examples on Surveillance, Foreground-Background Separation.	CO6	03	06
	Human Tracking and Image and Video Occlusion, Human Gait Analysis, Locating Roadway, Road Markings, Identifying Road Signs.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. D. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson. 2. J. Solem, Programming Computer Vision with Python: Tools and algorithms for analyzing images, O'Reilly. 3. S. Prince, Computer Vision: Models, Learning, and Inference, Ambridge University Press. 4. M. Sonka, Image Processing Computer Vision, Elsevier.			
Reference Books:	1. M. Nixon and A. Aquado, Feature Extraction & Image Processing for Computer Vision, Academic Press. 2. R. Jain, R. Kasturi, B. SchunckSahni, Machine Vision, Indo American Books. 3. R. Szeliski, Computer Vision: Algorithms and Applications, Springer.			
Useful Links:	1. https://nptel.ac.in/courses/106/105/106105216/# 2. https://www.coursera.org/learn/computer-vision-basics			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC7044	UI/UX Design Specializations	03	-	-	03
Prerequisites:	Web Technologies, Software Engineering.				
Course Objectives (COBs):	<div>1. To stress the importance of good interface design.</div> <div>2. To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.</div> <div>3. To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.</div> <div>4. To learn the techniques for prototyping and evaluating user experiences.</div> <div>5. To understand interaction design process.</div> <div>6. To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Explain fundamentals, limitations, and advantages of interface designs.</div> <div>2. Analyze conceptual design and cognitive aspects based on User experience.</div> <div>3. Analyze user needs and formulate user design specifications.</div> <div>4. Evaluate the data collected during the process.</div> <div>5. Explain designs based on theoretical frameworks and methodological approaches.</div> <div>6. Explain better techniques to improve the user interaction design interfaces.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Interaction Design	Good and Poor Design, Basics of Interaction Design, The User Experience.	CO1	03	06	
	The Process of Interaction Design, Interaction Design and the User Experience, Case Study UX, Accessibility.	CO1	03		
2. Conceptualizing Interaction Design	Understanding the Problem Space and Conceptualizing Design, Conceptual Model, Interface Types, Wireframe.	CO2	03	07	
	Cognitive Aspects, Social Interaction and the Emerging Social Phenomena, Emotions and the User Experience, Expressive and Frustrating Interfaces, Persuasive Technologies.	CO3	04		
3. Data Gathering, Establishing Requirements	Establishing Requirements, Five Key Issues, Techniques for Data Gathering.	CO4	03	07	
	Data Analysis Interpretation and Presentation, Task Description and Task Analysis.	CO4	04		
4. Process of Interaction Design	Interaction Design Process, Prototyping and Conceptual Design, Interface Metaphors and Analogies.	CO4	04	06	
	Introduction of Colour Palette - Case Study, Different Types of Design Pattern.	CO4	02		

5. Design Rules and Industry Standards	Design Principles, Principles to support Usability, Standards and Guidelines.	CO5	03	06
	Golden Rules and Heuristics, ISO/IEC Standards.	CO5	03	
6. Evaluation Techniques and Framework	The Why, What, Where and When of Evaluation, Types of Evaluation, Case Studies, DECIDE Framework, Usability Testing.	CO5, CO6	04	07
	Conducting Experiments, Field Studies, Heuristic Evaluation and Walkthroughs, Predictive Models, Matrix Analysis and Feedback.	CO5, CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. J. Preece, Y. Rogers and H. Sharp., Interaction Design, Wiley. 2. A. Dix, J. Finlay, G. Abowd, R. Beale, Human Computer Interaction, PHI. 3. A. Cooper, R. Reimann, and D. Cronin, About Face3: Essentials of Interaction Design, Wiley. 4. W. Galitz, The Essential Guide to User Interface Design, Wiley. 			
Reference Books:	<ol style="list-style-type: none"> 1. R. Hartson and P. Pyla, The UX Book, Morgan Kaufmann. 2. N. Donald, The Design of Everyday Things, Basic Books. 3. J. Johnson, Designing with the Mind in Mind, Morgan Kaufmann. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc21_ar05/preview 2. https://www.edusparkz.com/course_details?course_id=11263 3. https://www.coursera.org/specializations/user-interface-design 4. https://www.classcentral.com/course/swayam-user-interface-design-12889 5. https://www.udemy.com/topic/user-interface/ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7051	Product Lifecycle Management	03	-	-	03
Prerequisites:	Fundamentals of Engineering.				
Course Objectives (COBs):	<div>1. To familiarize the students with the need, benefits and components of PLM.</div> <div>2. To acquaint students with Product Data Management & PLM strategies.</div> <div>3. To give insights into new product development program and guidelines for designing and developing a product.</div> <div>4. To familiarize the students with Virtual Product Development.</div> <div>5. To familiarize the students with the need, benefits and components of PLM.</div> <div>6. To acquaint students with Product Data Management & PLM strategies.</div> <div>7. To give insights into new product development program and guidelines for designing and developing a product.</div> <div>8. To familiarize the students with Virtual Product Development.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Apply the different phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.</div> <div>2. Analyze various approaches and techniques for designing and developing products.</div> <div>3. Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal working etc.</div> <div>4. Applying virtual product development tools for components, machining and manufacturing plant.</div> <div>5. Explain integration of environmental aspects in product design.</div> <div>6. Analyze the life cycle assessment and life cycle cost analysis.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Product Lifecycle Management (PLM)	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications.	CO1	06	10	
	PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.	CO1	04		

2. PLM Strategies	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering.	CO2	05	09
	Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and their use in the Design Process.	CO2	04	
3. Product Data Management (PDM)	Product Data Management (PDM): Product and Product Data, PDM systems and Importance.	CO3	02	05
	Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.	CO3	03	
4. Virtual Product Development Tools	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques.	CO4	02	05
	Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case studies.	CO4	03	
5. Integration of Environmental Aspects in Product Design	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies.	CO5	03	05
	Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.	CO5	02	
6. Life Cycle Assessment and Life Cycle Cost Analysis	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment.	CO6	03	05
	Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. J. Stark, Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer.			

Reference Books:	<ol style="list-style-type: none"> 1. F. Giudice, G. Rosa, Antonino Risitano, Product Design for the environment - A life cycle approach, Taylor & Francis. 2. S. Antti, I. Anselmie, Product Life Cycle Management, Springer, Dreamtech. 3. M. Grieve, Product Lifecycle Management: Driving the next generation of lean thinking, McGraw Hill.
Useful Links:	<ol style="list-style-type: none"> 1. https://www.intechopen.com/books/product-lifecycle-management-terminology-and-applications/introductory-chapter-product-lifecycle-management-terminology 2. https://www.spectechular.walkme.com/top-3-product-lifecycle-management-books/ 3. https://dasme.co/wp-content/uploads/2016/07/plm.pdf 4. https://books.google.co.in/books/about/Product_Lifecycle_Management.html?id=PiVri4OyU7AC&redir_esc=y
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7052	Reliability Engineering	03	-	-	03
Prerequisites:	Fundamentals of Engineering and Mathematics.				
Course Objectives (COBs):	1. To familiarize the students with various aspects of probability theory. 2. To acquaint the students with reliability and its concepts. 3. To introduce the students to methods of estimating the system reliability of simple and complex systems. 4. To understand various aspects of Maintainability, Availability and FMEA procedure.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Apply the concept of Probability to engineering problems. 2. Apply various reliability concepts to calculate different reliability parameters. 3. Estimate the system reliability of simple and complex systems. 4. Apply the knowledge to improve reliability of complex system. 5. Analysis the maintainability and availability of system. 6. Identity a failure mode effect and criticality analysis.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Probability Theory	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Bayes Theorem.	CO1	02	08	
	Probability Distributions: Central Tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, Relations between them and their significance.	CO1	03		
	Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	CO1	03		
2. Reliability Concepts	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.	CO2	02	08	
	Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions.	CO2	03		
	Reliability Hazard Models: Constant Failure Rate, Linearly Increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and Reliability analysis.	CO2	03		
3. System Reliability	System Reliability: System Configurations: Series, Parallel.	CO3	03	05	
	Mixed Configuration, K out of N Structure, Complex Systems.	CO3	02		

4. Reliability Improvement	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby Redundancies, Markov Analysis.	CO4	04	08
	System Reliability Analysis – Enumeration Method, Cut-Set Method, Success Path Method, Decomposition Method.	CO4	04	
5. Maintainability and Availability	Maintainability and Availability: System Downtime, Design for Maintainability: Maintenance Requirements, Design Methods: Fault Isolation and Self-Diagnostics.	CO5	03	05
	Parts Standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – Qualitative Aspects.	CO5	02	
6. Failure Mode, Effects and Criticality Analysis	Failure Mode, Effects and Criticality Analysis: Failure Mode Effects Analysis, Severity/Criticality Analysis, FMECA examples.	CO6	03	05
	Fault Tree Construction, Basic Symbols, Development of Functional Reliability Block Diagram, Fault Tree Analysis and Event Tree Analysis.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. L. Srinath, Reliability Engineering, Affiliated East-West Press (P) Ltd. 2. C. Ebeling, Reliability and Maintainability Engineering, McGraw Hill. 3. B. Dhillon and C. Singh, Engineering Reliability, Wiley.			
Reference Books:	1. P. Conor, Practical Reliability Engineering, Wiley. 2. K. Kapur and L. Lamberson, Reliability in Engineering Design, Wiley. 3. M. Spiegel, Probability and Statistics, McGraw Hill.			
Useful Links:	1. https://victorops.com/blog/the-comprehensive-site-reliability-engineering-sre-pdf 2. https://nptel.ac.in/courses/105/108/105108128/ 3. https://nptel.ac.in/content/storage2/courses/112101005/ 4. https://documents.in/document/corso-nptel-reliability-engineering.html 5. https://www.coursera.org/learn/site-reliability-engineering-slos			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7053	Management Information System	03	-	-	03
Prerequisites:	Fundamentals of Engineering.				
Course Objectives (COBs):	1. To impart knowledge about blend of Management and Technical field. 2. To discuss the roles played by information technology in today’s business and define various technology architectures on which information systems are built. 3. To define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage. 4. To identify the basic steps in systems development.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe how information system transforms business. 2. Identify the impact information systems have on an organization. 3. Describe IT infrastructures and its components and its current trends. 4. Explain the principal tools and technologies for accessing information from databases. 5. Explain how to improve business performance and decision making. 6. Describe types of systems used for enterprise-wide knowledge management.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Information System	Computer Based Information Systems, Impact of IT on Organizations.	CO1	02	04	
	Importance of IS to Society, Organizational Strategy, Competitive Advantages and IS.	CO1	02		
2. Data and Knowledge Management	Data and Knowledge Management: Database Approach, Big Data, Data Warehouse and Data Marts, Knowledge Management.	CO2 CO3	04	07	
	Business intelligence (BI): Managers and Decision Making, BI for Data Analysis and Presenting Results.	CO2 CO3	03		
3. Ethical Issues and Privacy	Ethical Issues and Privacy: Information Security.	CO3	03	07	
	Threat to IS, and Security Controls.	CO3	04		
4. Social Computing	Social Computing (SC): Web 2.0 and 3.0, SC in Business-Shopping, Marketing.	CO4	03	07	
	Operational and Analytic CRM, E-business and E-Commerce – B2B B2C, Mobile Commerce.	CO4	04		
5. Computer Networks	Computer Networks Wired and Wireless technology.	CO5	03	06	
	Pervasive Computing, Cloud Computing Model.	CO5	03		
	Information System within Organization: Transaction Processing Systems, Functional Area Information System.	CO6	04	08	

6. System Design: Methodology and Considerations	ERP and ERP support of Business Process, Acquiring Information Systems and Applications: Various System Development life cycle models, Managing Without Authority, Areas of Further Study.	CO6	04	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. K. Rainer, Brad Prince, Management Information Systems, Wiley. 2. K. Laudon and J. Laudon, Management Information Systems: Managing the Digital Firm, PHI.			
Reference Books:	1. S. Jawadekar, Management Information Systems, McGraw Hill. 2. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, PHI.			
Useful Links:	1. https://nptel.ac.in/courses/110/105/110105148/ 2. https://www.coursera.org/specializations/information-systems			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7054	Design of Experiments	03	-	-	03
Prerequisites:	Fundamentals of Engineering.				
Course Objectives (COBs):	1. To understand the issues and principles of Design of Experiments (DOE). 2. To list the guidelines for designing experiments. 3. To become familiar with methodologies that can be used in conjunction with designs for robustness and optimization.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply different two-level factorial designs. 4. Differentiate the different fractional factorial methods. 5. Apply the methods taught to real life situations. 6. Plan, analyze, and interpret the results of experiments.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction	Strategy of Experimentation, Typical Applications of Experimental Design.	CO1	01	03	
	Guidelines for Designing Experiments, Response Surface Methodology.	CO1	02		
2. Fitting Regression Models	Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	CO2	04	08	
	Confidence Intervals in Multiple Regression, Prediction of new Response Observation, Regression Model Diagnostics, Testing for Lack of Fit.	CO2	04		
3. Two Levels Factorial Designs	The 2 ² Design, The 2 ³ Design, The General 2 ^k Design.	CO3	03	08	
	A Single Replicate of the 2 ^k Design, The Addition of Center Points to the 2 ^k Design, Blocking in the 2 ^k Factorial Design, Split-Plot Designs.	CO3	05		
4. Two Levels Fractional Factorial Methods	The One-Half Fraction of the 2 ^k Design, The One-Quarter Fraction of the 2 ^k Design, The General 2 ^{k-p} Fractional Factorial Design.	CO4	04	08	
	Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	CO4	04		
5. Response Surface Methods and Designs	Introduction to Response Surface Methodology, The Method of Steepest Ascent.	CO5	04	08	
	Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.	CO5	04		
	Crossed Array Designs and Signal-to-Noise Ratios.	CO6	02	04	

6. Taguchi Approach	Analysis Methods, Robust Design examples.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, Wiley. 2. D. Montgomery, Design and Analysis of Experiments, Wiley. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, Wiley. 			
Reference Books:	<ol style="list-style-type: none"> 1. G. Box, J Hunter and W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, Wiley. 2. A. Dean, and D. Voss, Design and Analysis of Experiments (Springer text in Statistics), Springer. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, PHI. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/110/105/110105087/ 2. https://www.udemy.com/course/design-of-experiments-i/ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7055	Operations Research	03	-	-	03
Prerequisites:	Mathematical Modeling.				
Course Objectives (COBs):	1. To understand research and research process. 2. To acquaint students with identifying problems for research and develop research strategies. 3. To familiarize students with the techniques of data collection, analysis of data and interpretation.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Define and formulate linear programming problems and solve them by applying appropriate techniques. 2. Determining the optimum solution for transportation and Assignment models. 3. Choose the appropriate queuing model for a given practical application and propose the best strategy and value of the given game model. 4. Use CPM and PERT techniques, to plan, schedule and control project activities. Determining the optimum sequence to process jobs. 5. Judge classical & probabilistic inventory models and simulate different real life probabilistic situation using Monte Carlo simulation technique. 6. Selecting the best strategy from various alternatives by applying various tools and methodology for decision-making..				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Linear Programming	Linear Programming: Problem Formulation, Graphical Method, Simplex Method.	CO1	03	09	
	Artificial Variable Simplex Techniques: Big-M Method and Two-Phase Method.	CO1	03		
	Advanced Topics in Linear Programming: Duality in Linear Programming and the Dual Simplex Method.	CO1	03		
2. Transportation Models and Assignment Models	Transportation Model: North-west corner method, Row Minima method, Column Minima method, Least – cost method, Vogel’s Approximation method, Optimality by MODI method and Unbalanced Transportation Problem.	CO2	03	06	
	Assignment Model: The Hungarian method for solution of Assignment problems, Unbalanced assignment problem and maximization problem.	CO2	03		
3. Queuing Model and Game Theory	Queuing Models: Introduction, Single-channel, Finite population model with Poisson Arrivals and Exponential Service Times (Limited Source Model).	CO3	03	06	
	Game Theory, Saddle Point, Minimax (Maximin) Method of Optimal strategies, Value of The Game. Solution of Games with Saddle Points, Dominance Principle. Rectangular Games Without Saddle Point – Mixed Strategy for 2 x 2 Games.	CO3	03		

4. Network Analysis in Project Planning and Sequencing Models	Project Management: Phases of Project Management, Network Construction, Critical Path Method (CPM) and Process Evaluation & Review Techniques (PERT), (Exclude Cost Analysis, Crashing, Resource Scheduling and Updating)	CO4	04	07
	Sequencing Models: Processing n Jobs through One Machine, Two Machines and Three Machines, Processing n Jobs through m Machines.	CO4	03	
5. Inventory Control and Simulation	Inventory Models: Introduction, Inventory models with Deterministic demand (with and without shortages) and Inventory models with price breaks.	CO3	04	07
	Simulation: Definition, Types of Simulation Models, Monte Carlo Technique, Practical Problems, Applications in Queuing and Inventory problems.	CO5	03	
6. Decision Theory	Steps in Decision theory approach, Decision – Making Environments, Decision making under conditions of certainty and uncertainty.	CO6	02	04
	Decision making under conditions of Risk and Decision Trees.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. H. Taha, Operations Research - An Introduction, PHI. 2. J. Solberg, J. Ravindran, A. Phillips, Operations Research: Principles and Practice, Wiley.			
Reference Books:	1. F. Liebermann, G. Hiller, Introduction to Operations Research, McGraw Hill. 2. S. Sharma, K. Nath, Operations Research, Macin. 3. P. Gupta, K. Swarup, and M. Mohan, Operations Research, S. Chand & Sons.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc19_ma29/preview 2. https://www.coursera.org/courses?query=operations%20research			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7056	Cyber Security and Laws	03	-	-	03
Prerequisites:	Computer Network & Security, Digital Forensics.				
Course Objectives (COBs):	1. To understand and identify different types cybercrime and cyber law. 2. To recognized Indian IT Act 2008 and its latest amendments. 3. To learn various types of security standards compliances.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the concept of cybercrime and its effect on outside world. 2. Classify and examine the cyber offences and security implication. 3. Illustrate and identify the modus operandi followed in cybercrimes. 4. Explain the aspects in Indian cyber laws. 5. Explain the penalties in cyber law. 6. Apply Information Security Standards compliance during software design and development.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Cybercrime	Cybercrime Definition and Origins of the World, Cybercrime and Information Security, Classifications of Cybercrime, Cybercrime.	CO1	03	04	
	Indian ITA 2000, A global Perspective on cybercrimes.	CO1	01		
2. Cyber Offenses & Cybercrime	How Criminal Plan the Attacks, Social Engineering, Cyber Stalking, Cyber Cafe and Cybercrimes, Bot Nets, Attack Vector, Cloud Computing.	CO2	02	09	
	Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security.	CO2	03		
	Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	CO2	04		
3. Tools and Methods Used in Cyber line	Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography.	CO3	03	06	
	DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft).	CO3	03		
4. The Concept of Cyberspace	E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law.	CO4	04	08	

	Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law.	CO4	04	
5. Indian IT Act	Cyber Crime and Criminal Justice: Penalties, Adjudication.	CO5	03	06
	Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments.	CO5	03	
6. Information Security Standard Compliances	SOX, GLBA, HIPAA, ISO.	CO6	03	06
	FISMA, NERC, PCI.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. N. Godbole and S. Belapure, Cyber Security, Wiley. 2. S. Vishwanathan, The Indian Cyber Law, Bharat Law House. 3. The Information Technology Act, 2000, Bare Act, Professional Book Publishers. 4. P. Mali, Cyber Law & Cyber Crimes, Snow White Publications.			
Reference Books:	1. N. Godbole, Information Systems Security, Wiley India, New Delhi. 2. K. Knapp, Cyber Security & Global Information Assurance Information Science Publishing. 3. W. Stallings, Cryptography and Network Security, Pearson.			
Useful Links:	1. https://www.coursera.org/specializations/information-security 2. https://www.coursera.org/learn/healthcare-data-security			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7057	Disaster Management and Mitigation Measures	03	-	-	03
Prerequisites:	Basics of Physics.				
Course Objectives (COBs):	1. To understand physics and various types of disaster occurring around the world. 2. To identify extent and damaging capacity of a disaster. 3. To study and understand the means of losses and methods to overcome/minimize it. 4. To understand role of individual and various organization during and after disaster. 5. To understand application of GIS in the field of disaster management. 6. To understand the emergency government response structures before, during and after disaster.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Illustrate the importance of disaster management. 2. Get to know natural as well as manmade disaster and their extent and possible effects on the economy. 3. Plan of national importance structures based upon the previous history. 4. Get acquainted with government policies, acts and various organizational structure associated with an emergency. 5. Devise various framework for disaster management in india by reviewing various approaches of disaster relief measures. 6. Get to know the simple do’s and don’ts in such extreme events and act accordingly.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction	Definition of Disaster, Hazard, Global and Indian Scenario, General Perspective, Importance of Study in Human Life.	CO1	02	03	
	Direct and Indirect Effects of Disasters, Long Term Effects of Disasters, Introduction to Global Warming and Climate Change.	CO1	01		
2. Natural Disaster and Manmade Disasters	Natural Disaster: Meaning and Nature of Natural Disaster, Flood, Flash Flood, Drought, Cloud Burst.	CO2	02	09	
	Earthquake, Landslides, Avalanches, Volcanic Eruptions, Mudflow, Cyclone, Storm, Storm Surge.	CO2	02		
	Climate Change, Global Warming, Sea Level Rise, Ozone Depletion.	CO2	02		
	Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards, Role of Growing Population and Subsequent Industrialization.	CO2	02		
	Urbanization and Changing Lifestyle of Human Beings in Frequent Occurrences of Manmade Disasters.	CO2	01		
3. Disaster Management,	Disaster Management: Meaning, Concept, Importance.	CO2	02	06	
	Objective of Disaster Management Policy, Disaster Risks in India, Paradigm Shift in Disaster Management.	CO2	02		

Policy and Administration	Policy and Administration Importance and Principles of Disaster Management Policies, Command and Co-ordination of in Disaster Management.	CO2	01	
	Rescue Operations - How to Start with and How to Proceed in due Course of Time, Study of Flowchart Showing the Entire Process.	CO2	01	
4. Institutional Framework for Disaster Management in India	Importance of Public Awareness, Preparation and Execution of Emergency Management Programme, Scope and Responsibilities of National Institute of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) in India.	CO4	02	06
	Methods and Measures to Avoid Disasters, Management of Casualties, Set Up of Emergency Facilities, Importance of Effective Communication Amongst Different Agencies in Such Situations.	CO4	02	
	Use of Internet and Software for Effective Disaster Management. Applications of GIS, Remote Sensing and GPS in this regard.	CO3, CO4	02	
5. Financing Relief Measures	Ways to Raise Finance for Relief Expenditure, Role of Government Agencies and NGOs in this Process.	CO5	02	09
	Legal Aspects related to Finance Raising as well as Overall Management of Disasters.	CO5	02	
	Various NGO's and the works they have carried out in the Past on the Occurrence of Various Disasters, Ways to approach these teams.	CO5	03	
	International Relief aid Agencies and their Role in Extreme Events.	CO5	02	
6. Preventive and Mitigation Measures	Pre-Disaster, During Disaster and Post-Disaster Measures in Some Events in General.	CO6	01	06
	Structural mapping: Risk Mapping, Assessment and Analysis, Sea Walls and Embankments, Bio shield, Shelters, Early Warning and Communication.	CO6	02	
	Non-Structural Mitigation: Community Based Disaster Preparedness, Risk Transfer and Risk Financing, Capacity Development and Training, Awareness and Education, Contingency Plans.	CO6	02	
	Dos and Don'ts in case of Disasters and Effective Implementation of Relief Aids.	CO6	01	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. G. Harsh, Disaster Management, Universities Press Publications. 2. O. Dagur, Disaster Management: An Appraisal of Institutional Mechanisms in India, Centre for Land Warfare Studies, New Delhi. 3. C. Damon and I. Butterworth, Introduction to International Disaster Management, Elsevier.			

Reference Books:	<ol style="list-style-type: none"> 1. K. Yonng, Concepts and Techniques of GIS – C.P.Lo, PHI. 2. R. Singh, Natural Hazards and Disaster Management, Vulnerability and Mitigation, Rawat Publications.
Useful Links:	<ol style="list-style-type: none"> 1. www.msme.gov.in/ 2. www.dcmesme.gov.in/ 3. www.msmetraining.gov.in/
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7058	Energy Audit and Management	03	-	-	03
Prerequisites:	Fundamentals of Engineering				
Course Objectives (COBs):	<div>1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.</div> <div>2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management.</div> <div>3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Identify and describe present state of energy security and its importance.</div> <div>2. Identify and describe the basic principles and methodologies adopted in energy audit of a utility.</div> <div>3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.</div> <div>4. Describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.</div> <div>5. Analyze the data collected during performance evaluation and recommend energy saving measures.</div> <div>6. Explain the concepts of Energy Conservation in buildings.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Energy Scenario	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance.	CO1	02	04	
	Energy Conservation Act- 2001 and its Features. Basics of Energy and its various forms, Material and Energy Balance.	CO1	02		
2. Energy Audit Principles	Definition, Energy Audit-need, Types of Energy Audit, Energy Management (Audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement.	CO2	03	08	
	Maximizing System Efficiencies, Optimizing the input energy requirements, Fuel and Energy Substitution. Elements of monitoring & targeting, Energy Audit Instruments, Data and Information-Analysis.	CO2	03		
	Financial Analysis Techniques: Simple Payback Period, NPV, Return on Investment (ROI), Internal Rate of Return (IRR).	CO2	02		

3. Energy Management and Energy Conservation in Electrical System	Electricity Billing, Electrical Load Management and Maximum Demand Control, Power Factor Improvement, Energy Efficient Equipment and Appliances, Star Ratings.	CO3	05	10
	Energy efficiency measures in lighting system, Lighting control: Occupancy Sensors, Daylight Integration, and use of Intelligent Controllers. Energy Conservation Opportunities in: Water Pumps, Industrial Drives, Induction Motors, Motor Retrofitting, Soft Starters, Variable Speed Drives.	CO3	05	
4. Energy Management and Energy Conservation in Thermal Systems	Review of Different Thermal Loads, Energy Conservation Opportunities in: Steam Distribution System, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System.	CO4	05	10
	General Fuel Economy Measures in Boilers and Furnaces, Waste Heat Recovery, Use of Insulation- Types and Application. HVAC System: Coefficient of Performance, Capacity, Factors Affecting Refrigeration, Air Conditioning System Performance and Savings Opportunities.	CO4	05	
5. Energy Performance Assessment	On Site Performance Evaluation Techniques, Case Studies Based on: Motors and Variable Speed Drive, Pumps.	CO5	02	04
	HVAC system calculations, Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	CO5	02	
6. Energy Conservation in Buildings	Energy Conservation Building Codes (ECBC): Green Building, LEED rating.	CO6	02	03
	Application of Non-Conventional and Renewable Energy Sources.	CO6	01	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. G. Stokes, Handbook of Electrical Installation Practice, Blackwell Science. 2. A. Valia, Designing with light: Lighting Handbook, Lighting System. 3. W. Turner, Energy Management Handbook, Wiley. 4. A. Tyagi, Handbook on Energy Audits and Management, edited Tata Energy Research Institute (TERI).			
Reference Books:	1. C. Smith, Energy Management Principles, Pergamon Press. 2. D. Patrick, S. Fardo, R. Richardson, Energy Conservation Guidebook, Fairmont Press. 3. A. Thumann, W. Younger and T. Niehus, Handbook of Energy Audits, CRC Press.			
Useful Links:	1. www.energymanagertraining.com 2. www.bee-india.nic.in			

Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7059	Development Engineering	03	-	-	03
Prerequisites:	Rural Development and Human Values				
Course Objectives (COBs):	<div>1. To understand the characteristics of rural society and the scope, nature and constraints of rural development.</div> <div>2. To study implications of 73rd CAA on planning, development and governance of rural areas.</div> <div>3. An exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’ in the context of work life and the personal life of modern Indian professionals.</div> <div>4. To understand the nature and type of human values relevant to planning institutions.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Apply knowledge for rural development.</div> <div>2. Demonstrate post-independence rural development.</div> <div>3. Apply knowledge for Initiatives and Strategies.</div> <div>4. Develop acumen for higher education and research.</div> <div>5. Master the art of working in group of different nature.</div> <div>6. Develop confidence to take up rural project activities independently.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Rural Development and Roots	Introduction to Rural Development Meaning, nature and scope of development, Nature of rural society in India, Hierarchy of settlements, Social, economic and ecological constraints for rural development.	CO1	03	08	
	Roots of Rural Development in India Rural Reconstruction and Sarvodaya Programme before Independence, Impact of Voluntary Effort and Sarvodaya Movement on Rural Development, Constitutional Direction, Directive Principles, Panchayati Raj - Beginning of Planning and Community Development, National Extension Services.	CO1	05		
2. Post-Independence and Rural Development	Post-Independence Rural Development Balwant Rai Mehta Committee - Three Tier System of Rural Local Government.	CO2	03	06	
	Need and Scope for People’s Participation and Panchayati Raj, Ashok Mehta Committee - Linkage between Panchayati Raj, Participation and Rural Development.	CO2	03		

3. Rural Development Initiatives in Five Years	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development, Planning Process at National, State, Regional and District levels, Planning, development, Implementing and Monitoring Organizations and Agencies.	CO3	03	07
	Urban and Rural Interface - Integrated Approach and Local Plans, Development Initiatives and Their Convergence, Special Component Plan and Sub-Plan for the Weaker Section, Micro-Eco Zones, Data Base for Local Planning, Need for Decentralized Planning, Sustainable Rural Development.	CO3	04	
4. Post 73rd Amendment Scenario	Post 73 rd Amendment Scenario 73 rd Constitution Amendment Act, Including - XI Schedule, Devolution of Powers, Functions and Finance, Panchayati Raj Institutions - Organizational Linkages, Recent Changes in Rural Local Planning.	CO4	02	04
	Gram Sabha - Revitalized Panchayati Raj, Institutionalization, Resource Mapping, Resource Mobilization Including Social Mobilization, Information Technology and Rural Planning, Need for Further Amendments.	CO4	02	
5. Values and Science and Technology Material Development	Values and Science and Technology Material Development and its Values, the Challenge of Science and Technology, Values in Planning Profession, Research and Education.	CO5	04	10
	Types of Values Psychological Values — Integrated Personality, Mental Health, Societal Values — The Modern Search for a Good Society, Justice, Democracy, Rule of Law, Values in The Indian Constitution, Aesthetic Values — Perception and Enjoyment of Beauty, Moral and Ethical Values, Nature of Moral Judgment, Spiritual Values, Different Concepts, Secular Spirituality, Relative and Absolute Values, Human Values— Humanism and Human Values, Human Rights, Human Values as Freedom, Creativity, Love and Wisdom.	CO5	06	
6. Ethics Canons of Ethics	Ethics Canons of Ethics, Ethics of Virtue, Ethics of Duty, Ethics of Responsibility, Work Ethics, Professional Ethics, Ethics in Planning Profession, Research and Education.	CO6	04	04
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. ITPI, Village Planning and Rural Development, ITPI, New Delhi. 2. K. Thooyavan, Human Settlements: A 2005 MA Publication, Chennai. 3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi. 4. Planning Commission, Five Year Plans. 5. Planning Commission, Manual of Integrated District Planning, New Delhi.			

Reference Books:	<ol style="list-style-type: none"> 1. R. C. Weaver, The Urban Complex, Doubleday. 2. W. P. Farmer, Ethics in Planning, American Planning Association, Washington. 3. E., How, Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150. 4. V. Watson, Conflicting Rationalities: - Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp. 395– 407
Useful Links:	<ol style="list-style-type: none"> 1. https://engineering.berkeley.edu/news/2014/09/defining-development-engineering/ 2. https://rural.nic.in/scheme-websites 3. https://transformingindia.mygov.in/category/rural-development/ 4. https://journals.sagepub.com/doi/abs/10.1177/0019556117735461
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Lab Code		Course Name	Credits				
			TH	P	TUT	Total	
ITL701		Artificial Intelligence and Data Science Lab		-	01	-	01
Hardware Requirements:		PC i3 Processor or above.					
Software Requirements:		Matlab, Python.					
Prerequisites:		C Programming.					
Lab Objectives (LOBs):		1. To understand recent trends in the field of AI and DS. 2. To understand data visualization and analyze data using different graphs. 3. To demonstrate data visualization using advanced charts like Google charts, D3.js. 4. To demonstrate cognitive skills of Artificial Intelligence. 5. To introduce to the Soft Computing techniques like Neural Network, Fuzzy Logic and Genetic Algorithm. 6. To understand and implement applications using concepts of AI and DS.					
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply the technologies for handling variety of data in the field of AI and DS. 2. Implement graphs for the data analysis and data visualization. 3. Implement data visualizations using advanced charts for Machine Learning applications. 4. Develop a cognitive application. 5. Develop solutions to complex real-world problems using Soft Computing techniques. 6. Implement applications using concepts of AI and DS.					
Lab No.	Experiment Title					LOs Mapped	Hours
0	Lab Prerequisites					-	02
1	Study and demonstrate python libraries to handle text, graph and spatial data.					LO1	02
2	Study and demonstrate python libraries to handle image, audio and video data.					LO1	02
3	Study and implement different graphs for suitable AI applications using Matplotlib library.					LO2	02
4	Study and implement different graphs for suitable AI applications using Seaborn library.					LO2	02
5	Study and demonstrate charts using Google Chart API.					LO3	02
6	Implementation of Recommendation Systems for suitable application.					LO4	02
7	Implementation of Fuzzy Logic for suitable application					LO5	02
8	Implementation of Graph data analytics for suitable application					LO5	02
9	Implementation of Time-series data analytics for suitable application					LO5	02
10	Study and design application using D3.js					LO6	02
11	Study and design application using Google Charts.					LO6	02
12	Study and design application using Tableau / PowerBI.					LO6	04
Virtual Lab Links:		https://python-iitk.vlabs.ac.in/					

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “Artificial Intelligence” and “Artificial Intelligence and Data Science Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITL702		Internet of Everything Lab	-	01	-	01
Hardware Requirements:		PC i3 Processor or above, Sensors –DHT11/22, PIR, MQ2/MQ3, HC-SR04, Moisture sensor etc., Arduino Uno/Mega board, RPi Board, Wireless Radio Modules- Zigbee RF module, Bluetooth Module (HC-05), Mobile Phone with Bluetooth antenna, Others-Breadboard, wires, power supplies, USB cables, buzzers, LEDs, LCDs.				
Software Requirements:		Ubuntu / Linux Desktop OS, VMware, Cooja Simulator in Contiki OS/Microchip Studio SimulIDE_0.4.15-SR1_Win64/ Arduino IDE/ ThingSpeak/ Blynk IO Cloud/ Cayenne IO Cloud/ ThingsBoard/ OpenRemote.				
Other Requirements:		Internet Connection.				
Prerequisites:		Basics of Java and Python Programming.				
Lab Objectives (LOBs):		1. To learn different types of sensors from Motes families. 2. To design the problem solution as per the requirement analysis done using Motes sensors. 3. To study the basic concepts of programming/sensors/ emulator like Cooja etc. 4. To design and implement the mini project intended solution for project-based learning. 5. To build and test the mini project successfully. 6. To improve the team building, communication and management skills of the students.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Conduct a survey of several available literatures in the preferred field of study. 2. Identify the requirements for the real world problems. 3. Create the IoT solution based on hardware requirements by coding, emulating and testing. 4. Evaluate the performance of the developed IoT system. 5. Prepare report and present the findings of the study conducted in the preferred domain 6. Demonstrate an ability to work in teams and manage conduct of the research study.				
Lab No.	Experiment Title			LOs Mapped	Hours	
0	Lab Prerequisites			-	02	
1	Understand IoT based network by using simulator like Cooja, Contiki and perform basic operations.			LO4	02	
2	Perform Sensor Activation through button in simulator.			LO4	02	
3	Perform UDP RPL Broadcast with Sky mote in simulator.			LO4	02	
4	Perform 6LoWPAN protocol with packet analyser in simulator.			LO4	02	
5	Perform report generation in simulator with: a. Average power consumption of all nodes b. Plot Sensor Map c. Display Complete Node Information			LO5	02	
6	Mini Project: a. Survey of existing IoE systems. b. Development of IoE system for real-world application. c. Development of interface using Mobile/Web to publish or remote access data on Internet. d. Testing of IoE system and sustainability analysis. e. Report writing on developed system.			LO1-LO6	16	

<p>Guidelines:</p>	<ol style="list-style-type: none"> 1. The mini project work is to be conducted by a group of three students. 2. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented. 3. The students must understand the <ul style="list-style-type: none"> • Concept • Importance • Interdisciplinary • Challenges • Various applications/smart objects • Major Players/Industry, Standards. 4. The students must understand the IoT Architecture: <ul style="list-style-type: none"> • Node Structure: Sensing, Processing, Communication, Powering • Networking: Topologies, Layer/Stack architecture • Communication Technologies: Introduction to ZigBee, BLE, WiFi, LTE, IEEE 802.11ah, Discuss data rate, range, power, computations/bandwidth, QoS • Smartness - Signal Processing/Analytics: Impact on Power/Energy savings, dynamic networks, simple case studies • IoT Fabricator: Introduction to Embedded electronics, fabricating electronics, Communication Network requirements, Data processing challenges – recreation, IP/security, Challenges • Hands-on in IoT: Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones), Software (Contiki, TinyOS, Android), IoT Fabricator etc. can be used. 5. The students may do will visit different websites to identify their IOT topic for the mini project. 6. The students may do survey for different application using different types of sensors for their mini project. 7. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirement for their mini project problem statement. 8. Design your own circuit board using multiple sensors etc. 9. Installation, configure and manage your sensors in such away so that they can communicate with each other. 10. Each group will identify the Hardware and software requirement for their mini project problem statement. 11. Create and interface using Mobile/Web to publish or remotely access the data on Internet. 12. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted. 13. Each group may present their work in various project competitions and paper presentations. 14. A detailed report is to be prepared as per guidelines given by the concerned faculty.
<p>Virtual Lab Links:</p>	<p>https://vlab.amrita.edu/index.php?sub=78&brch=256</p>

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 03 experiments and Mini Project. • Journal must include at least 02 assignments on content of theory of the course “Internet of Everything” and “Internet of Everything Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments and Mini Project: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list and mini project for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL7041		Machine Learning and Deep Learning Lab	-	01	-	01
Hardware Requirements:		PC with Configuration: Intel i3 core or above, 8 GB RAM or above, 500 GB HDD.				
Software Requirements:		Linux / Windows Operating System, Python.				
Prerequisites:		Fundamentals of Data Mining and Fundamentals of Mathematics.				
Lab Objectives (LOBs):		1. To identify and analyze various data distributions. 2. To understand need and apply concepts of Ensemble Learning. 3. To understand the functioning of Neural Networks. 4. To design Convolutional Neural Network for real-life application. 5. To design Recurrent Neural Network for real-life applications. 6. To understand advanced concepts in Deep Learning.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply Machine Learning concepts for evaluating data distribution. 2. Apply Ensemble and incremental learning methods for performance enhancement of Machine Learning algorithms. 3. Apply basic Neural Networks for real-world applications. 4. Apply Convolutional Neural Networks for real-world applications. 5. Apply Recurrent Neural Networks for real-world applications. 6. Apply advanced techniques in Deep Learning.				
Lab No.	Experiment Title			LOs Mapped	Hours	
0	Lab Prerequisites.			-	02	
1	Apply Goodness of Fit tests to analyse the data distribution.			LO1	04	
2	Implement Ensemble Learning in a distributed environment and compare the performance with corresponding centralized model.			LO2	02	
3	Implement Incremental Learning for suitable application and compare its performance with traditional algorithms.			LO2	02	
4	Implement Neural Networks for a real-world classification problem and analyze its performance.			LO3	02	
5	Implement Neural Networks for a real-world prediction problem and analyze its performance.			LO3	02	
6	Implement Convolutional Neural Networks for suitable application using any of the following architectures: a. AlexNet b. GoogLeNet c. ResNet			LO4	04	
7	Implement Recurrent Neural Networks for suitable application using Long Short-Term Memory (LSTM).			LO5	02	
8	Implement Recurrent Neural Networks for suitable application using Gated Recurrent Units (GRUs).			LO5	04	
9	Implement Advanced Deep Learning algorithms for Image Data.			LO6	04	

Virtual Lab Links:	<ol style="list-style-type: none"> 1. https://vlab.spit.ac.in/ai/#/home 2. http://www.iitk.ac.in/idea/aidar.html 3. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory course “Machine Learning and Deep Learning” and “Machine Learning Deep Learning Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral 10 Marks).

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL7042		Digital Forensics Lab	-	01	-	01
Hardware Requirements:		PC i3 Processor or above.				
Software Requirements:		TCL, NS2.35, Ubuntu Operating System, Protocol Analyzer (e.g. Wireshark).				
Prerequisites:		C++, Java, Python Programming.				
Lab Objectives (LOBs):		<div><div>1.</div><div>To get familiar with the environment of ethical hacking.</div><div>2.</div><div>To discover potential vulnerabilities which are present in the system in network using vulnerability assessment tools.</div><div>3.</div><div>To describe underlying principles and many of the techniques associated with the digital forensic practices and cybercrime.</div><div>4.</div><div>To develop an excellent understanding of current cyber security issues and analyzed the ways that exploits in securities.</div><div>5.</div><div>To learn the importance of evidence handling and storage for various devices.</div><div>6.</div><div>To apply digital forensic knowledge to use computer forensic tools and investigation report writing.</div></div>				
Lab Outcomes (LOs):		<div><div>Upon completion of the course, the learners will be able to:</div><div><div>1.</div><div>Demonstrate the installation and configuration of ethical hacking environment.</div><div>2.</div><div>Implement the concept of ethical hacking and its associated applications in Information Communication Technology world.</div><div>3.</div><div>Demonstrate the importance of digital forensic duplication and various tools for analysis to achieve adequate perspectives of digital forensic investigation in various applications devices.</div><div>4.</div><div>Analyze the methodology of incident response and various security issues in ICT world, and apply digital forensic tools for data collection.</div><div>5.</div><div>Apply the knowledge of different forensics tools to investigate and secure system and network.</div><div>6.</div><div>Generate legal evidence and supporting investigation reports and will also be able to use various digital forensic tools.</div></div></div>				
Lab No.	Experiment Title			LOs Mapped		Hours
0	Lab Prerequisites.			-		02
1	To set up the Ethical Hacking Environment with VMware, VirtualBox, VULNHUB Machines and Kali Linux.			LO1		02
2	To demonstrate the hacking tools and skills: nmap, Metasploit, Burp Suite, Angry IP Scanner, Cain & Abel, Ettercap, EtherPeek, SuperScan, QualysGuard, WebInspect, LANguard, Network Security Scanner, Network Stumbler, One Loc on given case study.			LO2		02
3	<div><div>a.</div><div>To demonstrate the “Footprinting and Reconnaissance”: Domain Name Information, Quick Fix, Finding IP Address, Finding Hosting Company, IP Address Ranges, History of the Website on given case study.</div><div>b.</div><div>To demonstrate the Fingerprinting: Port Scanning, Ping Sweep, DNS Enumeration on given case study.</div></div>			LO2		02

4	To demonstrate the system Hacking: TCP/IP Hijacking, Trojan Attacks, Trojan Information, EMail Hijacking, Social Engineering, Inserting Viruses in a User System, Password Hacking, Dictionary Attack, Hybrid Dictionary Attack, Brute-Force Attack, Rainbow Tables on given case study.	LO2	02
5	To demonstrate the Wireless Hacking: Kismet, NetStumbler, Wired Equivalent Privacy, WEPcrack, Aircrack-ng, Wireless DoS Attacks on given case study.	LO2	02
6	To demonstrate the Computer Forensics and different tools used for forensic investigation: EnCase, FTK, ProDiscover on given case study.	LO3	02
7	To demonstrate the Recovery of Deleted Files using Forensics Tools on given case study.	LO3	02
8	To implement the steps for hiding and extract any text file behind an image file/ Audio file using Command Prompt and Exifreader on given case study.	LO4	02
9	To make and restore the forensic image of the hard drive using EnCase Forensics on given case study.	LO4	02
10	To collect Email Evidence in Victim PC by using dumpit tool on given case study.	LO5	02
11	To analyse of system logs by: a. View Last Activity of Your PC. b. To Extract Browser Artifacts. with help of LastActivityView tool on given case study.	LO5	02
12	Find Last Connected USB on your system (USB Forensics).	LO5	02
13	Live Forensics Case Investigation using Autopsy and report writing.	LO6	02
Virtual Lab Links:	1. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Security/ 2. http://vlabs.iitb.ac.in/vlabsdev/vlab_bootcamp/bootcamp/The_Four_Wizards/		
Term Work (TW):	<ul style="list-style-type: none"> Term work should consist of a minimum of 08 experiments. Journal must include at least 02 assignments on content of theory of “Ethical Hacking & Forensics” and “Digital Forensics Lab”. Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).		

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL7043		Computer Vision Lab	-	01	-	01
Hardware Requirements:		PC i3 Processor or above.				
Software Requirements:		MATLAB / Open CV, Python.				
Prerequisites:		Computer Graphics, Image Processing.				
Lab Objectives (LOBs):		1. To review image processing techniques for computer vision. 2. To describe shape and region analysis. 3. To explain Hough Transform and its applications to Edge linking lines, circles, ellipses. 4. To describe three-dimensional image analysis techniques. 5. To describe motion analysis. 6. To implement computer vision algorithms for real-world problems.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Implement fundamental image processing techniques required for computer vision. 2. Analyze shapes and regions using suitable algorithms. 3. Apply Hough Transform for edge linking of line, circle and ellipse detections. 4. Apply and analyze 3D vision techniques. 5. Implement motion analysis. 6. Develop applications using computer vision techniques, Team work and communication skills.				
Lab No.	Experiment Title				LOs Mapped	Hours
0	Lab Prerequisites				-	02
1	Implementation of Image Processing fundamentals: Corner and Interest Point Detection				LO1	02
2	Implementation and Processing of Shapes and Regions: a. Skeletons and Thickening and Thinning b. Boundary Detection Procedures.				LO2	02
3	Implementation of Line Detection through Hough Transforms or edge linking to Hough Transforms.				LO3	02
4	Implementation of RANSAC algorithm.				LO3	02
5	Implementation of 3D Vision Methods and conversion of 2D into 3D vision.				LO4	02
6	Implementation of applying texture to 3D image or vision.				LO4	02
7	Implementation of SIFT algorithm.				LO4	02
8	Implementation to measure distance between two Human in motion.				LO5	02
9	Implementation of spline-based motion algorithm.				LO5	02
10	Implementation of face recognition.				LO6	04
11	Application Development: a. Surveillance b. Road Markings c. Object Location d. Hole Detection				LO6	04
Virtual Lab Links:		https://cse19-iiith.vlabs.ac.in/				

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “Computer Vision” and “Computer Vision lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLL7044	UI/UX Design Lab	-	01	-	01
Hardware Requirements:	PC i3 Processor or above.				
Software Requirements:	HTML, Java Programming, Internet Programming, Open Source Tools like Figma, Adobe XD.				
Prerequisites:	Web Technologies, Software Engineering.				
Lab Objectives (LOBs):	<div>1. To stress the importance of good interface design.</div> <div>2. To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.</div> <div>3. To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.</div> <div>4. To learn the techniques for prototyping and evaluating user experiences.</div> <div>5. To understand interaction design process.</div> <div>6. To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.</div>				
Lab Outcomes (LOs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Analyze and formalize the limitations and advantages of interface designs.</div> <div>2. Analyze conceptual design and cognitive aspects based on User experience.</div> <div>3. Analyze user needs and formulate user design specifications.</div> <div>4. Construct the data analysis and task analysis of user design specifications.</div> <div>5. Develop designs based on frameworks and methodology.</div> <div>6. Formulate better techniques to improve the user interaction design interfaces.</div>				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites	-		02	
1	Plan a UX research study, including the project background, research goals, research questions, Key Performance Indicators, methodology, participants, and script.	LO1		02	
2	Sketch a prototype of the interface based on UI/UX.	LO2		02	
3	Conduct a moderated and unmoderated usability study and Take notes during a usability study.	LO2		02	
4	Create affinity diagrams to group and analyze data.	LO3		02	
5	Synthesize observations from research and come up with insights.	LO4		02	
6	Designing the User Interface based on Interaction Operators, Interface Styles, Colour Palette.	LO4		02	
7	Evaluate an interactive design by UI/UX design recommendations (e.g., affordances/feedback, interface complexity, interface styles, design heuristics).	LO5		02	
8	Design a mobile app to include in your professional portfolio.	LO6		02	
9	Mini Project based UI/UX Design.	LO1-LO6		10	
Virtual Lab Links:	https://hci-iitg.vlabs.ac.in/umtel.html				

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “UI/UX Design Specializations” and “UI/UX Design Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral - 10 Marks).

PBL Course Code	PBL Course Name	Credits			
		TH	P	TUT	Total
1UITPR75	PBL – Major Project A	-	03	-	03
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	JDK 8 or above, Python, DevOps Tools, Web/Android Development Platforms.				
Prerequisites:	Programming skills, IT Engineering Core Concepts				
PBL Objectives (PROBs):	<ol style="list-style-type: none">1. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.2. To practice the process of identifying the needs and converting it into a problem statement.3. To apply engineering knowledge and modern tools/technologies for deriving solutions to the real-world problems.4. To inculcate the process of self-learning and research.5. To be acquainted with solving the problem in a group.6. To improve communication, management and report-writing skills of the students.				
PBL Outcomes (PROs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none">1. Identify societal / research needs, formulate problem statements, review research literature, and analyse complex engineering problems.2. Design suitable solutions for the problems including scope, objectives, timeline, system flow, user interface, algorithms, etc.3. Gather, analyse, and interpret data — and apply knowledge of engineering fundamentals, modern tools / technologies for development of solutions.4. Analyze sustainability and scalability of the developed solution and its impact in terms of environmental, societal, safety, legal, cultural, health, etc. aspects.5. Apply ethical principles, excel in written and oral communication, and engage in independent and life-long learning.6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects.				
	<ol style="list-style-type: none">1. Students are allowed to form the team of 2-3, based on their area of interest.. Interdisciplinary (inter-departmental) teams are allowed and encouraged.2. Students have to develop an IT Application / Service with a proper user interface using any suitable technology.3. Students should do survey and identify needs, which shall be converted into problem statement for minor project in consultation with Faculty Guide / Head of Department / Internal committee of faculties.4. Projects with application in healthcare, agriculture, or any kind of societal contribution are preferred. Students should try to take up need-based live projects so as to get exposure to communication with beneficiaries and skills for understanding client requirements.5. Based on the idea presentation as well as discussion on feasibility, novelty, and contribution of the idea, a project definition will be finalized.6. Students shall submit their implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the Major project.				

<p>Guidelines for Project-Based Learning (PBL):</p>	<ol style="list-style-type: none"> 7. A log book is to be prepared by each group, wherein the group can record weekly work progress and the faculty guide can verify and record notes/comments. 8. Faculty Guide may give inputs to students during major project activity; however, focus shall be on self-learning. 9. Students in a group shall understand the problem effectively, propose multiple solutions, and select the best possible solution in consultation with their guide. 10. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate. 11. The solution is to be validated with proper justification and report (blue book) is to be compiled in standard format of the Department. 12. In this semester, students are expected to identify problems in real-world, formulate proper problem statement, conduct a literature review, gather, interpret, and pre-process the data, design a solution, suitable algorithms, etc. Three reviews will be conducted based on the presentation given by the student group. First review shall be for finalization of the problem, second shall be for evaluation of work progress, and the third shall be on finalisation of design of the proposed solution of the problem. 13. The same problem statement should be continued for 8th semester – Major Project B. 14. Minor Project shall be assessed based on parameters like: <ul style="list-style-type: none"> • Attainment of Course Outcomes. • Technical efficiency and quality of developed solution. • Innovativeness in solutions. • Impact on environment. • Cost effectiveness. • Sustainability analysis. • Societal impact. • Effective use of standard engineering norms. • Contribution of an individual as member or leader. • Clarity in written and oral communication. 15. All groups have to submit a Technical Paper based on the work done for publication in Conferences / International journals — preferably indexed in Scopus / Web of Science). The papers should have less than 10% plagiarism — checked through Turnitin / standard plagiarism-checking software. 16. Students should participate in Project Competitions at State, National, and International level like Smart India Hackathon, National Innovation Contest, etc. 17. Students should attempt for filling a Patent / Copyright from the work done. 18. Students shall be motivated to establish a start-up based on the project idea.
<p>Useful Learning Links:</p>	<ol style="list-style-type: none"> 1. http://nlp-iiith.vlabs.ac.in/ 2. https://www.coursera.org/specializations/project-management 3. https://nptel.ac.in/courses/110/104/110104073/ 4. https://www.coursera.org/specializations/website-development 5. https://www.udemy.com/course/fullscreen-background-video-for-a-website-dreamweaver-premiere-pro/

Term Work (TW):	<ul style="list-style-type: none"> • Term Work evaluation shall be for Total 25 Marks. • Total 15 out of 25 Marks shall be based on the following evaluation: <ul style="list-style-type: none"> ○ Presentation in Review 1 ○ Presentation in Review 2 ○ Presentation in Review 3 ○ Project Report and Log Book • And, total 10 out of 25 Marks will be based on: <ul style="list-style-type: none"> ○ Students' active participation in Technology learning. ○ Presenting / showcasing learned Technology uses in Social / Outreach / Extension Activities / Events / Idea or Project Competitions / Trainings / Internships / Development Programs, Technical Paper Preparations and Presentations / etc.
Practical & Oral (P&O):	P&O examination will be of Total 50 Marks and shall be based on the Project Demonstration, Presentation, and Report.

SEMESTER VIII - B.TECH. (INFORMATION TECHNOLOGY)

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
ITC801	Blockchain and DLT	3 – 0 – 0	03	3 – 0 – 0	03	PC
ITDLC802	Department Level Elective – V	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ITDLC803	Department Level Elective – VI	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
ILC804	Institute Level Elective – II	3 – 0 – 0	03	3 – 0 – 0	03	OE-ILC
ITL801	Blockchain Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITL805	RPA Lab	0 – 2 – 0	02	0 – 1 – 0	01	PC
ITDLL802	Department Level Elective – V Lab	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
ITPR86	PBL – Major Project B	0 – 12 – 0	12*	0 – 6 – 0	06	PBL
Total		12 – 18 – 0	30	12 – 9 – 0	21	

*Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Avg. of T1 & T2	IA						
ITC801	Blockchain and DLT	30	30	30	10	60	-	-	-	-	100
ITDLC802	Department Level Elective – V	30	30	30	10	60	-	-	-	-	100
ITDLC803	Department Level Elective – VI	30	30	30	10	60	-	-	-	-	100
ILC804	Institute Level Elective – II	30	30	30	10	60	-	-	-	-	100
ITL801	Blockchain Lab	-	-	-	-	-	25	25	-	-	50
ITL805	RPA Lab	-	-	-	-	-	25	-	25	-	50
ITDLL802	Department Level Elective – V Lab	-	-	-	-	-	25	-	-	25	50
ITPR86	PBL – Major Project B	-	-	-	-	-	50	-	-	100	150
Total		120	120	120	40	240	125	-	-	175	700

Abbreviations: TH – Theory, P – Practical, TUT – Tutorial, PC – Professional Core Course, PE-DLC – Professional Elective - Department Level Elective Course, OE-ILC – Open Elective - Institute Level Elective Course, PBL – Project-Based Learning, CA – Continuous Assessment, T1 – Test 1, T2 – Test 2, IA – Internal Assessment, ESE – End Semester Exam, TW – Term Work, O – Oral Exam, P – Practical Exam, P&O – Practical & Oral Exam.

Professional Electives - Department Level Elective Courses & Labs (PE-DLC – V & PE-DLC – VI)

Group A: Artificial Intelligence	Group B: Network & Security	Group C: Multimedia	Group D: Optimization
Natural Language Processing (ITDLC8021)	Cloud Security (ITDLC8022)	Remote Sensing and GIS (ITDLC8023)	High Performance Computing (ITDLC8024)
NLP Lab (ITDLL8021)	Cloud Security Lab (ITDLL8022)	Remote Sensing and GIS Lab (ITDLL8023)	HPC Lab (ITDLL8024)
Explainable AI & Responsible AI (ITDLC8031)	Edge Computing (ITDLC8032)	Augmented Reality – Virtual Reality (ITDLC8033)	Optimization Techniques (ITDLC8034)

Open Electives - Institute Level Elective Courses (OE-ILE – II)

Courses
Project Management (ILC8041)
Finance Management (ILC8042)
Entrepreneurship Development and Management (ILC8043)
Human Resource Management (ILC8044)
Professional Ethics and CSR (ILC8045)
Research Methodology (ILC8046)
IPR and Patenting (ILC8047)
Digital Business Management (ILC8048)
Environmental Management (ILC8049)

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITC801	Blockchain and DLT	03	-	-	03
Prerequisites:	Basic of Cryptography, Knowledge of Programming ,Computer Network				
Course Objectives (COBs):	1. To get acquainted with the concept of Distributed ledger system and Blockchain. 2. To learn the concepts of consensus and mining in Blockchain through the Bitcoin network. 3. To understand Ethereum and develop-deploy smart contracts using different tools and frameworks. 4. To understand permissioned Block chain and explore Hyperledger Fabric. 5. To understand different types of crypto assets. 6. To apply Block chain for different domains IOT, AI and Cyber Security				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the basic concept of Blockchain and Distributed Ledger Technology. 2. Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions 3. Implement smart contracts in Ethereum using different development frameworks. 4. Develop applications in permissioned Hyperledger Fabric network. 5. Interpret different Crypto assets and Crypto currencies. 6. Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Basic of Cryptography, Knowledge of Programming, Computer Network	-	02	02	
1. Introduction to DLT and Blockchain	Introduction To Blockchain: Technical Definition of Blockchain. Elements of a Blockchain, Features of Blockchain, Types of Blockchain, What is DLT. DLT V/S Blockchain, CAP Theorem Byzantine, Generals Problem Consensus Mechanism and its Types, Cryptographic Primitives and Data Structure Used In Blockchain.	CO1	01	05	
	Block in a Blockchain: Structure of a Block, Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree.	CO1	02		
2. Bitcoin	What is Bitcoin and the History of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: Keys, Addresses and Wallets, Bitcoin Transactions, UTXO.	CO2	01	09	
	Validation of Transactions, Bitcoin Keys, Addresses, ECC, Base58 , BIP-38 , Pay-to Script and Multisig Addresses, Vanity Addresses.	CO2	02		

	Concept of Wallet, Wallet Technologies in Bitcoin HD wallet from Seed. Transaction Scripts and Scripts Address, Bitcoin Mining and Difficulty levels Structure of Blocks and Blockheader and Genesis Block, Linking of Block.	CO2	01	
	Bitcoin Network: Bitcoin Core node and API, Peer-to Peer Network Architecture, Node Types and Roles, Incentive based Engineering, The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging “Inventory”,	CO2	03	
	Simplified Payment Verification (SPV) Nodes, SPV Nodes and Privacy, Transaction Pools, Blockchain Forks Bitcoin.	CO2	01	
	Testnet Basics of Bitcoin Forensics: Analysis of Address and Wallet , Clustering of Addresses following Money	CO2	01	
3. Permissionless Blockchain: Ethereum	Introduction to Ethereum, Ethereum 1.0 and 2.0 , Turing Completeness EVM and compare with Bitcoin Basics of Ether Units.	CO3	02	10
	Ethereum Wallets Working with Metamask EOA and Contracts Transaction:: Structure of Transaction, Transaction Nonce, Transaction GAS, Recipient, Values and Data, Transmitting Values to EOA and Contract.	CO3	01	
	Smart Contracts and Solidity, Development Environment and Client, Basic of Solidity and Web 3 Lifecycle of Smart contract.	CO3	03	
	Smart Contract Programming using Solidity, Metamask (Ethereum Wallet), Setting up Development Environment, Use Cases of Smart Contract.	CO3	03	
	Smart Contracts: Opportunities and Risk. Smart Contract Deployment: Introduction to Truffle, Use of Remix and test networks for deployment.	CO3	01	
4. Permissioned Blockchain: Hyperledger Fabric	Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain.	CO4	02	07
	Components: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFT Designing Hyperledger Blockchain Other Challenges : Interoperability and Scalability of Blockchain	CO4	05	
5. Crypto assets and Cryptocurrencies	ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, NFT, ICO, STO, Different Crypto currencies, ER 1155 Introduction	CO5	03	03
6. Blockchain	Block chain in IoT, AI, Cyber Security	CO6	01	06

Applications & Case Studies	Applications of Blockchain in various domains Education, Energy, Healthcare.	CO6	05	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. A. Antonopoulos, Mastering Bitcoin, Programming The Open Blockchain, O'Reilly. 2. M. Andreas. G Wood, Mastering Ethereum, Building Smart Contract and DApps, O'Reilly. 3. C. Subramanian, A George, K Abhillash, M Karthikeyen, Blockchain Technology, Universities Press. 4. A. Kumar, Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications using Hyperledger Fabric, BPB. 5. R. Modi, Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Packt. 			
Reference Books:	<ol style="list-style-type: none"> 1. I. Bashir, Mastering Blockchain, Packt. 2. M. Andreas. Antonopoulos, Mastering Bitcoin Unlocking Digital Cryptocurrencies, O'Reilly. 3. K. Saurabh and A. Saxena, Blockchain Technology: Concepts and Applications, Wiley. 4. R. Modi, A. Lewis, The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them for Ethereum and Blockchain, Packt. 			
Useful Links:	<ul style="list-style-type: none"> • https://onlinecourses.nptel.ac.in/noc22_cs44/preview • https://onlinecourses.nptel.ac.in/noc19_cs63/preview • https://ethereum.org/en/ • https://www.trufflesuite.com/tutorials • https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h • https://andersbrownworth.com/blockchain/ • https://andersbrownworth.com/blockchain/public-private-keys/ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8021	Natural Language Processing	03	-	-	03
Prerequisites:	Fundamentals of Mathematics, Probability Theory, Data structure & Algorithms, Theory of Computer Science.				
Course Objectives (COBs):	1. To understand Natural Language Processing and to learn how to apply basic algorithms in this field. 2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics. 3. To design and implement applications based on Natural Language Processing 4. To implement various language Models. 5. To design systems that uses Natural Language Processing techniques .				
Couse Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the components of Natural Language Processing. 2. Apply the word level analysis for morphemes, using finite automata, lemmatization, etc. 3. Explain approaches to syntax and linguistic phenomena with formal grammars. 4. Analyze the approaches to semantics for English sentence in natural language processing. 5. Apply the discourse generation in Natural Language Processing 6. Apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction, etc.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Natural Language Processing	History of Natural Language Processing (NLP), Generic NLP System, Levels of NLP.	CO1	01	03	
	Knowledge in Language Processing, Ambiguity in Natural Language, Stages in NLP.	CO1	01		
	Challenges of NLP, Applications of NLP.	CO1	01		
2. Word Level Analysis	Morphology Analysis – Survey of English Morphology, Inflectional Morphology & Derivational Morphology.	CO2	03	08	
	Lemmatization, Regular Expression, Finite Automata, Finite State Transducers (FST), Morphological Parsing with FST, Lexicon Free FST Porter Stemmer.	CO2	03		
	N-Grams, N-Gram Language Model, N-Gram for Spelling Correction.	CO2	02		
3. Syntax Analysis	Part-of-Speech Tagging (POS)- Tag Set for English (Penn Treebank), Rule based POS Tagging, Stochastic POS Tagging.	CO3	03	08	
	Issues - Multiple Tags & Words, Unknown Words.	CO3	01		
	Introduction to Context Free Grammar CFG.	CO3	01		

	Sequence Labelling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	CO3	03	
4. Semantic Analysis	Lexical Semantics, Attachment for Fragment of English - Sentences, Noun Phrases, Verb Phrases, Prepositional Phrases.	CO4	03	09
	Relations Among Lexemes & Their Senses –Homonymy, Polysemy, Synonymy, Hyponymy.	CO4	03	
	WordNet, Robust Word Sense Disambiguation (WSD), Dictionary Based Approach.	CO4	03	
5. Pragmatics	Discourse Reference Resolution, Reference Phenomenon.	CO5	03	05
	Syntactic and Semantic Constraints on Co-reference.	CO5	02	
6. Applications and Case Studies	Implementation of Applications like Machine Translation, Information Retrieval, Question Answers System.	CO6	02	06
	Categorization, Summarization, Sentiment Analysis, Named Entity Recognition.	CO6	02	
	Case Studies and Recent Researches in Natural Language Processing.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. D. Jurafsky, J. Martin Speech and Language Processing, PHI. 2. T. Siddiqui and U. Tiwari, Natural Language Processing and Information Retrieval, Oxford University Press. 3. S. Bird, E. Klein, Natural Language Processing with Python, O'Reilly 4. C. Manning and H. Schutze, Foundations of Statistical Natural Language Processing, MIT Press. 			
Reference Books:	<ol style="list-style-type: none"> 1. D. Bikel and I. Zitouni, Multilingual Natural Language Processing Applications, Pearson. 2. A. Clark, C. Fox, S. Lappin, The Handbook of Computational Linguistics and Natural Language Processing, Wiley. 3. T. Davies, The Book of R, No Starch Press. 4. N. Roux, S. Lubbe, A Step-by-Step Tutorial: An Introduction into R Application and Programming, BookBoon. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://www.coursera.org/learn/natural-language-processing-tensorflow 2. https://nptel.ac.in/courses/106/105/106105158 3. https://www.udemy.com/course/complete-nlp-course 4. https://onlinecourses.nptel.ac.in/noc19_cs56/preview 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8022	Cloud Security	03	-	-	03
Prerequisites:	Computer Networks, Cryptography and Network Security, Cloud Computing.				
Course Objectives (COBs):	1. To understand fundamental of cloud computing and security. 2. To describe the concepts of virtualization. 3. To understand cloud data security in different cloud computing services. 4. To understand importance of network security. 5. Aware about cloud security. 6. To discuss security risks within the cloud environment.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain different cloud computing services and security aspects involved therein. 2. Describe infrastructure security for cloud. 3. Analyze cloud data security. 4. Apply different components of cloud network security. 5. Apply cloud application security. 6. Discuss legal and compliance domain in cloud security.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Cloud Architecture	Introduction to Cloud Computing, NIST cloud Model, Introduction & Cloud Architecture, Cloud Essential Characteristics, - Cloud Service Models, Cloud Deployment Models.	CO1	03	04	
	Benefits and Challenges of Cloud Computing, Overview of Virtualization.	CO1	01		
2. Infrastructure Security for Cloud	Cloud Infrastructure Components, Physical Environment, Networking, Computing, Virtualization, Management Plane Risks Associated with Cloud Infrastructure, Risk Assessment and Analysis, Virtualization Risks, Countermeasure Strategies.	CO2	04	08	
	Design and Plan Security Controls, Physical and Environmental Protection, System and Communication Protection, Virtualization Systems Protection, Management of Identification, Authentication, and Authorization, Auditing, Disaster Recovery and Business Continuity Management Planning.	CO2	04		
3. Cloud Data Security	Cloud Data Lifecycle, Design and Implement Cloud Data Storage Architectures.	CO3	02	05	
	Design and Apply Data Security Strategies, Data Discovery and Classification Techniques.	CO3	03		

4. Network Security	Differences from Traditional IT, Concepts and Definitions: Whitelists and Blacklists, DMZs, Proxies, Software-Defined Networking, Network Features, Virtualization, Overlay Networks and Encapsulation, Virtual Private Clouds, Network Address Translation, IPv6.	CO4	03	07
	Sample Application: Encryption in Motion, Firewalls and Network Segmentation, Allowing Administrative Access, Web Application Firewalls and RASP, Anti-DDoS, Intrusion Detection and Prevention Systems, Egress Filtering, Data Loss Prevention, Introduction to AAA framework.	CO4	04	
5. Cloud Application Security	Awareness in Application Security, Cloud Software Assurance and Validation, Verified Secure Software, Understanding the Software Development Lifecycle, Applying the Secure Software Development Lifecycle.	CO5	05	07
	Cloud Application Architecture, Identity and Access Management (IAM) Solutions.	CO5	02	
6. Legal and Compliance Domain for Cloud Services	Legal Requirements and Unique Risks Within the Cloud Environment: International Legislation Conflicts, Appraisal of Legal Risks Specific to Cloud Computing, Legal Controls.	CO6	03	08
	Privacy Issues and Jurisdictional Variation: Audit Processes, Methodologies, and Required Adaption, Internal and External Audit Controls.	CO5	03	
	Impact of Requirements Programs by the Use of Cloud, Assurance Challenges of Virtualization and Cloud, Types of Audit Reports.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Text Books:	1. D. Carter, Certified Cloud Security Professional, McGraw Hill. 2. C. Dotson, Practical Cloud Security, O' Reilly Media,			
Reference Books:	1. M. Liyanage, A. Gurtov, M. Ylianttila, Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture, Wiley. 2. B. Sosinsky, Cloud Computing Bible, Wiley. 3. K. Jayaswal, J. Kallalurchi, D. J. Houde, Dr. D. Shah, Cloud Computing Black Book, Dreamtech Press. 4. T. Erl, R. Cope, A. Naserpour, Cloud Computing Design Patterns, Pearson.			
Useful Links:	1. https://www.coursera.org/learn/cloud-computing-security 2. https://www.udemy.com/course/azure-cloud-security 3. https://www.coursera.org/learn/cloud-security-basics 4. https://www.coursera.org/learn/cloud-computing-security 5. https://www.coursera.org/learn/cloud-application-security			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. 			

	<ul style="list-style-type: none"> • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8023	Remote Sensing and GIS	03	-	-	03
Prerequisites:	Image Processing				
Course Objectives (COBs):	<div>1. To prepare the students in identifying, analyzing and solving geospatial problems.</div> <div>2. To train the students in developing practical and executable solutions to the challenges of growing field of Remote Sensing and GIS.</div> <div>3. To impart the students with strong base of knowledge that makes them suitable both for industries as well as for teaching and research.</div> <div>4. To inculcate the students with the sensitivity towards ethics, public policies and their responsibilities towards the society.</div> <div>5. To develop a basic understanding about Geo-Spatial techniques and its applications.</div> <div>6. Usage of diverse remote sensing data for extracting needed geo-spatial information.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Explain Geo-Spatial techniques and its applications.</div> <div>2. Describe various GIS techniques within spatial analytical framework and handle huge spatial and non-spatial database.</div> <div>3. Explain Satellite Hard copy FCC images and Survey of India Topo sheets.</div> <div>4. Discuss various radiometric and spatial enhancement techniques and create land cover map using different clustering techniques using DIP methods.</div> <div>5. Describe various GIS techniques within spatial analytical framework and handle huge spatial and non-spatial database.</div> <div>6. Explain integrated geospatial techniques and apply them in solving real world problems.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Fundamental of Remote Sensing	Definition: Components of Remote Sensing, Active and Passive Remote Sensing, Electro Magnetic Spectrum, Interaction of EMR with the Earth’s Surface.	CO1	03	09	
	Interactions with the Atmosphere Energy Sources and Radiation. Active and Passive Remote Sensing.	CO1	03		
	Energy Interaction with the Earth Surface Features. Data Acquisition and Recording. Remote Sensing Data Products.	CO1	03		
2. Image Interpretation And Digital Image Processing	Introduction to Digital Image and Imaging Sensors: Data Formats of Digital Image,	CO2	03	06	
	Display of Digital Image: Image Processing Systems, Strategies, Keys, Equipment, Fundamentals of Image Classification and Analysis.	CO2	03		
	Introduction to GIS: Definitions of GIS and Related Terminology, Components of GIS.	CO3	03	06	

3. Geographic Information System	GIS Data: Georeferenced Data, introduction to Data Input and Output in GIS, Fundamentals of Data Quality and Management.	CO3	03	
4. Spatial Data Analysis	Characteristics of Map Coordinate Systems: Introduction to Map projections- Geo-referencing Frameworks and Reference.	CO4	03	09
	Coordinate Systems. GIS analysis functions, Retrieval Reclassification, Buffering and Neighbourhood.	CO4	03	
	Overlaying: Data Output, Fundamentals of GIS Analysis Functions.	CO4	03	
5. GIS Software	GIS and Image Interpretation Software, Salient features, Capabilities and Limitations.	CO5	03	06
	Data management in public domain GIS software, Attribute Data Management.	CO5	03	
6. Case Studies	Application of Remote Sensing GIS: Case studies, GIS and Remote Sensing.	CO6	03	03
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. Lilliesand T.M. and Kiefer R.W., Remote Sensing and image Interpretation, John Wiley and Sons, New York, 2004. 2. Burrrough P.A and McDonnel R.A., Principles of Geographic Information Systems, Oxford university press, 1998. 3. A.M. Chandra and S.K. Ghosh, Remote Sensing and Geographical Information System, Narosa Publishing House, New Delhi, 2006.			
Reference Books:	1. B. Bhatta, Remote Sensing and GIS, Oxford University Press. 2. S. Aronoff, Geographical Information Systems, WDL. 3. N. Agrawal, Essentials of GPS, BS Publications.			
Useful Links:	1. https://www.coursera.org/learn/remote-sensing . 2. https://www.coursera.org/specializations/gis-mapping-spatial-analysis 3. https://www.classcentral.com/course/swayam-remote-sensing-and-gis-14272			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8024	High Performance Computing	03	-	-	03
Prerequisite:	Computer Organization, C Programming, Data structures and Algorithm Analysis.				
Course Objectives (COBs):	The course aims: 1. Learn the concepts of high-performance computing. 2. Gain knowledge of platforms for high performance computing. 3. Design and implement algorithms for parallel programming applications. 4. Analyze the performance metrics of High Performance Computing. 5. Understand the parallel programming paradigm, algorithms and applications. 6. Demonstrate the understanding of different High Performance Computing tools.				
Couse Outcomes (COs):	On successful completion, of course, learner/student will be able to: 1. Understand fundamentals of parallel Computing. 2. Describe different parallel processing platforms involved in achieving High Performance Computing. 3. Demonstrate the principles of Parallel Algorithms and their execution. 4. Evaluate the performance of HPC systems. 5. Apply HPC programming paradigm to parallel applications. 6. Discuss different current HPC Platforms.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction	Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation).	CO1	04	06	
	Parallel Architectures: Interconnection network, Processor Array, Multiprocessor.	CO1	02		
2. Parallel Programming Platforms	Implicit Parallelism: Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines.	CO2	04	05	
	Trends in Microprocessor & Architectures, Limitations of Memory System Performance	CO2	01		
3. Parallel Algorithm And Concurrency	Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing.	CO3	04	08	
	Basic Communication operations: Broadcast and Reduction Communication types. Parallel Algorithm Models	CO3	04		

4. Performance Measures for HPC	Performance Measures: Speedup, Execution Time, Efficiency, Cost, Scalability, Effect of Granularity on Performance, Scalability of Parallel Systems	CO4	05	07
	Amdahl's Law, Gustavson's Law, Performance Bottlenecks.	CO4	02	
5. Programming Paradigms for HPC	Programming Using the Message-Passing Paradigm : Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding.	CO5	04	07
	Parallel Algorithms and Applications : One-Dimensional Matrix-Vector Multiplication, Graph Algorithms, Sample Sort, Two-Dimensional Matrix Vector Multiplication.	CO5	03	
6. GPGPU Architecture and Programming	General Purpose Graphics Processing Unit (GPGPU), Introduction to OpenMP, OpenCL Device Architectures, Introduction to OpenCL Programming.	CO6	04	06
	Introduction to CUDA architecture, and Introduction to CUDA Programming.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. A. Grama, A. Gupta, G. Karypis, V. Kumar , Introduction to Parallel Computing, Pearson. 2. K. Hwang, N. Jotwani, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill. 3. E. Kandrot and J. Sanders, CUDA by Example – An Introduction to General Purpose GPU Programming, Addison-Wesley. 4. G. Hager, G. Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press. 5. B. Gaster, L. Howes, D. Kaeli, P. Mistry, D. Schaa , Heterogeneous Computing with OpenCL, Elsevier. 			
Reference Books:	<ol style="list-style-type: none"> 1. M. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill. 2. K. Hwang, Z. Xu, Scalable Parallel Computing: Technology, Architecture, Programming, McGraw Hill. 3. L. Yang, M. Guo, High- Performance Computing: Paradigm and Infrastructure, Wiley. 4. F. Gebali, Algorithms and Parallel Computing, John Wiley & Sons.. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc21_cs46/preview 2. https://onlinecourses.nptel.ac.in/noc22_cs21/preview 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8031	Explainable AI and Responsible AI	03	-	-	03
Prerequisites:	Concepts of Artificial Intelligence.				
Course Objectives (COBs):	1. To understand the need of explainable and responsible AI and introduce to the concept of Interpretability. 2. To design an Interpretable Models. 3. To use Model Agnostic Methods to achieve explain-ability. 4. To deduce explain-ability with the help of example-based explanations. 5. To achieve responsible AI with the help of ethical decision making. 6. To implement responsible AI using TensorFlow.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the need of explainable AI and responsible AI and the concept of Interpretability. 2. Implement an Interpretable Models. 3. Use Model Agnostic Methods to achieve explain-ability. 4. Infer explain-ability with the help of example-based explanations. 5. Explain responsible AI through the ethical decision making. 6. Implement responsible AI using TensorFlow.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction of Explainable AI	Need of explaining AI Models, Need of Responsible AI Introduction to Interpretability: Importance of Interpretability, Taxonomy of Interpretability Methods.	CO1	03	06	
	Scope of Interpretability, Evaluation of Interpretability, Properties of Explanations, Human Friendly Explanations.	CO1	03		
2. Interpretable Models	Deriving Explanation from Linear Regression, Logistic Regression, GLM, GAM.	CO2	03	07	
	Deriving Explanation from Decision Tree, Decision Rules, RuleFit.	CO2	02		
	Deriving Explanation from other Interpretable Models: Naïve Bayes Classifier, K-Nearest Neighbor.	CO2	02		
3. Model-Agnostic Methods	Partial Dependence Plot, Individual Conditional Expectation, Accumulated Local Effects Plot.	CO3	03	06	
	Feature Interaction, Permutation Feature Importance, Global Surrogate, Local Surrogate (LIME) Scoped Rules (Anchors), Shapely Values, Eli5.	CO3	03		
4. Example Based Explanations	Counterfactual Explanations, Adversarial Examples.	CO4	03	07	
	Prototypes and Criticism, Influential Instances.	CO4	04		
	Expectations in the Impact of AI.	CO5	03	06	

5. Ethical Decision Making	Responsibility in AI, Responsible AI Challenges.	CO5	03	
6. Ensuring Responsible AI in Practice	Need of Responsible AI, Principles of Responsible AI.	CO6	03	07
	Designing Responsible AI, Responsible AI using TensorFlow.	CO6	04	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. C. Molnar, Interpretable Machine Learning, Creative Commons License, Lulu.com. 2. W. Samek, G. Montavon, A. Vedaldi, L. Hansen and K. Muller, Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Springer. 3. V. Dignum, Responsible Artificial Intelligence, Springer.			
Reference Books:	1. D. Rothman, Hands-on Explainable AI (XAI) with Python, Packt Publishing. 2. P. Hall and R. Chowdhury, Responsible AI, O'Reilly.			
Useful Links:	1. https://christophm.github.io/interpretable-ml-book/ 2. https://youtu.be/2nUiVJiVchw			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8032	Edge Computing	03	-	-	03
Prerequisites:	Internet of Things, Artificial Intelligence Fundamentals.				
Course Objectives (COBs):	1. To understand the core fundamentals of edge computing. 2. To learn about the key technologies and platforms for edge, fog computing. 3. To learn technical terms related to edge computing. 4. To discuss network slicing. 5. To discuss application of edge computing.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain computing paradigms and their features. 2. Describe middleware for edge & fog computing. 3. Explain importance of orchestration of network slices in 5G. 4. Analyze computing problems in edge & fog computing. 5. Describe optimization problem in edge & fog computing. 6. Apply the various edge computing applications.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. IoT and New Computing Paradigms	Introduction, Relevant Technologies, Fog and Edge Computing Completing the Cloud.	CO1	02	04	
	Advantages of FEC, How FEC Achieves These Advantages, Hierarchy of Fog and Edge Computing.	CO1	02		
2. Integrating IoT, Fog, Cloud Infrastructures	Introduction, Analytical Models, Petri Net Models, Integer Linear Programming, other Approaches.	CO2	03	05	
	Energy Consumption, Performance, Resource Consumption.	CO2	02		
3. Management & Orchestration of Network Slices in 5G	Networking Challenges in a Federated Edge Environment, Background, Network Slicing in 5G.	CO3	02	06	
	Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog, Software-Defined Clouds, Edge and Fog Computing.	CO3	04		
4. Optimization Problems in Edge and Fog Computing	Background, The Case for Optimization in Fog Computing, Metrics.	CO4	02	06	
	Optimization Opportunities along the Service Life Cycle.	CO4	02		
	Optimization Opportunities along the Fog Architecture, Optimization Techniques.	CO4	02		
5. Middleware for Edge and Fog Computing	Need for Fog and Edge Computing Middleware, Design Goals, State-of-the-Art Middleware Infrastructures, System Model, Proposed Architecture Case Study Example.	CO52	03	06	

	A Lightweight Container Middleware for Edge Cloud Architectures, Clusters for Lightweight Edge Clouds, IoT Integration, Security Management for Edge Cloud Architectures.	CO2	03	
6. Edge Computing Application	Need of Environmental Care, IoT Data Analytics Techniques for: Fire Detection, Air Pollution Prediction, Earthquake Early Detection.	CO6	03	12
	Recent Research in IoT Data Analytics for Smart Environmental Care, Introduction and Need of Smart Travelling.	CO6	03	
	IoT Data Analytics techniques for: Self-Driving Cars, Travel Route Optimization, Smart Traffic Management.	CO6	03	
	Recent Research in IoT Data Analytics For Smart Travelling.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. A. Zomaya, A. Abbas and S. Khan, Fog Computing Theory & Practice, Wiley. 2. R. Buyya and S. Srirama, Fog, Edge Computing: Principles and Paradigms, Wiley. 3. T. Andrew, Distributed System Principal & Paradigm, PHI.			
Reference Books:	1. N. Wilkins, Internet of Things: What You Need to Know about IoT, Big Data, etc., Independent Publishers. 2. H. Geng, Internet of Things and Data Analytics Handbook, Wiley.			
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc19_cs64/preview 2. https://www.udemy.com/course/edge-computing-a-complete-guide-on-computing-at-the-edge/ 3. https://nptel.ac.in/courses/106/104/106104182/ 4. https://www.coursera.org/lecture/iot-wireless-cloud-computing/5-10-edge-computing-pOK8T			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8033	Augmented Reality - Virtual Reality	03	-	-	03
Prerequisites:	Fundamentals of Image Processing.				
Course Objectives (COBs):	1. To present a review of current Virtual Reality (VR). 2. To provide a detailed analysis of the engineering, scientific and functional aspects of VR. 3. To familiarize with development of VR and AR applications. 4. To explain virtual environments and simulators.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe the various components in VR and its applications. 2. Explain different visual perception and concept of Rendering. 3. Interpret the software technologies used in VR and interactive techniques in VR. 4. Discuss design guidelines for interactive techniques in VR. 5. Describe the AR technologies and various methods of AR. 6. Explain different tools and applications to design and develop AR/VR industrial applications and future technologies.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Virtual Reality and Virtual Environments	The Historical Development of Virtual Reality (VR), Fundamental Concept and Components of Virtual Reality, Hardware and Software Requirements for VR, Benefits of Virtual Reality, Primary Features and Present Development on Virtual Reality, Key Elements of Virtual Reality Experience, Virtual Environments.	CO1	04	08	
	Virtual Reality Applications: Engineering, Architecture, Education, Medicine, Entertainment, Science, Training.	CO1	02		
	Multiple Models of Input and Output Interface in Virtual Reality: Input-Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -Visual /Auditory / Haptic Devices.	CO1	02		
2. Visual Perception & Rendering Visual Perception	Perception of Depth, Perception of Motion, Perception of Colour, Combining Sources of Information, Visual Rendering.	CO2	03	06	
	Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.	CO2	03		

3. Software Technologies	Database-World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other Attributes.	CO3	02	06
	VR Environment-VR Database, Tessellated Data, LODs, Cullers and Occludes, Lights and Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface.	CO3	03	
	Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR Toolkits, SDKs.	CO3	01	
4. Interactive Techniques in Virtual Reality	3D Interaction Techniques: 3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Design Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding.	CO4	03	07
	User Centred Wayfinding Support, Environment Centred Wayfinding Support, Evaluating Wayfinding Aids.	CO4	02	
	Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestural Commands, Tools, Multimodal System Control Techniques.	CO4	01	
	Case Study: Mixing System Control Methods, Symbolic Input Tasks, and Symbolic Input Techniques, Beyond Text and Number entry.	CO4	01	
5. Introduction to Augmented Reality	Augmented and Mixed Reality, Taxonomy, Technology and Features of Augmented Reality, Difference between AR and VR.	CO5	02	06
	System Structure of Augmented Reality (AR), Key Technology in AR, Challenges With AR, AR Systems and Functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Wireless Displays in Educational Augmented Reality Applications.	CO5	02	
	Mobile Projection Interfaces, Marker-Less Tracking for Augmented Reality, Enhancing Interactivity in AR Environments, Evaluating AR Systems, Marker based AR.	CO5	02	
6. Applications and Development Tools	Designing and Developing 3D user Interfaces. Application of VR in Digital Entertainment: VR Technology in Film & TV Production, VR Technology in Physical Exercises and Games.	CO6	03	06
	Demonstration of Digital Entertainment by VR tools: Development Tools in VR.X3D Standard, Vega, MultiGen, Virtools, Blender, Unity and Maya.	CO6	03	

ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. A. Craig, W. Sherman and J. Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann. 2. D. Bowman, E. Kuijff, J. LaViola, I. Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley. 3. A. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann.			
Reference Books:	1. B. Grigore and P. Coiffet, Virtual Reality Technology, Wiley - Inderscience. 2. W. Sherman and A. Craig, Understanding Virtual Reality: Interface, Application and Design, Morgan Kaufmann. 3. T. Parisi, Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, O'Reilly.			
Useful Links:	1. https://www.coursera.org/learn/ar 2. https://nptel.ac.in/courses/106/106/106106138/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLC8034	Optimization Techniques	03	-	-	03
Prerequisites:	Courses in Information Technology like Networks, Operating Systems, Artificial Intelligence.				
Course Objectives (COBs):	<div>1. To introduce various optimization techniques and its fundamental concepts.</div> <div>2. To explain the concepts of Linear Programming and its application for optimization.</div> <div>3. To explore Constrained and Unconstrained optimization techniques for solving and optimizing real-world problems.</div> <div>4. To discuss modern optimization methods for solving real-world problems.</div> <div>5. To discuss applications and suitability of various optimization Problems.</div> <div>6. To provide knowledge of formulating optimization problem statements for real-world problems.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Explain the fundamental concepts and techniques of optimization.</div> <div>2. Apply the concepts of Linear Programming for optimization of real-world problem-solutions.</div> <div>3. Apply Unconstrained optimization and Constrained optimization algorithms for real-world problem-solving.</div> <div>4. Apply modern algorithms like ACO, PSO, GA, etc. for optimization.</div> <div>5. Identify the appropriate optimization technique for the given problem and relate key concepts & applications of various optimization techniques.</div> <div>6. Formulate appropriate objective functions and constraints to solve real-world optimization problems.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Optimization	Introduction to Optimization, Engineering Applications of Optimization, Statement of an Optimization Problem, Optimal Problem Formulation, Classification of Optimization Problems.	CO1, CO5, CO6	03	08	
	Classical Optimization Techniques: Single variable Optimization, Constrained and Unconstrained Multivariable Optimization.	CO1	02		
	Optimum Design Concepts: Definition of Global and Local Optima, Optimality Criteria, Review of Basic Calculus Concepts, Global Optimality.	CO1	03		
2. Linear Programming	Introduction to Linear Programming, Formulation of Linear Programming Problems, Applications of Linear Programming in Engineering.	CO2, CO5, CO6	02	08	
	Graphical Solution Method, Alternative or Multiple Optimal Solutions, Unbounded, Infeasible Solutions.	CO2	02		

	Maximization - Simplex Algorithm, Minimization - Simplex Algorithm using Big-M Method.	CO2	02	
	Two Phase Method, Duality in Linear Programming, Integer Linear Programming.	CO2	02	
3. Unconstrained Optimization	Unconstrained Optimization Problems and Applications, Introduction to Optimization Algorithms for Solving Unconstrained Optimization Problems.	CO3, CO5, CO6	02	05
	Gradient-based Method: Cauchy's Steepest Descent Method, Newton's Method, Conjugate Gradient Method.	CO3	03	
4. Constrained Optimization	Constrained Optimization Problems and Applications, Introduction to Optimization Algorithms for Solving Constrained Optimization Problems.	CO3, CO5, CO6	02	05
	Direct Methods: Penalty Function Methods, Steepest Descent Method.	CO3	03	
5. Modern Methods of Optimization	Genetic Algorithms for Optimization of Real-World Problem-Solving.	CO4	02	08
	Ant Colony Optimization for Real-World Problem-Solving.	CO4	02	
	Neural-Network based Optimization for Real-World Problem-Solving.	CO4	02	
	Particle Swarm Optimization for Real-World Problem-Solving.	CO4	02	
6. Case Studies	Case Studies and Analysis of Suitable Methods for Optimization.	CO5, CO6	03	05
	Use of MATLAB to Solve Optimization Problems.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. S. Rao, Engineering Optimization, Theory & Practice, New Age International Publishers. 2. G. Hadley, Linear Programming, Narosa Publishing. 3. K. Deb, Optimization for Engineering Design: Algorithms and Examples, PHI. 4. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.			
Reference Books:	1. D. Floreano and C. Mattiussi, Bio-inspired Artificial Intelligence, MIT Press. 2. K. Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley. 3. D. Marco, S. Thomas, Ant Colony Optimization, PHI.			
Useful Links:	1. https://www.coursera.org/learn/optimization-for-decision-making 2. https://nptel.ac.in/courses/111/105/111105039/ 3. https://www.coursera.org/learn/calculus-and-optimization-for-machine-learning			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8041	Project Management	03	-	-	03
Course Objectives (COBs):	1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. 2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Apply selection criteria and select an appropriate project from different options. 2. Explain work break down structure for a project and develop a schedule based on it. 3. Identify opportunities and threats to the project and decide an approach to deal with them strategically. 4. Use earned value technique and determine & predict status of the project. 5. Elaborate lessons learned during project phases and document them for future reference 6. Inculcate leadership qualities and ethics.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Project Management Foundation	Definition of a Project, Project versus Operations, Necessity of Project Management, Triple Constraints, Project Life Cycles (Typical & Atypical) Project Phases and Stage Gate Process, Role of Project Manager.	CO1	03	05	
	Role of Project Manager, Negotiations and Resolving Conflicts. Project Management in Various Organization Structures, PM Knowledge Areas as per Project Management Institute (PMI).	CO1	02		
2. Initiating Project	How to get a Project Started, Selecting Project Strategically, Project Selection Models (Numeric /Scoring Models and Non-numeric models), Project Portfolio Process.	CO2	03	06	
	Project Portfolio Process, Project Sponsor and Creating Charter, Project Proposal, Effective Project Team, Stages of Team Development & Growth (Forming, Storming, Norming & Performing), Team Dynamics.	CO2	03		
3. Project Planning and Scheduling	Work Breakdown Structure (WBS) and Linear Responsibility Chart, Interface Co-ordination and Concurrent Engineering, Project Cost Estimation and Budgeting.	CO3	04	08	
	Project Cost Estimation and Budgeting, Top Down and Bottoms Up Budgeting, Networking and Scheduling Techniques, PERT, CPM, Gnatt Chart.	CO3	03		
	Introduction to Project Management Information System.	CO3	01		

4. Planning Project	Crashing Project Time, Resource Loading and Leveling, Goldratt's Critical Chain, Project Stakeholders and Communication Plan.	CO4	02	06
	Risk Management in Projects: Risk Management Planning, Risk Identification and Risk Register.	CO4	02	
	Qualitative and Quantitative Risk Assessment, Probability and Impact Matrix, Risk Response Strategies for Positive and Negative Risks.	CO4	02	
5. Executing, Monitoring and Controlling	Executing Projects: Planning Monitoring and Controlling Cycle, Information Needs and Reporting, Engaging with All Stakeholders of the Projects, Team Management, Communication and Project Meetings.	CO5	03	08
	Monitoring and Controlling Projects: Earned Value Management Techniques for Measuring Value of Work Completed, Using Milestones for Measurement, Change Requests and Scope Creep, Project Audit.	CO5	03	
	Project Contracting, Project Procurement Management, Contracting and Outsourcing.	CO5	02	
6. Project Leadership and Ethics and Closing the Projects	Introduction to Project Leadership, Ethics in Projects, Multicultural & Virtual Projects.	CO6	03	06
	Closing the Project: Customer Acceptance, Reasons of Project Termination, Various types of Project Terminations (Extinction, Addition, Integration, Starvation), Process of Project Termination, Completing a Final Report, doing a Lesson Learned Analysis, Acknowledging Successes and Failures, Project Management Templates and Other Resources, Managing Without Authority, Areas of Further Study.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. J. Meredith, S. Mantel, Project Management: A Managerial Approach, Wiley. 2. M. Gopalan, Project Management, Wiley.			
Reference Books:	1. A Guide to Project Management Body of Knowledge, Project Management Institute, USA. 2. G. Clements, Project Management, Cengage Learning. 3. D. Lock, Project Management, Gower Publishing.			
Useful Links:	1. https://nptel.ac.in/courses/110/104/110104073/ 2. https://www.coursera.org/search?query=project%20management			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8042	Finance Management	03	-	-	03
Prerequisites:	Fundamentals of Engineering.				
Course Objectives (COBs):	1. Overview of Indian financial system, instruments and market. 2. Basic concepts of value of money, returns and risks, corporate finance working capital and its management. 3. Knowledge about sources of finance, capital structure, dividend policy.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the Indian financial system and corporate finance. 2. Describe the take investment, finance as well as dividend decisions. 3. Analyze financial ratio in a corporate environment. 4. Describe the Capital Budgeting and Management. 5. Identify the sources and structure of capital finance. 6. Describe Dividend Policy Theories and Approaches.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Financial System	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.	CO1	01	06	
	Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments, Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.	CO1	02		
	Financial Markets: Meaning, Characteristics and Classification of Financial Markets.	CO1	01		
	Capital Market, Money Market and Foreign Currency Market.	CO1	02		
2. Concepts of Returns and Risks	Concepts of Returns: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio.	CO2	02	06	
	Concepts of Risks: Measurement of Historical Risk, Expected Risk of a Single Security and a Two-security Portfolio.	CO2	02		
	Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due, Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due, Continuous Compounding and Continuous Discounting.	CO2	02		
3. Corporate Finance and Financial Ratio	Overview of Corporate Finance: Objectives of Corporate Finance, Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	CO3	03	09	
	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, Cash Flow Statement.	CO3	02		

	Purpose of Financial Ratio Analysis, Liquidity Ratios, Efficiency or Activity Ratios, Profitability Ratios, Capital Structure Ratios, Stock Market Ratios, Limitations of Ratio Analysis.	CO3	04	
4. Capital Budgeting and Management	Capital Budgeting: Meaning and Importance of Capital Budgeting, Inputs for Capital Budgeting Decisions, Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period.	CO4	03	10
	Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR).	CO4	02	
	Working Capital Management: Concepts of Meaning Working Capital, Importance of Working Capital Management, Factors Affecting an Entity's Working Capital Needs.	CO4	03	
	Estimation of Working Capital Requirements, Management of Inventories, Management of Receivables, and Management of Cash and Marketable Securities.	CO4	02	
5. Sources of Finance and Capital Structure	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids, Mezzanine Finance, Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper, Project Finance.	CO5	02	05
	Capital Structure: Factors Affecting an Entity's Capital Structure, Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach, Traditional Approach, Modigliani-Miller Approach.	CO5	02	
	Relation between Capital Structure and Corporate Value, Concept of Optimal Capital Structure.	CO5	01	
6. Dividend Policy	Dividend Policy: Meaning and Importance of Dividend Policy, Factors Affecting an Entity's Dividend Decision.	CO6	01	03
	Overview of Dividend Policy Theories and Approaches Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach.	CO6	02	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. E. Brigham, J. Houston, Fundamentals of Financial Management, Cengage Publications. 2. R. Higgins, Analysis for Financial Management; Publishers: McGraw Hill.			
Reference Books:	1. M. Khan, Indian Financial System, McGraw Hill Education. 2. I. Pandey, Financial Management, S. Chand and Sons.			
Useful Links:	1. https://edition.cnn.com/business 2. https://www.cnbc.com/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			

**End Semester
Examination
(ESE):**

- End Semester Exam shall be conducted for Total 60 Marks.
- Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8043	Entrepreneurship Development and Management	03	-	-	03
Prerequisites:	Fundamentals of Technology.				
Course Objectives (COBs):	1. To acquaint with entrepreneurship and management of business. 2. Understand Indian environment for entrepreneurship. 3. Idea of EDP, MSME. 4. Discuss the government plan for startup business. 5. Analyze the business risk. 6. Discuss the successful business stories.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the concept of business plan and the role of money and capital markets in entrepreneurial development. 2. Analyze key regulations and legal aspects of entrepreneurship in India. 3. Explain government policies for startup. 4. Describe different government initiatives for startup. 5. Explain issues and problems faced by micro and small enterprises. 6. Describe growth strategies for small businesses.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Overview of Entrepreneurship	Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development.	CO1	01	04	
	Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur.	CO1	01		
	Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing Information for Entrepreneurship.	CO1	02		
2. Business Plans and Importance of Capital to Entrepreneurship	Introduction: Preliminary and Marketing Plans, Management and Personnel.	CO2	02	09	
	Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur.	CO2	03		
	Entrepreneurship and Business Development: Starting a New Business, Buying an Existing Business.	CO2	02		
	New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	CO2	02		
3. Entrepreneurship Development	Women’s Entrepreneurship Development, Social Entrepreneurship-Role and Need, EDP Cell.	CO3	02	04	

	Role of Sustainability and Sustainable Development for SMEs, Case Studies, Exercises.	CO3	02	
4. Indian Environment for Entrepreneurship	Key Regulations and Legal Aspects, MSMED Act 2006 and its Implications, Schemes and Policies of the Ministry of MSME, Role and Responsibilities of various Government Organisations, Departments, Banks etc.	CO4	03	09
	Role of State Governments in Terms of Infrastructure Developments and Support etc.	CO4	04	
	Public Private Partnerships, National Skill Development Mission, Credit Guarantee Fund, PMEGP, Discussions, Group Exercises etc.	CO4	02	
5. Effective Management of Business	Issues and Problems Faced by Micro and Small Enterprises and Effective Management of M and S Enterprises.	CO5	04	08
	Risk Management, Credit Availability, Technology Innovation, Supply Chain Management, Linkage with Large Industries, Exercises, E-Marketing.	CO5	04	
6. Achieving Success in The Small Business	Stages of the Small Business Life Cycle, Four Types of Firm-Level Growth Strategies, Options – Harvesting or Closing Small Business Critical Success Factors of Small Business.	CO6	05	05
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. P. Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson 2. R. Hisrich and M. Peters, Entrepreneurship, McGraw Hill. 3. D. Kuratko, Entrepreneurship- Principles and Practices, Thomson Publication			
Reference Books:	1. T. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi. 2. Law and Practice Relating to Micro, Small and Medium Enterprises, Taxmann Publication. 3. L. Maddhurima, S. Shikah, Entrepreneurship, Excel Books. 4. R. Bansal, Stay Hungry Stay Foolish, CIIE, IIM Ahmedabad.			
Useful Links:	1. www.msme.gov.in/ 2. www.dcmesme.gov.in/ 3. www.msmetraining.gov.in/			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8044	Human Resource Management	03	-	-	03
Prerequisites:					
Course Objectives (COBs):	<div>1. To introduce the students with basic concepts, techniques and practices of the human resource management.</div> <div>2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations.</div> <div>3. To familiarize the students about the latest developments, trends & different aspects of HRM.</div> <div>4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.</div>				
Course Outcomes (COs):	<div>Upon completion of the course, the learners will be able to:</div> <div>1. Describe the concepts, aspects, techniques and practices of human resource management.</div> <div>2. Describe the Human resource management (HRM) processes, functions, changes and challenges in today’s emerging organizational perspective.</div> <div>3. Apply the knowledge about the latest developments and trends in HRM.</div> <div>4. Analyze the knowledge of Cross-cultural Leadership and Decision Making.</div> <div>5. Apply the knowledge of behavioral skills learnt and integrate it with in interpersonal and intergroup environment emerging as future stable engineers and managers.</div> <div>6. Apply the Labor Laws & Industrial Relations and various Act.</div>				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction Human Resource Management	Introduction to Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM Functions.	CO1	03	05	
	Human Resource Development (HRD): Changing Role of HRM – Human Resource Planning, Technological Change, Restructuring and Rightsizing, Empowerment, TQM, Managing Ethical Issues.	CO1	02		
2. Organizational Behavior (OB)	Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary Issues.	CO2	02	07	
	Personality: Meaning and Determinants of Personality, Personality Development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness.	CO2	01		
	Perception: Attitude and Value, Effect of Perception on Individual Decision-making, Attitude and Behavior.	CO2	01		

	Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor).	CO2	01	
	Group Behaviour and Group Dynamics: Work groups Formal and Informal Groups and Stages of Group Development. Team Effectiveness: High Performing Teams, Team Roles, Cross Functional and Self-Directed Team, Case Study.	CO2	02	
3. Organizational Structure & Design	Structure, Size, Technology, Environment of Organization, Organizational Roles & Conflicts: Concept of Roles, Role Dynamics, Role Conflicts and Stress.	CO3	02	06
	Leadership: Concepts and Skills of Leadership, Leadership and Managerial Roles, Leadership Styles and Contemporary Issues in Leadership.	CO3	02	
	Power and Politics: Sources and Uses of Power, Politics at Workplace, Tactics and Strategies.	CO3	02	
4. Human Resource Planning	Recruitment and Selection Process, Job-Enrichment, Empowerment - Job-Satisfaction, employee morale.	CO4	01	05
	Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning.	CO4, CO6	02	
	Training & Development: Identification of Training Needs, Training Methods.	CO4	02	
5. Emerging Trends in HR	Organizational Development, Business Process Re-Engineering (BPR), BPR as a Tool for Organizational Development, Managing Processes & Transformation in HR. Organizational Change, Culture, Environment.	CO4	03	06
	Cross Cultural Leadership and Decision Making: Cross Cultural Communication and Diversity at Work, Causes of Diversity, Managing Diversity with Special Reference to Handicapped, Women and Ageing People, Intra Company Cultural Difference in Employee Motivation.	CO5	03	
6. Strategic HRM	HR & MIS: Need, Purpose, Objective and Role of Information System in HR, Applications in HRD in Various Industries (e.g. Manufacturing R&D, Public Transport, Hospitals, Hotels and Service Industries.	CO6	04	10
	Strategic HRM: Role of Strategic HRM in the Modern Business World, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making, Strategic Intent – Corporate Mission, Vision, Objectives and Goals	CO6	03	
	Labour Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labour Laws in India, Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01

Text Books:	<ol style="list-style-type: none"> 1. S. Robbins, Organizational Behavior, Pearson Education Limited. 2. V. Rao, Human Resource Management, Excel publishing. 3. K. Aswathapa, Human resource management: Text & cases.
Reference Books:	<ol style="list-style-type: none"> 1. C. Mamoria and S. Gankar, Dynamics of Industrial Relations in India, Himalaya Publishing. 2. P. Rao, Essentials of Human Resource management and Industrial relations, Himalaya Publishing. 3. L. Mullins, Management & Organizational Behavior, Pearson.
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/110/105/110105069/ 2. https://nptel.ac.in/courses/110/102/110102058/
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8045	Professional Ethics and Corporate Social Responsibility	03	-	-	03
Prerequisites:	Basic Communication & Ethics.				
Course Objectives:	1. To understand professional ethics in business. 2. To recognized corporate social responsibility.				
Course Outcomes:	Upon completion of the course, the learners will be able to: 1. Explain rights and duties of business. 2. Explain and understand the ethics in market and towards environment. 3. Solve the problems of consumers and job discrimination ethically. 4. Show corporate and social responsibility. 5. Distinguish different aspects of corporate social responsibility. 6. Explain global aspects of corporate social responsibility.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Professional Ethics and Business	The Nature of Business Ethics, Ethical Issues in Business, Moral Responsibility and Blame.	CO1	02	04	
	Utilitarianism: Weighing Social Costs and Benefits, Rights and Duties of Business.	CO1	02		
2. Professional Ethics in the Marketplace and the Environment	Perfect Competition, Monopoly Competition, Oligopolistic Competition, Oligopolies and Public Policy.	CO2	04	08	
	Dimensions of Pollution and Resource Depletion, Ethics of Pollution Control, Ethics of Conserving Depletable Resources.	CO2	04		
3. Professional Ethics of Consumer Protection and Job Discrimination	Markets and Consumer Protection, Contract View of Business Firm’s Duties to Consumers, Due Care Theory, Advertising Ethics, Consumer Privacy.	CO3	03	06	
	Nature of Job Discrimination, Extent of Discrimination, Reservation of Jobs.	CO3	03		
4. Introduction to Corporate Social Responsibility	Potential Business Benefits—Triple Bottom Line, Human Resources, Risk Management, Supplier Relations, Criticisms and Concerns.	CO4	03	05	
	Nature of Business, Motives, Misdirection, Trajectory of Corporate Social Responsibility in India.	CO4	02		
5. Corporate Social Responsibility	Articulation of Gandhian Trusteeship.	CO5	02	08	
	Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India.	CO5	03		

	Corporate Social Responsibility and Public-Private Partnership (PPP) in India.	CO5	03	
6. Corporate Social Responsibility in Globalizing India	Corporate Social Responsibility Voluntary Guidelines 2009 issued by the Ministry of Corporate Affairs, Government of India.	CO6	02	08
	Legal Aspects of Corporate Social Responsibility - Companies Act, 2013.	CO6	03	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. A. Gupta, Business Ethics: Texts and Cases from the Indian Perspective, Springer. 2. A. Crane, D. Matten, L. Spence, Corporate Social Responsibility: Readings and Cases in a Global Context Routledge. 3. M. Velasque, Business Ethics: Concepts and Cases, Pearson. 4. B. Chakrabarty, Corporate Social Responsibility in India, Routledge. 			
Reference Books:	<ol style="list-style-type: none"> 1. Wilson, Westport, The New Rules of Corporate Conduct: Rewriting the Social Charter, Quorum Books. 2. N. Tichy, A. McGill, L. Clair, Corporate Global Citizenship, Lexington Books. 3. D. Roy, L. Regelbrugge, D. Logan, D. Washington, Global Corporate Citizenship: Rational and Strategies, Hitachi Foundation. 4. J. Andriof and M. McIntosh, Perspectives on Corporate Citizenship, Greenleaf Publishing. 			
Useful Links:	<ol style="list-style-type: none"> 1. http://www.business-ethics.com/ 2. http://www.bsr.org/index.cfm 3. http://www.csrwire.com 4. http://www.globalreporting.org/Home 5. http://www.accountability21.net/default.aspx?id=54 6. http://www.wbcsd.org/ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8046	Research Methodology	03	-	-	03
Prerequisite:	Basic level knowledge of research.				
Course Objectives (COBs):	1. To infer Research and Research Process 2. To acquaint students with identifying problems for research and develop research strategies 3. To familiarize students with the techniques of data collection, analysis of data and interpretation.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Describe about the methodologies in research. 2. Prepare a preliminary research design for projects in their subject matter areas. 3. Accurately collect, analyze and report data. 4. Present complex data or situations clearly. 5. Review and analyze research findings. 6. Summarize the different aspects and steps in conducting research.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction and Basic Research Concepts	Research – Definition, Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle, Research Methods vs. Methodology.	CO1	02	09	
	Need of Research in Business and Social Sciences.	CO1	02		
	Objectives of Research.	CO1	01		
	Issues and Problems in Research.	CO1	02		
	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical.	CO1	02		
2. Types of Research	Basic Research.	CO1, CO2	01	07	
	Applied Research.	CO1, CO2	01		
	Descriptive Research.	CO1, CO2	01		
	Analytical Research.	CO1, CO2	01		
	Empirical Research.	CO1, CO2	01		
	Qualitative and Quantitative Approaches.	CO1, CO2	02		
	Research Design – Meaning, Types and Significance.	CO1	04	07	

3. Research Design and Sample Design	Sample Design – Meaning and Significance Essentials of a Good Sampling Stages in Sample Design Sampling Methods/Techniques Sampling Errors.	CO1	03	
4. Research Methodology	Meaning of Research Methodology.	CO6	01	08
	Stages in Scientific Research Process: Identification and Selection of Research Problem, Formulation of Research Problem, Review of Literature, Formulation of Hypothesis.	CO6	04	
	Formulation of Research Design, Sample Design, Data Collection, Data Analysis, Hypothesis Testing and Interpretation of Data, Preparation of Research Report.	CO6	03	
5. Formulating Research Problem	Considerations: Relevance, Interest, Data Availability, Choice of Data, Analysis of Data, Generalization and Interpretation of Analysis.	CO4 CO5	04	04
6. Outcome of Research	Preparation of the Report on Conclusion Reached.	CO3	02	04
	Validity Testing & Ethical Issues.	CO3	01	
	Suggestions and Recommendation.	CO3	01	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. C. Kothari, Research Methodology-Methods and Techniques, Wiley.			
Reference Books:	1. C. Dawson, Practical Research Methods, New Delhi, UBS Publishers Distributors. 2. R. Kumar, Research Methodology-A Step-by-Step Guide for Beginners, Pearson.			
Useful Links:	https://libguides.newcastle.edu.au/researchmethods			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8047	IPR and Patenting	03	-	-	03
Prerequisites:	Fundamentals of Technology.				
Course Objectives (COBs):	1. To understand intellectual property rights protection system. 2. To promote the knowledge of intellectual property laws of India as well as international treaty procedures. 3. To get acquaintance with patent search and patent filing procedure and applications.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain Intellectual Property assets. 2. Explain the enforcements in IPR. 3. Investigate the issues in IPR 4. Apply intellectual property principal to real-time problems. 5. Illustrate basics of patent and explain the patent rules. 6. Apply the procedure of filing patent nationally and internationally.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Intellectual Property Rights (IPR)	Meaning of IPR, Different Category of IPR Instruments Patents, Trademarks, Copyrights, Industrial Designs, Plant Variety Protection, Geographical Indications, Transfer of Technology etc.	CO1	02	04	
	Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical Aspects of IPR Laws, Need for IPR, IPR as an Instrument of Development.	CO1	02		
2. Enforcement of Intellectual Property Rights	Introduction, Magnitude of Problem, Factors that Create and Sustain Counterfeiting, Piracy.	CO2	01	07	
	International Agreements, International Organizations (e.g. WIPO, WTO) Active in IPR Enforcement	CO2	01		
	Indian Scenario of IPR. Introduction, History of IPR in India, Overview of IP Laws in India, Indian IPR.	CO2	03		
	Administrative Machinery, Major International Treaties Signed by India, Procedure for Submitting patent and Enforcement of IPR at National Level etc.	CO2	02		
3. Emerging Issues in IPR	Challenges for IP in Digital Economy, E-Commerce, Human Genome.	CO3	01	02	
	Biodiversity and Traditional Knowledge etc.	CO3	01		
4. Basics of Patents	Definition of Patents, Conditions of Patentability, Patentable and Non-Patentable Inventions, Types of Patent Applications.	CO3	03	09	

	Process Patent and Product Patent, Precautions While Patenting, Patent Specification Patent Claims.	CO4	04	
	Disclosures and Non-disclosures, Patent rights and Infringement, Method of Getting a Patent.	CO4	02	
5. Patent Rules	Indian Patent Act, European Scenario, US Scenario, Australia Scenario.	CO5	04	
	Japan Scenario, Chinese Scenario, Multilateral Treaties where India is a Member.	CO5	04	08
6. Procedure for Filing a Patent	Legislation and Salient Features, Patent Search.	CO6	03	
	Drafting and Filing Patent Applications, Processing of Patent, Patent Litigation.	CO6	03	
	Patent Publication etc., Time Frame and Cost, Patent Licensing, Patent Infringement. Patent Databases: Important Websites, Searching International Databases.	CO6	03	09
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. R. Adukia, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India. 2. K. Keayla, Patent System and Related Issues at a Glance, National Working Group on Patent Laws. 3. W. Cornish and L. Lewelyn, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right. 4. M. Mathew, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company. 5. K. Bansal and P. Bansal, Fundamentals of IPR for Engineers, BS Publications. 			
Reference Books:	<ol style="list-style-type: none"> 1. N. Rathore, S. Mathur, P. Mathur and A. Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency. 2. V. Irish, Intellectual Property Rights for Engineers, IET. 3. Entrepreneurship Development and IPR Unit, BITS Pilani, A Manual on Intellectual Property Rights. 4. M. Kumar and M. Ali, Intellectual Property Rights, Serial Publications. 5. K. Bansal and P. Bansal, Fundamentals of IPR for Engineers, BS Publications. 6. R. Krishnan & S. Balasubramanian, Intellectual Property Rights, Excel Books. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-hs45/. 2. https://www.udemy.com/topic/intellectual-property/ 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8048	Digital Business Management	03	-	-	03
Prerequisites:	Business Intelligence.				
Course Objectives (COBs):	1. To familiarize with digital business concept. 2. To acquaint with E-commerce. 3. To give insights into E-business and its strategies.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Identify drivers of digital business. 2. Reviewing the concepts of E-commerce. 3. Devise the services of Digital Business. 4. Illustrate various techniques of managing E-business. 5. Illustrate various approaches of E-business Strategy. 6. Prepare E-business plan.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction to Digital Business	Introduction to Digital Business Introduction, Background and Current Status, E-market Places, Structures, Mechanisms, Economics and Impacts.	CO1	03	09	
	Difference Between Physical and Digital Economy.	CO1	01		
	Drivers of Digital Business - Big Data & Analytics, Mobile, Cloud Computing, Social Media, BYOD, Internet of Things (Digitally Intelligent Machines/Services).	CO1	04		
	Opportunities and Challenges in Digital Business.	CO1	01		
2. Overview of E-Commerce	E-Commerce Meaning, Retailing in E-Commerce, Products and Services, Consumer Behaviour, Market Research and Advertisement.	CO2	01	06	
	B2B E-Commerce Selling and Buying in Private E-Markets, Public B2B Exchanges and Support Services, E-Supply Chains, Collaborative Commerce, Intra Business EC and Corporate Portals.	CO2	02		
	Other E-C Models and Applications, Innovative EC System- from E-Government and Learning to C2C, Mobile Commerce and Pervasive Computing.	CO2	01		
	EC Strategy and Implementation-EC Strategy and Global EC, Economics and Justification of EC, Using Affiliate Marketing to Promote your Ecommerce Business, Launching a Successful Online Business and EC project, Legal, Ethics and Societal Impacts of EC.	CO2	02		
3. Digital Business	Digital Business Support Services: ERP as E-Business Backbone, Knowledge Tope Apps, Information and Referral System.	CO3	03	06	

Support Services	Application Development: Building Digital Business Applications and Infrastructure.	CO3	03	
4. Managing E-Business	Managing E-Business-Managing Knowledge, Management Skills for E-business, Managing Risks in E -Business.	CO4	02	06
	Security Threats to E-Business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols Over Public Networks: HTTP, SSL, Firewall as Security Control, and Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications.	CO4	04	
5. E-Business Strategy	E-Business Strategy-E-Business Strategic formulation-Analysis of Company's Internal and External Environment, Selection of Strategy.	CO5	02	04
	E-Business Strategy into Action, Challenges and E-Transition (Process of Digital Transformation).	CO5	02	
6. Materializing E-Business	Materializing E-Business: From Idea to Realization-Business Plan Preparation.	CO6	04	08
	Case Studies and Presentations.	CO6	04	
ii. Course Conclusion	Recap of Modules, Outcome, Applications, and Summarization.	-	01	01
Text Books:	1. E. Mishra and W. Sarwade, A Textbook on E-commerce, Neha Publishers & Distributors. 2. E. Coupey, Digital Business Concepts and Strategy, Pearson. 3. D. Chaffey, Digital Business and E-Commerce Management, Pearson. 4. Perspectives of Digital Enterprise – A Framework for Transformation, TCS Consulting Journal. 5. Measuring Digital Economy - A New Perspective, OECD Publishing.			
Reference Books:	1. E. Awad, E-commerce from vision to fulfilment, PHI. 2. C. Combe Introduction to E-Business-Management and Strategy, Elsevier. 3. V. Morabito, Trend and Challenges in Digital Business Innovation, Springer. 4. P. Macmillan, Digital Business Discourse Erika Darics, Palgrave Macmillan. 5. E-Governance - Challenges and Opportunities, Proceedings in 2 nd International Conference Theory and Practice of Electronic Governance.			
Useful Links:	1. https://cio-wiki.org/wiki/E-Strategy 2. https://www.liferay.com/resources/l/digital-business 3. https://www.coursera.org/specializations/business-technology-managment			
Continuous Assessment (CA):	<ul style="list-style-type: none"> Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), Internal Assessment: 10 Marks. Duration of each Test shall be 1 Hour and 15 Minutes. Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8049	Environmental Management	03	-	-	03
Prerequisite:	General Awareness of environment and factors affecting the environment				
Course Objectives (COBs):	1. To learn and identify environmental issues relevant to India and global concerns. 2. To learn concepts of ecology. 3. To familiarize learners about environment related legislations. 4. To learn to protect and sustain our natural resources of land, water, air, and vegetation.				
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Interpret the concept of environmental management. 2. Learn the ecosystem and interdependence, food chain etc. and interpret environment related legislations. 3. Identify the environmental issues important to India. 4. Learn the regulating policies of Government in environmental management. 5. Identify solutions to protect the environment from pollution. 6. Examine the quality environmental management.				
Module No. and Name	Subtopics	COs Mapped	Hours / Subtopic	Total Hours / Module	
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02	
1. Introduction and Definition of Environment	Significance of Environment Management for Contemporary Managers.	CO1	02	10	
	Career Opportunities.	CO1	01		
	Environmental Issues Relevant to India.	CO1	02		
	Sustainable Development.	CO1	03		
	The Energy Scenario.	CO1	02		
2. Global Environmental Concerns	Global Warming.	CO3	01	06	
	Acid Rain.	CO3	01		
	Ozone Depletion.	CO3	01		
	Hazardous Waste and Endangered Life-Species.	CO3, CO5	01		
	Loss of Biodiversity.	CO3, CO5	01		
	Industrial, Man-Made, Disasters, Atomic, Biomedical Hazards etc.	CO3, CO5	01		
3. Concepts of Ecology	Ecosystems and Interdependence between Living Organisms.	CO2	01	05	
	Habitats and Limiting Factors.	CO2	01		
	Carrying Capacity.	CO2	01		
	Food Chain.	CO2	01		
	Ecology.	CO2	01		
	Scope of Environment Management.	CO1	03	10	

4. Scope of Environment Management	Role and Functions of Government as a Planning and Regulating Agency.	CO1, CO4	03	
	Environment Quality Management and Corporate Environmental Responsibility.	CO1, CO4	04	
5. Quality Environmental Management	Total Quality Environmental Management.	CO6	02	05
	ISO-14000.	CO6	02	
	EMS Certification.	CO6	01	
6. General Overview of Major Legislations	Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act.	CO4, CO3	03	03
ii. Course Conclusion	Recap of Modules, Outcome, Applications and Summarization.	-	01	01
Text Books:	<ol style="list-style-type: none"> 1. C. Barrow, Environmental Management: Principles and Practice, Routledge Publishers. 2. J. Lovett and D. Ockwell, A Handbook of Environmental Management, Edward Elgar Publishing. 3. V. Ramachandra and V. Kulkarni, Environmental Management, TERI Press. 			
Reference Books:	<ol style="list-style-type: none"> 1. Indian Standard Environmental Management Systems Requirements with Guidance for Use, Bureau of Indian Standards. 2. M. Theodore, L. Theodore, Introduction to Environmental Management, CRC. 3. M. Hussain, Environment and Ecology, Access Publishing. 4. S. Chary and V. Vyasulu, Environment Management: An Indian Perspective, Macmillan India. 			
Useful Links:	<ol style="list-style-type: none"> 1. https://libguides.library.qut.edu.au/EVB302_Environmental_pollution/links 2. https://www.epd.gov.hk/epd/epic/english/epichome.html 3. http://www.ecovacservices.com/Useful-Links-6-5511.html 			
Continuous Assessment (CA):	<ul style="list-style-type: none"> • Continuous Assessment shall be conducted for Total 40 Marks, and includes — <ul style="list-style-type: none"> ○ Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), ○ Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 15 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity. 			
End Semester Examination (ESE):	<ul style="list-style-type: none"> • End Semester Exam shall be conducted for Total 60 Marks. Duration of End Semester Exam shall be 02 Hours and 30 Minutes. 			

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITL801	Blockchain Lab	-	01	-	01
Hardware Requirements:	PC with following Configuration Intel Core i3/i5/i7, 8 GB RAM				
Software Requirements:	Google Chrome Browser (latest), Go/Java 8 or above, NodeJS, React, Internet Connection.				
Lab Prerequisites:	Knowledge of Java programming and object-oriented programming.				
Lab Objectives (LOBs):	1. To develop and deploy smart contracts on local Blockchain. 2. To deploy the smart contract on test networks. 3. To deploy and publish smart contracts on Ethereum test network 4. To design and develop crypto currency. 5. To deploy chain code on permissioned Blockchain. 6. To design and develop a Full-fledged DApp using Ethereum/Hyperledger				
Lab Outcomes (LOs):	1. Develop and test smart contract on local Blockchain 2. Develop and test smart contract on Ethereum test networks 3. Write and deploy smart contract using Remix IDE and Metamask 4. Design and develop Block chain based application. 5. Write and deploy chain code in Hyperledger Fabric. 6. Develop and test a Full-fledged DApp using Ethereum/Hyperledger				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	--		02	
1	Introduction to Truffle, establishing local Blockchain using Truffle Mini Project: Allocation of the groups	LO1		02	
2	Solidity programming Language, Chain Code (Java/Javascript/Go), Deployment on Truffle local Blockchain Mini Project: Topic selection	LO2		04	
3	Ethereum Test networks (Ropsten/Gorelli/Rinkeby), Deployment on Test Networks, Web3.js/Web3.py for interaction with Ethereum smart contract Mini Project: Topic validation and finalizing software requirements	LO3		04	
4	Smart Contract Development And Deployment using Metamask and Remix Design and Develop Crypto Currency Mini Project: Study the required Programming Language for Smart Contract	LO4		04	
5	Chain code Deployment in Hyperledger Fabric.	LO5		06	
6	Implementation of Mini Project: Design, configure and testing of mini project using Etherum / Hyperledger Fabric	LO6		06	
Useful Links:	1. https://trufflesuite.com/ 2. https://metamask.io/ 3. https://remix.ethereum.org/ 4. https://www.hyperledger.org/use/fabric				

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 05 Experiments and Mini Project. • Term work evaluation shall be for Total 25 Marks (Experiments and Mini Project: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Oral (O):	Oral examination will be conducted based on the Mini-Project for Total 25 Marks.

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITL805	RPA Lab	-	01	-	01
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	Windows Desktop OS, Citrix environment-XenApp v6.5 or greater, XenDesktop v7.0 or greater, .NET Framework, Web Browsers, Microsoft Office (for projects created in the StudioX profile)				
Lab Prerequisite:	Basic Programming Skills.				
Lab Objectives (LOBs):	1. To understand knowledge of basic concepts of Robotic Process Automation (RPA). 2. To learn the importance, different Products of UiPath. 3. To understand the RPA Design and Development strategies and methodologies specifically in context of UiPath products.				
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Install RPA packages and UiPath Studio. 2. Create, remove and manage variables, arguments and control flow. 3. Implement the data manipulation and capture the recording and types of recordings. 4. Implement the automation business process with scrapping, invoice automation, automated buying on E commerce, sales order automation, etc. 5. Use selectors to extract and take action on controls. 6. Apply the concepts of Image and text, Excel and Data tables and Email automation etc.				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	Installation of RPA Packages: UiPath – Basics, Installation and Understanding User Interface Components.	LO1		02	
2	Hands-on Variables, data types and arguments.	LO2		02	
3	Hands-on Control flow: a. Conditional Statements, b. Iteration.	LO2		02	
4	Hands-on Data Manipulation - scalar variables, collections, tables, text manipulation.	LO3		04	
5	Implementation of Recording - Basic, Desktop, and Web applications.	LO3		02	
6	Implementation of Scrapping: a. Screen scrapping, b. Data scrapping.	LO4		04	
7	Implementation of Invoice and Sales Order Automation for E-Commerce.	LO4		02	
8	Implementation of various selectors available in UiPath to extract and take action on controls.	LO5		02	
9	Implementation of Image and Text automation.	LO6		02	
10	Implementation of Excel and Data tables Automation.	LO6		02	
11	Implementation of Email Automation.	LO6		02	
Useful Learning Links:	1. https://www.uipath.com/ 2. https://www.ibm.com/in-en/products/robotic-process-automation				

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments • Journal must include at least 02 assignments on “RPA Lab” • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical (P):	Practical examination will be based on the experiment list for Total 25 Marks

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL8021		Natural Language Processing Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.				
Software Requirements:		Python 3.6 or higher, Jupyter Notebook, Python IDEs.				
Lab Prerequisites:		Python Programming Language.				
Lab Objectives (LOBs):		1. To formulate the problems and solutions of NLP and establish their relation to linguistics and statistics. 2. To implement various language Models. 3. To implement and analyze various NLP algorithms. 4. To design systems that uses NLP techniques. 5. To train and evaluate empirical NLP systems.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Implement the basic language preprocessing. 2. Model linguistic phenomena with formal grammar. 3. Implement, and analyze NLP algorithms. 4. Implement approaches to syntax, semantics and discourse generation in NLP. 5. Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction, etc. 6. Implement proper experimental methodology for training and evaluating empirical NLP systems.				
Lab No.	Experiment Title			LOs Mapped		Hours
0	Lab Prerequisites			-		02
1	Python IDE installation and environment setup, NLTK, Numpy, Matplotlib etc packages installation.			LO1		02
2	Implement the basic functions of NLTK, Spacy, Word2Vec,etc.			LO1		02
3	Perform the Pre-processing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)			LO1, LO6		02
4	Perform the Morphological analysis of a word, to generate word forms from root and suffix information			LO2, LO6		02
5	Implement the morphology of a word by the use of Add-Delete table			LO2, LO6		02
6	Implementation of bigrams from a given corpus and calculate probability of a sentence.			LO3, LO6		02
7	Learn how to apply add-one smoothing on sparse bigram table and implement it			LO3, LO6		02
8	Find POS tags of words in a sentence.			LO4, LO6		02
9	Calculate emission and transition matrix which will be helpful for tagging Parts of Speech using Hidden Markov Model.			LO4, LO6		02

10	A. Implementation of WordNet with features. B. Implementation of word sense disambiguation	LO4, LO6	02
11	Understand and implement the concept of chunking and get familiar with the basic chunk tagset.	LO4, LO6	02
12	Implementation of any applications like Machine translation, Information retrieval, Question answers system, Categorization, Summarization; Sentiment analysis, Named Entity Recognition.	LO5, LO6	04
Virtual Lab Links:	https://nlp-iiith.vlabs.ac.in/Introduction.html?domain=ComputerScience		
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “Natural Language Processing” and “Natural Language Processing Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 		
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).		

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL8022		Cloud Security Lab	-	01	-	01
Hardware Requirements:		PC with i3 Processor or above.				
Software Requirements:		Docker, EC2, Nagios, SonarQube, CISCO packer tracer, Virtual Machine, Ingress & Egress, Q-Radar				
Prerequisites:		Computer Network, Operating System, Java Programming.				
Lab Objectives (LOBs):		1. To understand and demonstrate infrastructure as service. 2. To perform network analysis. 3. To explain access control and authentication in cloud. 4. To operate code analysis in CI/CD. 5. To study Analyze different tools in cloud for real-time case studies.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Demonstrate infrastructure as service. 2. Demonstrate Network analysis and analyze cloud firewall. 3. Implement authentication in cloud. 4. Operate code analysis in CI/CD. 5. Analyze Q-Radar for real-time case studies. 6. Organize cloud infrastructure using Terraform.				
Lab No.	Experiment Title				LOs Mapped	Hours
0	Lab Prerequisites				-	02
1	Design a web page and deploy it on EC2 instance.				LO1	02
2	Monitor Docker Metrics and generate report based on analysis.				LO2	02
3	Perform Network Analysis using Nagios.				LO2	04
4	Deploy Web Application on Docker & Identify Vulnerabilities.				LO4	02
5	Perform Static Analysis of Code using SonarQube.				LO4	02
6	Exploring Authentication and access control using AAA framework				LO3	02
7	Create a CI/CD pipeline and implement Role-Based Authentication.				LO3, LO4	04
8	Perform Authentication on Virtual Machine using Ingress & Egress.				LO3	02
9	Case Study on Q-Radar SIEM.				LO5	02
10	Case Study on Cloud firewall.				LO2	02
11	Use Terraform to launch virtual machine.				LO6	02
Virtual Lab Links:		1. http://cse29_iiith.vlabs.ac.in/exp10/ 2. https://www.sans.org/webcasts/continuous-security-monitoring-active-defense-cloud-107585 3. https://www.jblearning.com/cybersecurity/labs 4. https://towardsdatascience.com/ci-cd-logical-and-practical-approach-to-build-four-step-pipeline-on-aws-3f54183068ec				

Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “Cloud Security” and “Cloud Security Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code		Course Name	Credits			
			TH	P	TUT	Total
ITDLL8023		Remote Sensing and GIS Lab	-	01	-	01
Hardware Requirements:		PC i3 Processor or above.				
Software Requirements:		MATLAB / Open CV, Python.				
Prerequisites:		None				
Lab Objectives (LOBs):		1. To prepare the students in identifying, analyzing and solving geospatial problems. 2. To train the students in developing practical and executable solutions to the challenges of growing field of Remote Sensing and GIS. 3. To impart the students with strong base of knowledge that makes them suitable both for industries as well as for teaching and research. 4. To inculcate the students with the sensitivity towards ethics, public policies and their responsibilities towards the society. 5. To develop a basic understanding about Geo-Spatial techniques and its applications. 6. Usage of diverse remote sensing data for extracting needed geo-spatial information.				
Lab Outcomes (LOs):		Upon completion of the course, the learners will be able to: 1. Apply various GIS techniques within spatial analytical framework and handle huge spatial and non-spatial database. 2. Interpret Satellite Hard copy FCC images and Survey of India Topo sheets. 3. Collect Field Spectra for various land cover features. 4. Execute various radiometric and spatial enhancement techniques. 5. Create land cover map using different clustering techniques using DIP methods. 6. Implement integrated geospatial techniques and apply them in solving real world problems.				
Lab No.	Experiment Title			LOs Mapped	Hours	
0	Lab Prerequisites			-	02	
1	Understanding Remote Sensing Data and Visual Interpretation.			LO1	02	
2	Import / Export of Satellite Data, Display, Analysis, and Digital interpretation of earth surface features in Standard FCC.			LO2	02	
3	Topology creation and correcting topological errors & Non-topological editing.			LO2	02	
4	Field Spectra Collection: vegetation, bare soil, and concrete using Spectro Radiometer.			LO3	02	
5	Radiometric and atmospheric corrections.			LO4	02	
6	Geo-referencing and Geocoding.			LO5	02	
7	Basics of Geodatabase, Vector, Raster, Catalogue and Georeferencing.			LO5	02	
8	Linking spatial with non-spatial data.			LO5	02	
9	Understanding different projection, coordinate system and Datums & Standardisation.			LO6	02	
10	Analysis of satellite derived spectral response and field spectra.			LO6	02	

Virtual Lab Links:	<ol style="list-style-type: none"> 1. https://www.coursera.org/learn/remote-sensing. 2. https://www.coursera.org/specializations/gis-mapping-spatial-analysis 3. https://www.classcentral.com/course/swayam-remote-sensing-and-gis-14272
Term Work (TW):	<ul style="list-style-type: none"> • Term work should consist of a minimum of 8 experiments. • Journal must include at least 2 assignments on content of theory of the course “Remote Sensing and GIS” and “Remote Sensing and GIS Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation.
Practical & Oral (P&O):	P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code	Course Name	Credits			
		TH	P	TUT	Total
ITDLL8024	HPC Lab	-	01	-	01
Hardware Requirements:	PC i3 processor or above				
Software Requirements:	Turbo / Borland C Compiler / Online C Compiler / JAVA / Python				
Lab Prerequisite:	C Programming / JAVA / Python				
Lab Objectives (LOBs):	1. Learn the concepts of high-performance computing. 2. Gain knowledge of platforms for high performance computing. 3. Design and implement algorithms for parallel programming applications. 4. Analyze the performance metrics of High Performance Computing. 5. Understand the parallel programming paradigm, algorithms and applications. 6. Demonstrate the understanding of different High Performance Computing tools.				
Lab Outcomes (LOs):	Upon completion of the course, the learners will be able to: 1. Understand fundamentals of parallel Computing. 2. Describe different parallel processing platforms involved in achieving High Performance Computing. 3. Demonstrate the principles of Parallel Algorithms and their execution. 4. Evaluate the performance of HPC systems. 5. Apply HPC programming paradigm to parallel applications. 6. Discuss different current HPC Platforms.				
Lab No.	Experiment Title	LOs Mapped		Hours	
0	Lab Prerequisites.	-		02	
1	a. Implement Parallel Reduction using Min, Max, Sum and Average operations. b. Write a CUDA program that, given an N-element vector, find <ul style="list-style-type: none">The maximum element in the vectorThe minimum element in the vectorThe arithmetic mean of the vectorThe standard deviation of the values in the vector c. Test for input N and generate a randomized vector V of length N (N should be large). The program should generate output as the two computed maximum values as well as the time taken to find each value.	LO1		06	
2	Implement Vector and Matrix Operations Design parallel algorithm to <ul style="list-style-type: none">Add two large vectorsMultiply Vector and MatrixMultiply two $N \times N$ arrays using n^2 processors	LO1		02	
3	Implement Parallel Sorting Algorithms Bubble Sort and Merger Sort, based on existing sequential algorithms, design and implement parallel algorithm utilizing all resources available.	LO2		02	

4	Design and implement parallel algorithm utilizing all resources available for any one of the following: <ul style="list-style-type: none"> • Binary Search for Sorted Array • Depth-First Search (tree or an undirected graph) • Breadth-First Search (tree or an undirected graph) • Best-First Search that (traversal of graph to reach a target in the shortest possible path). 	LO2	02
5	Parallel implementation of the K Nearest Neighbours Classifier	LO3	02
6	Implement: <ul style="list-style-type: none"> • Compression Module (Image /Video) Large amount of bandwidth is required for transmission or storage of images. This has driven the research area of image compression to develop parallel algorithms that compress images. • For video, RGB To YUV Transform concurrently on many core GPU 	LO3	02
7	Implement Generic Compression: Run length encoding concurrently on many core GPU.	LO4	02
8	Implement Huffman encoding concurrently on many core GPU	LO4	02
9	Implement Database Query Optimization: Long running database Query processing in parallel.	LO5	02
10	To study a Grid Simulation Toolkit.	LO5	02
11	To run two sample programs using GridSim Toolkit.	LO6	02
12	To study a Cloud Simulation Toolkit	LO6	02
Useful Learning Links:		1. https://www.vlab.co.in/ba-nptel-labs-computer-science-and-engineering 2. https://rcc.uq.edu.au/characterisation-virtual-laboratory 3. https://www.vmware.com/in/solutions/high-performance-computing.html 4. https://nptel.ac.in/courses/106108055	
Term Work (TW):		<ul style="list-style-type: none"> • Term work should consist of a minimum of 08 experiments. • Journal must include at least 02 assignments on content of theory of the course “High Performance Computing” and “HPC Lab”. • Term work evaluation shall be for Total 25 Marks (Experiments: 20 Marks, Assignments: 05 Marks). • The final certification and acceptance of term work will be based on attendance in Theory and Lab sessions, satisfactory performance of laboratory work, and minimum passing marks in term work evaluation. 	
Practical & Oral (P&O):		P&O examination will be based on the experiment list for Total 25 Marks (Practical: 15 Marks and Oral 10 Marks).	

PBL Course Code	PBL Course Name	Credits			
		TH	P	TUT	Total
1UITPR86	PBL – Major Project B	-	06	-	06
Hardware Requirements:	PC with i3 Processor or above.				
Software Requirements:	JDK 8 or above, Python, DevOps Tools, Web/Android Development Platforms.				
Prerequisites:	Programming skills, IT Engineering Core Concepts.				
PBL Objectives (PROBs):	<ol style="list-style-type: none">1. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.2. To practice the process of identifying the needs and converting it into a problem statement.3. To apply engineering knowledge and modern tools/technologies for deriving solutions to the real-world problems.4. To inculcate the process of self-learning and research.5. To be acquainted with solving the problem in a group.6. To improve communication, management and report-writing skills of the students.				
PBL Outcomes (PROs):	<p>Upon completion of the course, the learners will be able to:</p> <ol style="list-style-type: none">1. Identify societal / research needs, formulate problem statements, review research literature, and analyze complex engineering problems.2. Design suitable solutions for the problems including scope, objectives, timeline, system flow, user interface, algorithms, etc.3. Gather, analyze, and interpret data and apply knowledge of engineering fundamentals, modern tools / technologies for development of solutions.4. Analyze sustainability and scalability of the developed solution and its impact in terms of environmental, societal, safety, legal, cultural, health, etc. aspects.5. Apply ethical principles, excel in written and oral communication, and engage in independent and life-long learning.6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects.				
	<ol style="list-style-type: none">1. Students should continue and complete the same problem statement started in 7th semester – Major Project A.2. Students have to develop an IT Application / Service with a proper user interface using any suitable technology.3. The project should be hosted (at least temporarily) and added to Git. Extensive testing for all use cases is expected.4. A log book is to be prepared by each group, wherein the group can record weekly work progress and the faculty guide can verify and record notes/comments.5. Faculty Guide may give inputs to students during major project activity; however, focus shall be on self-learning.6. The solution is to be validated with proper justification and report (black book) is to be compiled in standard format of the Department. In this semester, students are expected to complete building of working prototype, and perform testing and validation of results based on work completed in an earlier semester.				

Guidelines for Project-Based Learning (PBL):	<ol style="list-style-type: none"> 7. Three reviews will be conducted: First review shall be based on readiness of building working prototypes to be conducted, second shall be for evaluation of work progress and technical paper written, and third review shall be based on poster presentation cum demonstration of working model — in last month of the said semester. 8. Minor Project shall be assessed based on parameters like: <ul style="list-style-type: none"> • Attainment of Course Outcomes. • Technical efficiency and quality of developed solution. • Innovativeness in solutions. • Impact on environment. • Cost effectiveness. • Sustainability analysis. • Societal impact. • Effective use of standard engineering norms. • Contribution of an individual as member or leader. • Clarity in written and oral communication. 9. All groups have to submit a Technical Paper based on the work done for publication in Conferences / International journals — preferably indexed in Scopus / Web of Science). The papers should have less than 10% plagiarism — checked through Turnitin / standard plagiarism-checking software. 10. Students should participate in Project Competitions at State, National, and International level like Smart India Hackathon, National Innovation Contest, etc. 11. Students should attempt for filling a Patent / Copyright from the work done. 12. Students shall be motivated to establish a start-up based on the project idea.
Useful Learning Links:	<ol style="list-style-type: none"> 1. http://nlp-iiith.vlabs.ac.in/ 2. https://www.coursera.org/specializations/project-management 3. https://nptel.ac.in/courses/110/104/110104073/ 4. https://www.coursera.org/specializations/website-development 5. https://www.udemy.com/course/fullscreen-background-video-for-a-website-dreamweaver-premiere-pro/
Term Work (TW):	<ul style="list-style-type: none"> • Term Work evaluation shall be for Total 50 Marks. • Total 35 out of 50 Marks shall be based on the following evaluation: <ul style="list-style-type: none"> ○ Presentation in Review 1 ○ Presentation in Review 2 ○ Presentation in Review 3 ○ Project Report and Log Book • And, total 15 out of 50 Marks will be based on: <ul style="list-style-type: none"> ○ Students' active participation in Technology learning. ○ Presenting / showcasing learned Technology uses in Social / Outreach / Extension Activities / Events / Idea or Project Competitions / Trainings / Internships / Development Programs, Technical Paper Preparations and Presentations / etc. ○ Participation in Smart India Hackathon, Project Competitions, etc. ○ Conference / Journal Publication, Filling Patent, Creation of Product & Licencing, Start-up
Practical & Oral (P&O):	P&O examination will be of Total 100 Marks and shall be based on the Project Demonstration, Presentation, and Report.



SOMAIYA
VIDYAVIHAR

Item No.: 5
A.C.: 09/07/2022

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program Manual

(Prepared based on the Guidelines for AICTE and University of Mumbai)

For

- 1. Computer Engineering**
- 2. Information Technology**
- 3. Electronics & Telecommunication Engineering**
- 4. Artificial Intelligence & Data Science**

(with effect from AY 2022-2023)



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

ACADEMIC YEAR 2022-23

Honours Degree Programs in **Engineering and Technology Manual**

Introduction:

As per the AICTE's Approval Process Handbook-2020-21: Chapter VII- clause 7.3.2 (Page 99-101) and APH 2021-22, all branches of Engineering and Technology shall offer Elective Courses in the EMERGING AREAS viz., Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Robotics, Quantum Computing, Data Sciences, Cyber Security, 3D Printing and Design, Augmented Reality/ Virtual Reality (AR/VR), as specified in Annexure 1 of the Approval Process Handbook.

- a) Under Graduate Degree Courses in EMERGING AREAS shall be allowed as specialization from the same Department. The minimum additional Credits for such Courses shall be in the range of 18-20 and the same shall be mentioned in the degree, as specialization in that particular area. For example, doing extra credits for Robotics in Mechanical Engineering shall earn B.E./ B.Tech. (Hons.) Mechanical Engineering with specialization in Robotics
- b) Minor specialization in EMERGING AREAS in Under Graduate Degree Courses may be allowed where a student of another Department shall take the minimum additional Credits in the range of 18-20 and get a degree with minor from another Department.

It is also made very clear by AICTE that areas in which Honours Degree may be offered are numerous. It is up to the Universities with the help of their Academic Board/Council to decide whether Honours. degree is to be offered or not in any particular area, which is not mentioned above. The criteria for "Honours. Degree will cumulatively require additional 18 to 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 169 credits of KJSIEIT)"

1. Honours Degree under KJSIEIT:

Honours degree program is introduced in order to facilitate the students to choose additionally the specialized courses in the emerging areas of their choice and build their competence in such domains. Based on AICTE guidelines, KJSIEIT has proposed to offer following Honours degree program corresponding to each engineering program as shown in Table 1.

Table 1: Honours Degree Programs

Sr. No	Honours degree programs
1	Artificial Intelligence and Machine Learning
2	Blockchain
3	Cyber Security
4	Augmented and Virtual Reality
5	Data Science
6	Internet of Things (IoT)

2. Honours Degree Eligibility Criteria for Students:

In view of the above-mentioned guidelines issued by AICTE in APH 2020-21 and APH 2021-22 for offering Honours degree in the various engineering programs, the following recommendations are proposed on the eligibility criteria for students opting for same;

i) Eligibility criteria for opting the Honours Degree program:

- a. Students with no backlog in semester I, II, and III
- b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above
- c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

ii) Each eligible student can opt for maximum one Honour's Programs at any time.

iii) Students registered for Honours Degree Program need to complete (clear/pass) Honours Degree along with regular B Tech degree to get benefit of Award of Honours along with B Tech Degree. Students with clear pass out in regular B Tech program and having ATKT in Honours program; will only be awarded with regular B Tech degree.

iv) However it is optional (not the compulsion) for eligible students to take additional honours degree program.

v) Student shall complete Honors degree program in the stipulated four semesters only.

3. Examination and Evaluation of Honours Degree Courses:

Hons degrees courses will be offered in Third and Final Year of engineering as specialisation in emerging areas. Modalities for Examination and Evaluation will be,

- a. The continuous assessment (CA= Average of 2 tests+ Internal Assessment (IA)) and End Sem. Examination (ESE) evaluation shall follow the same pattern as adopted for corresponding semester stated by the University/ Autonomous Institute.

- b. End semester Assessment will be done as per the laid down practices by following all applicable ordinances and regulations of University of Mumbai/Rules stated in Manual of KJSIEIT.
- c. Hons. degree courses can be treated as Audit type of courses, wherein passing marks set will be 40. If any student scored equal or more than passing marks in particular course can be declared as pass.
- d. Grading of courses offered under Honours degree shall be avoided and also not included in overall CUMMULATIVE GRADE POINT AVERAGE, to bring parity with all students admitted for the basic program.
- e. Hons. degree shall be conferred in addition to basic degree only after successfully completion of all courses.
- f. Institute can make provision for entering pass or fail in course offered under Honours degree.

4. Award of Honours Degree Program:

The students successfully completing the Honours Degree shall be awarded with the degree designated as: "B. Tech. (_____Engineering) (Hons. - Specialization)"

Example 1: Students s successfully completing B Tech in Computer Engineering with specialization (Honours) in Cyber Security shall get a degree as “ **B Tech (Computer Engineering) (Hons.- Cyber Security) ”**

Example 2: Students successfully completing B Tech in Electronics and Telecommunication Engineering with specialization in Internet of Things (IoT) shall get a degree as “**B Tech (Electronics and Telecommunication Engineering) (Hons.- Internet of Things)**”

5. Honours Degree Program Scheme and Structure:

Honours degree program be offered from academic year 2022-23 onwards along with KJSIEITs Autonomous Scheme II syllabus. Honours credit courses will be offered from Semester V onwards to Semester VIII as shown in Table 2.

Table 2: Honours degree Program credit and Examination Scheme

Honours in ----- (With effect from 2022-23)												
Year & Sem	Course Code and Course Title	Teaching Scheme (Hours / Week)			Examination Scheme and Marks						Credits	
		Theory	Seminar /Tutorial	Pract.	Average of Test 1 & Test 2	Internal Assessment	End Sem. Exam	Term Work	Oral/ Pract	Total	Credits	
TY Sem. V	HXXC501: TH Subject 1	04	--	--	30	10	60	--	--	100	04	
Total Marks & Credits =											100	04
TY Sem. VI	HXXC601: TH Subject 2	04	--	--	30	10	60	--	--	100	04	
Total Marks & Credits =											100	04
LY Sem. VII	HXXC701: TH Subject 3	04	--	--	30	10	60	--	--	100	04	
	HXXL701: Lab-1	--	--	04	--		--	50	50	100	02	
Total Marks & Credits =											200	06
LY Sem. VIII	HXXC801: TH Subject 4	04	-	--	30	10	60	--	--	100	04	
Total Marks & Credits =											100	04
Total Marks for Semesters V,VI, VII &VIII =100+100+200+100 = 500												
Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04 = 18												

6. Honours Degree Programs offered for KJSIEIT:

Mapping with existing Engineering/Technology Programs of KJSIEIT- Honour's degree programs are conducted as per AICTE guidelines. Each eligible student can opt for maximum one Honour's Degree Programs at any time as shown in Table 3.

Table 3: Honours Programs offered for KJSIEITs Branches

Sr. No	Honours Degree Programs	Programs who can offer this Honours Degree Program
1	Artificial Intelligence and Machine Learning	1. Computer Engineering 2. Electronics and Telecommunication Engineering 3. Information Technology
2	Blockchain	1. Computer Engineering 2. Electronics and Telecommunication Engineering 3. Information Technology 4. Artificial Intelligence and Data Science
3	Cyber Security	1. Computer Engineering 2. Electronics and Telecommunication Engineering 3. Information Technology 4. Artificial Intelligence and Data Science
4	Augmented and Virtual Reality	1. Computer Engineering 2. Electronics and Telecommunication Engineering 3. Information Technology 4. Artificial Intelligence and Data Science
5	Data Science	1. Computer Engineering 2. Electronics and Telecommunication Engineering 3. Information Technology
6	IoT	1. Computer Engineering 2. Electronics and Telecommunication Engineering 3. Information Technology 4. Artificial Intelligence and Data Science

Additional 4 Theory & One Lab courses to be cleared and evaluated under each Honours program for total 18 credits and 500 marks, are as given under table 4 to 9 respectively.

Table 4: Honours Degree Program in Artificial Intelligence and Machine Learning

Honours Degree Program	Sem	Additional Subjects to be learnt and passed through the examination	Credits	Marks
Artificial Intelligence and Machine Learning	Sem V	HXXC501: Mathematics for AI & ML	4	100
	Sem VI	HXXC601: Game Theory using AI & ML	4	100
	Sem VII	HXXC701: AI&ML in Healthcare	4	100
	Sem VII	HXXL701: AI&ML in Healthcare lab	2	100
	Sem VIII	HXXC801: Text, Web and Social Media Analytics	4	100
Total		4 Theory +1 Lab	18	500

Table 5: Honours Degree Program in Block chain

Honours Degree Program	Sem	Additional Subjects to be learnt and passed through the examination	Credits	Marks
BlockChain	Sem V	HXXC501: Bit coin and Crypto currency	4	100
	Sem VI	HXXC601: Block chain Platform	4	100
	Sem VII	HXXC701: Block chain Development	4	100
	Sem VII	HXXL701: Block chain Setup Lab	2	100
	Sem VIII	HXXC801: DeFi (Decentralized Finance)	4	100
Total		4 Theory +1 Lab	18	500

Table 6: Honours Degree Program in Cyber Security

Honours Degree Program	Sem	Additional Subjects to be learnt and passed through the examination	Credits	Marks
Cyber Security	Sem V	HXXC501: Ethical Hacking	4	100
	Sem VI	HXXC601: Digital Forensic	4	100
	Sem VII	HXXC701: Security Information Management	4	100
	Sem VII	HXXL701: Vulnerability Assessment Penetration Testing (VAPT) Lab	2	100
	Sem VIII	HXXC801: Application Security	4	100
Total		4 Theory +1 Lab	18	500

Table 7: Honours Degree Program in Data Science

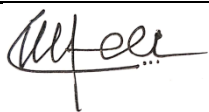
Honours Degree Program	Sem	Additional Subjects to be learnt and passed through the examination	Credits	Marks
Data Science	Sem V	HXXC501: Mathematics for Data Science	4	100
	Sem VI	HXXC601: Statistical Learning for Data Science	4	100
	Sem VII	HXXC701: Data Science for Health and Social Care	4	100
	Sem VII	HXXL701: Data Science for Health and Social Care Lab	2	100
	Sem VIII	HXXC801: Text, Web and Social Media Analytics	4	100
Total		4 Theory +1 Lab	18	500

Table 8: Honours Degree Program in Augmented and Virtual Reality

Honours Degree Program	Sem	Additional Subjects to be learnt and passed through the examination	Credits	Marks
Augmented and Virtual Reality	Sem V	HXXC501: Virtual Reality	4	100
	Sem VI	HXXC601: AR and Mix Reality	4	100
	Sem VII	HXXC701: ARVR Application-I	4	100
	Sem VII	HXXL701: ARVR Lab	2	100
	Sem VIII	HXXC801: Game Development with VR	4	100
Total		4 Theory +1 Lab	18	500

Table 9: Honours Degree Program in Internet of Things

Honours Degree Program	Sem	Additional Subjects to be learnt and passed through the examination	Credits	Marks
Internet of Things	Sem V	HXXC501: IoT Sensor Technologies	4	100
	Sem VI	HXXC601: IoT System Design	4	100
	Sem VII	HXXC701: Dynamic Paradigm in IoT	4	100
	Sem VII	HXXL701: Interfacing & Programming with IoT Lab	2	100
	Sem VIII	HXXC801: Industrial IoT	4	100
Total		4 Theory +1 Lab	18	500



Dr. Suresh Ukarande
Principal



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program

(Prepared based on the Guidelines for AICTE and University of Mumbai)

in

Artificial Intelligence and Machine Learning

(With effect from AY 2022-2023)

Bachelor of Technology in IT/CE/ET/ Engineering

(With effect from 2022-23)

Honours* in Artificial Intelligence and Machine Learning (AI&ML)

Year & Sem	Course Code & Course Title	Teaching Scheme Hrs / Week					Examination Scheme and Marks					Credit Scheme
		Theory	Practical	Test -1	Test -2	Average	Internal Assessment	End Sem Exam	Term Work	Oral / Practical	Total	Credits
TE Sem V	HAIMLC501: Mathematics for AI & ML	04	--	30	30	30	10	60	--	--	100	04
	Total	04	-	--		100	-	-	100	04		
Total Credits = 04												
TE Sem VI	HAIMLC601: Game Theory using AI & ML	04	--	30	30	30	10	60	--	--	100	04
	Total	04	-	-		100	-	-	100	04		
Total Credits = 04												
BE Sem VII	HAIMLC701: AI&ML in Healthcare	04	--	30	30	30	10	60	--	--	100	04
	HAIMLSBL701: AI&ML in Healthcare Lab	--	04				--	--	50	50	100	02
	Total	04	04				100	50	50	200	06	
Total Credits = 06												
BE Sem m	HAIMLC801: Text, Web	04	-	30	30	30	10	60	--	--	100	04

VII I	and Social Media Analytics											
	Total	04	-	-		100	-	-	100	04		
Total Credits = 04												
Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04 = 18												

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HAIMLC501	Mathematics for AI&ML	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HAIMLC501	Mathematics for AI&ML	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
Applied Mathematics, Discrete mathematics	
Course Objectives:	
1	To build an intuitive understanding of Mathematics and relating it to Artificial Intelligence, Machine Learning and Data Science.
2	To provide a strong foundation for probabilistic and statistical analysis mostly used in varied applications in Engineering.
3	To focus on exploring the data with the help of graphical representation and drawing conclusions.
4	To explore optimization and dimensionality reduction techniques.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Use linear algebra concepts to model, solve, and analyze real-world problems.
2	Apply probability distributions and sampling distributions to various business problems.
3	Select an appropriate graph representation for the given data.
4	Apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization
5	Analyze various optimization techniques.
6	Describe Dimension Reduction Algorithms

Module No.		Topics	Hrs.
1.0		Linear Algebra	05
	1.1	Vectors and Matrices, Solving Linear equations, The four Fundamental Subspaces, Eigenvalues and Eigen Vectors, The Singular Value Decomposition (SVD).	
2.0		Probability and Statistics	09
	2.1	Introduction, Random Variables and their probability Distribution, Random Sampling, Sample Characteristics and their Distributions, Chi-Square, t-, and F-Distributions: Exact Sampling Distributions, Sampling from a Bivariate Normal Distribution, The Central Limit Theorem.	

3.0		Introduction to Graphs	10
	3.1	Quantitative vs. Qualitative data, Types of Quantitative data: Continuous data, Discrete data, Types of Qualitative data: Categorical data, Binary data, Ordinary data, Plotting data using Bar graph, Pie chart, Histogram, Stem and Leaf plot, Dot plot, Scatter plot, Time-series graph, Exponential graph, Logarithmic graph, Trigonometric graph, Frequency distribution graph.	
4.0		Exploratory Data Analysis	09
	4.1	Need of exploratory data analysis, cleaning and preparing data, Feature engineering, Missing values, understand dataset through various plots and graphs, draw conclusions, deciding appropriate machine learning models.	
5.0		Optimization Techniques	10
	5.1	Types of optimization-Constrained and Unconstrained optimization, Methods of Optimization-Numerical Optimization, Bracketing Methods-Bisection Method, False Position Method, Newton's Method, Steepest Descent Method, Penalty Function Method.	
6.0		Dimension Reduction Algorithms	05
	6.1	Introduction to Dimension Reduction Algorithms, Linear Dimensionality Reduction: Principal component analysis, Factor Analysis, Linear discriminant analysis.	
	6.2	Non-Linear Dimensionality Reduction: Multidimensional Scaling, Isometric Feature Mapping. Minimal polynomial	
		Total	48

Text Books:	
1	Linear Algebra for Everyone,
2	Gilbert Strang, Wellesley Cambridge Press.
3	An Introduction to Probability and Statistics, Vijay Rohatgi, Wiley Publication
4	An introduction to Optimization, Second Edition, Wiley-Edwin Chong, Stanislaw Zak.
5	Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press.
6	Exploratory Data Analysis, John Tukey, Princeton University and Bell Laboratories.
References:	
1	Introduction to Linear Algebra, Gilbert Strang.
2	Advanced Engineering Mathematics, Erwin Kreyszig
3	Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. Foundations of Machine Learning. MIT Press, 2018.
4	Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014
5	Last updated on Sep 9, 2018.
6	Mathematics and Programming for Machine Learning with R, William B. Claster, CRC Press, 2020
Useful Links:	
1	https://math.mit.edu/~gs/linearalgebra/
2	https://www.coursera.org/learn/probability-theory-statistics
3	https://nptel.ac.in/courses/111/105/111105090/
4	https://onlinecourses.nptel.ac.in/noc21_ma01/preview
5	https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/
Assessment:	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HAIMLC601	Game Theory using AI & ML	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HAIMLC601	Game Theory using AI & ML	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
Knowledge of probability theory, discrete mathematics, and algorithm design is required.	
Course Objectives:	
1	To acquire the knowledge of game theory.
2	To understand the basic concept of AI, strength and weakness of problem solving and search
3	To study about various heuristic and game search algorithms
4	To optimize the different linear methods of regression and classification
5	To interpret the different supervised classification methods of support vector machine.
6	To acquire the knowledge of different generative models through unsupervised learning
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Understand basic concept of game theory.
2	Evaluate Artificial Intelligence (AI) methods and describe their foundations
3	Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning
4	Demonstrate knowledge of reasoning and knowledge representation for solving real world problems
5	Recognize the characteristics of machine learning that makes it useful to realworld problems and apply different dimensionality reduction techniques
6	Apply the different supervised learning methods of support vector machine and tree based models

Module No.	Topics	Hrs.
1.0	Introduction to Game Theory	05

	1.1	Introduction, The theory of rational choice, Games with Perfect Information, Nash Equilibrium: Theory, Prisoner's Dilemma, Stag Hunt, Matching pennies, BOS, Multi NE, Cooperative and Competitive Games, Strict and Non Strict NE, Best response functions for NE.	
	1.2	Nash Equilibrium: Illustrations, Cournot's model of oligopoly, Bertrand's model of oligopoly, Electoral competition, The War of Attrition, Auctions, Mixed Strategy Equilibrium, Strategic games in which players may randomize, Dominated actions, Extensive Games with Perfect Information	
2.0		Games with Imperfect Information	09
	2.1	Bayesian Games, Introduction, Motivational examples, General definitions, two examples concerning information, Strictly Competitive Games and Maximization, Rationalizability	
	2.2	Evolutionary Equilibrium, Monomorphic pure strategy equilibrium, Mixed strategies and polymorphic equilibrium, Repeated games: The Prisoner's Dilemma, Infinitely repeated games, Strategies, General Results,	
3.0		Introduction to AI & Problem Solving	10
	3.1	Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning,	
	3.2	Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best first Search; Problem Reduction.	
	3.3	Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments	
4.0		Knowledge and Reasoning	09
	4.1	Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities,	
	4.2	Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markov models, Kalman filter, dynamic bayesian network, keeping track of many objects	
5.0		Introduction to ML	10
	5.1	Introduction to Machine Learning, Examples of Machine Learning Applications, Learning Types, Supervised Learning -Learning a Class from Examples, Vapnik- Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm	
	5.2	Introduction, Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods, Logistic Regression- Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression, SVM -Introduction to SVM, The Support Vector Classifier, Support Vector Machines and Kernels- Computing the SVM for Classification	
6.0		Unsupervised Learning	05
	6.1	Introduction, Association Rules-Market Basket Analysis, The Apriori Algorithm, Unsupervised as Supervised Learning, Generalized Association Rules, Cluster Analysis Proximity Matrices, Clustering Algorithms -K-mean, Gaussian Mixtures as Soft K-means Clustering, Example: Human Tumor Microarray Data, Vector Quantization, K-medoids, Hierarchical Clustering, Self-Organizing Maps, PCA-Spectral Clustering	
	6.2	Hidden Markov Models -Introduction, Discrete Markov Processes, Hidden Markov Models, Three Basic Problems of HMMs, Evaluation Problem, Finding the State Sequence, Learning Model Parameters, Continuous Observations, The HMM with Input, Model Selection in HMM	
		Total	48
Text Books:			
1	Martin Osborne, An Introduction to Game Theory, Oxford University Press.		
2	Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd		

	edition,Prentice Hall									
3	Introduction to Machine Learning Edition 2, by Ethem Alpaydin									
References:										
1	Thomas Ferguson, Game Theory, World Scientific, 2018.									
2	Stef Tijs. Introduction to Game Theory, Hindustan Book Agency									
3	J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition , 2016									
4	Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011									
5	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997									
Assessment:										
Continuous Assessment (CA): The distribution of Continuous Assessment marks will be as follows – <table><tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr><tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr><tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr></table>		1.	Class Test 1	30 marks	2.	Class Test 2	30 marks	3.	Internal Assessment	10 marks
1.	Class Test 1	30 marks								
2.	Class Test 2	30 marks								
3.	Internal Assessment	10 marks								
Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour. Internal Assessment(IA) (10 marks): Marks will be allotted as per designed rubrics.										
End Semester Theory Examination will be of 60-Marks with Three hour duration.										

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HAIMLC701	AI&ML in Healthcare	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HAIML C701	AI&ML in Healthcare	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
Artificial Intelligence, Machine Learning	
Course Objectives: The course aims	
1	To understand the need and significance of AI and ML for Healthcare.
2	To study advanced AI algorithms for Healthcare.
3	To learn Computational Intelligence techniques .
4	To understand evaluation metrics and ethics in intelligence for Healthcare systems,
5	To learn various NLP algorithms and their application in Healthcare,
6	To investigate the current scope, implications of AI and ML for developing futuristic Healthcare Applications.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Understand the role of AI and ML for handling Healthcare data.
2	Apply Advanced AI algorithms for Healthcare Problems.
3	Learn and Apply various Computational Intelligence techniques for Healthcare Application.
4	Use evaluation metrics for evaluating healthcare systems.
5	Develop NLP applications for healthcare using various NLP Techniques..
6	Apply AI and ML algorithms for building Healthcare Applications

Module No.		Topics	Hrs.
1.0		Introduction	04
	1.1	Overview of AI and ML,A Multifaceted Discipline, Applications of AI in Healthcare - Prediction, Diagnosis, personalized treatment and behavior modification, drug discovery, followup care etc,	
	1.2	Realizing potential of AI and ML in healthcare, Healthcare Data - Use Cases.	
2.0		AI, ML, Deep Learning and Data Mining Methods for Healthcare	10
	2.1	Knowledge discovery and Data Mining, ML, Multi classifier Decision Fusion, Ensemble Learning, Meta-Learning and other Abstract Methods.	
	2.2	Evolutionary Algorithms, Illustrative Medical Application-Multiagent Infectious Disease	

		Propagation and Outbreak Prediction, Automated Amblyopia Screening System etc.	
	2.3	Computational Intelligence Techniques, Deep Learning, Unsupervised learning, dimensionality reduction algorithms.	
3.0		Evaluating learning for Intelligence	06
	3.1	Model development and workflow, evaluation metrics, Parameters and Hyperparameters, Hyperparameter tuning algorithms, multivariate testing, Ethics of Intelligence.	
4.0		Natural Language Processing in Healthcare	08
	4.1	NLP tasks in Medicine, Low-level NLP components, High level NLP components, NLP Methods.	
	4.2	Clinical NLP resources and Tools, NLP Applications in Healthcare. Model Interpretability using Explainable AI for NLP applications.	
5.0		Intelligent personal Health Record	04
	5.1	Introduction, Guided Search for Disease Information, Recommending SCA's. Recommending HHP's , Continuous User Monitoring.	
6.0		Future of Healthcare using AI and ML	07
	6.1	Evidence based medicine, Personalized Medicine, Connected Medicine, Digital Health and Therapeutics, Conversational AI, Virtual and Augmented Reality, Blockchain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.	
	6.2	Blockchain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.	
		Total	48

Textbooks:	
1	Arjun Panesar, "Machine Learning and AI for Healthcare", A Press.
2	Arvin Agah, "Medical applications of Artificial Systems ", CRC Press
References:	
1	Erik R. Ranschaert Sergey Morozov Paul R. Algra, "Artificial Intelligence in medical Imaging- Opportunities, Applications and Risks", Springer
2	Sergio Consoli Diego Reforgiato Recupero Milan Petković, "Data Science for Healthcare-Methodologies and Applications", Springer
3	Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp, Gia Nhu Nguyen, "Emerging technologies for health and medicine", Wiley.
4	Ton J. Cleophas • Aeilko H. Zwinderman, "Machine Learning in Medicine- Complete Overview", Springer
Assessment:	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HAIMLC801	Text, Web and Social Media Analytics	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HAIML C801	Text, Web and Social Media Analytics	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
Python, Data Mining	
Course Objectives: The course aims	
1	To have a strong foundation on text, web and social media analytics.
2	To understand the complexities of extracting the text from different data sources and analysing it.
3	To enable students to solve complex real-world problems using sentiment analysis and Recommendation systems.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Extract Information from the text and perform data pre-processing
2	Apply clustering and classification algorithms on textual data and perform prediction.
3	Apply various web mining techniques to perform mining, searching and spamming of web data.
4	Provide solutions to the emerging problems with social media using behaviour analytics and Recommendation systems.
5	Apply machine learning techniques to perform Sentiment Analysis on data from social media.

Module No.		Topics	Hrs.
1.0		Introduction	06
	1.1	Introduction to Text Mining: Introduction, Algorithms for Text Mining, Future Directions	
	1.2	Information Extraction from Text: Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction	
	1.3	Text Representation: tokenization, stemming, stop words, NER, N-gram modelling	
2.0		Clustering and Classification	10

	2.1	Text Clustering: Feature Selection and Transformation Methods, distance based Clustering Algorithms, Word and Phrase based Clustering, Probabilistic document Clustering	
	2.2	Text Classification: Feature Selection, Decision tree Classifiers, Rule-based Classifiers, Probabilistic based Classifiers, Proximity based Classifiers.	
	2.3	Text Modelling: Bayesian Networks, Hidden Markovian Models, Markov random Fields, Conditional Random Fields	
3.0		Web-Mining:	05
	3.1	Introduction to Web-Mining: Inverted indices and Compression, Latent Semantic Indexing, Web Search,	
	3.2	Meta Search: Using Similarity Scores, Rank Positions	
	3.3	Web Spamming: Content Spamming, Link Spamming, hiding Techniques, and Combating Spam	
4.0		Web Usage Mining:	05
	4.1	Data Collection and Pre-processing, Sources and types of Data, Data Modelling, Session and Visitor Analysis, Cluster Analysis and Visitor segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigational Patterns, Classification and Prediction based on Web User Transactions.	
5.0		Social Media Mining:	05
	5.1	Introduction, Challenges, Types of social Network Graphs	
	5.2	Mining Social Media: Influence and Homophily, Behaviour Analytics, Recommendation in Social Media: Challenges, Classical recommendation Algorithms, Recommendation using Social Context, Evaluating recommendations.	
6.0		Opinion Mining and Sentiment Analysis:	08
	6.1	The problem of opinion mining,	
	6.2	Document Sentiment Classification: Supervised, Unsupervised	
	6.3	Opinion Lexicon Expansion: Dictionary based, Corpus based	
	6.4	Opinion Spam Detection: Supervised Learning, Abnormal Behaviours, Group Spam Detection.	
		Total	48

Textbooks:	
1	Daniel Jurafsky and James H. Martin, "Speech and Language Processing," 3rd edition, 2020
2	Charu. C. Aggarwal, Cheng Xiang Zhai, Mining Text Data, Springer Science and Business Media, 2012.
3	BingLiu, "Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data", Springer, Second Edition, 2011.
4	Reza Zafarani, Mohammad Ali Abbasi and Huan Liu, "Social Media Mining- An Introduction", Cambridge University Press, 2014
Assessment:	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HXXSBL701	AI&ML in Healthcare: Lab	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HXXSBL701	AI&ML in Healthcare: Lab						--	--	

Course Prerequisites:	
Python	
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Students will be able to understand computational models of AI and ML.
2	Students will be able to develop healthcare applications using appropriate computational tools.
3	Students will be able to apply appropriate models to solve specific healthcare problems.
4	Students will be able to analyze and justify the performance of specific models as applied to healthcare problems.
5	Students will be able to design and implement AI and ML-based healthcare applications.

Suggested Experiments:	
Sr. No.	Name of the Experiment
	Introduction
1	Collect, Clean, Integrate and Transform Healthcare Data based on specific disease.
2	Perform Exploratory data analysis of Healthcare Data.
3	AI for medical diagnosis based on MRI/X-ray data.
4	AI for medical prognosis .
5	Natural language Entity Extraction from medical reports.
6	Predict disease risk from Patient data.
7	Medical Reviews Analysis from social media data.
8	Explainable AI in healthcare for model interpretation.
9	Mini Project-Design and implement innovative web/mobile based AI application using Healthcare Data.
10	Documentation and Presentation of Mini Project.

Useful Links:

1	https://www.coursera.org/learn/introduction-tensorflow?specialization=tensorflow-in-practice
2	https://www.coursera.org/learn/convolutional-neural-networks-tensorflow?specialization=tensorflow-in-practice
3	https://datarade.ai/data-categories/electronic-health-record-ehr-data
4	https://www.cms.gov/Medicare/E-Health/EHealthRecords
5	https://www.coursera.org/learn/tensorflow-sequences-time-series-and-prediction?specialization=tensorflow-in-practice
Term Work:	
1	Term work should consist of 8 experiments and a Mini Project.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 10-Marks, Mini Project-10 Marks, Attendance Theory & Practical: 05-marks)
Oral & Practical exam	
1	Based on the entire syllabus of AI ML for Healthcare



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program

(Prepared based on the Guidelines for AICTE and University of Mumbai)

in

Blockchain

(With effect from AY 2022-2023)

Bachelor of Technology in IT/CE/ET/AI&DS Engineering
(With effect from 2022-23)

Year & Sem	Course Code and Course Title		Teaching Scheme Hours / Week				Examination Scheme and Marks					Credit Scheme
		Theory	Practical	Test-1	Test-2	Average	Internal Assessment	End Sem Exam	Term Work	Oral / Practical	Total	Credits
TE Sem V	HBCC501: Bit coin and Cryptocurrency	04		30	30	30	10	60	--	--	100	04
	Total	04		-	--	100			-	-	100	04
Total Credits = 04												
TE Sem. VI	HBCC601: Blockchain Platform	04		30	30	30	10	60	--	--	100	04
	Total	04		-	-	100			-	-	100	04
Total Credits = 04												
BE Sem. VII	HBCC701: Block chain Development	04		30	30	30	10	60	--	--	100	04
	HBCSBL601: Private Blockchain Setup Lab	--	04	--	-		--	--	50	50	100	02
	Total	04	04	-		100			50	50	200	06
Total Credits = 06												
BE Sem. VIII	HBCC801: DeFi (Decentralized Finance)	04		30	30	30	10	60	--	--	100	04
	Total	04		-	-	100			-	-	100	04
Total Credits = 04												
Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04=18												

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HBCC501	Bit coin and Crypto currency	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HBCC501	Bit coin and Crypto currency	30	30	30	10	60	--	--	--	100

Course Objectives:

	Course Objectives
The course aims:	
1	To get acquainted with the concept of Block and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain.
3	To get familiar with the bitcoin currency and its history.
4	To understand and apply the concepts of keys, wallets and transactions in the Bitcoin Network.
5	To acquire the knowledge of Bitcoin network, nodes and their roles.
6	To analyze the applications& case studies of Blockchain.

Course Outcomes:

	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy Level
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Block chain.	L1,L2
2	Associate knowledge of consensus and mining in Block chain.	L1,L2
3	Summarize the bit coin crypto currency at an abstract level.	L1,L2
4	Apply the concepts of keys, wallets and transactions in the Bit coin network.	L3
5	Interpret the knowledge of Bit coin network, nodes and their roles.	L1,L2
6	Illustrate the applications of Block chain and analyze case studies.	L3

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction to Cryptography: Hash functions, Public key cryptography, Digital Signature (ECDSA).	2	--
I	Introduction to Block chain	Structure of a Block, Block Header, Block Identifiers: Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Block chain, Merkle Trees and Simplified Payment Verification (SPV). Self-learning Topics: Block chain Demo.	6	CO1
II	Consensus and Mining	Decentralized Consensus, Byzantine General's Problem, Independent Verification of Transactions, Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block header, Mining the Block, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Block chain Forks Self-learning Topics: Study different consensus algorithms	12	CO2
III	Introduction to Bit coin	What is Bit coin and the history of Bit coin, Getting the first bit coin, finding the current price of bit coin and sending and receiving bit coin, Bit coin Transactions. Self-learning Topics: Study the website coinmarketcap.com/	4	CO3
IV	Concepts of Bit coin	Keys and addresses, Wallets and Transactions: Public Key Cryptography and Crypto currency, Private and Public Keys, Bit coin Addresses, Base58 and Base58Check Encoding, Nondeterministic (Random) Wallets, Deterministic (Seeded) Wallets, HD Wallets (BIP-32/BIP-44), Wallet Best Practices, Using a Bit coin Wallets, Transaction Outputs and Inputs, Transaction Fees, Transaction Scripts and Script Language, Turing Incompleteness, Stateless Verification, Script Construction (Lock + Unlock), Pay-to-Public-Key-Hash (P2PKH), Bitcoin Addresses, Balances, and Other Abstractions Self-learning Topics: Visit and use https://bitcoin.org/en/	13	CO4
V	Bit coin Networks	Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes,	7	CO5

		Exchanging “Inventory”, Simplified Payment Verification (SPV) Nodes, Bloom Filters, SPV Nodes and Privacy, Encrypted and Authenticated Connections, Transaction Pools Self-learning Topics: Study technical papers based on bitcoin security		
VI	Blockchain Applications & case studies	Domain-Specific Applications: FinTech, Internet of Things, Industrial and Manufacturing, Energy, Supply chain & Logistics, Records & Identities, Healthcare Case studies related to cryptocurrencies Concept of Altcoin Self-learning Topics: Read Technical papers on blockchain applications	8	CO6

Text Books:

1. “Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN” , 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. “Blockchain Applications: A Hands-On Approach”, by ArshdeepBahga, Vijay Madiseti, Paperback – 31 January 2017.
3. “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, July 19, 2016, by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University Press.

Reference Books:

1. “Mastering Blockchain”, by Imran Bashir, Third Edition, Packt Publishing
2. “Mastering Ethereum: Building Smart Contracts and Dapps Paperback” by Andreas Antonopoulos, Gavin Wood, Publisher(s): O'Reilly Media
3. “Blockchain revolution: how the technology behind bitcoin is changing money, business and the world \$ don tapscott and alex tapscot, portfolio penguin, 856157449

Online References:

Sr. No.	Website Name
1.	https://andersbrownworth.com/blockchain/
2.	https://andersbrownworth.com/blockchain/public-private-keys/
3.	https://www.coursera.org/learn/cryptocurrency
4.	https://coinmarketcap.com/

Assessment:**Continuous Assessment (CA):**

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HBCC601	Block chain Platform	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HBCC601	Block chain Platform	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Understand the blockchain platform and its terminologies.
2	Understand smart contracts, wallets, and consensus protocols.
3	Design and develop decentralized applications using Ethereum, and Hyperledger.
4	Creating blockchain networks using Hyperledger Fabric deployment.
5	Understand the considerations for creating blockchain applications.
6	Analyze various Blockchain Platforms.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the Blockchain platform and its types.	L1,L2
2	Create Public Blockchain using Ethereum.	L3,L4,L5, L6
3	Develop Smart Contracts using REMIX IDE.	L3,L4,L5
4	Apply the concept of private blockchain using Hyperledger.	L3
5	Analyze different types of blockchain platforms.	L3,L4
6	Deploy Enterprise Applications on Blockchain.	L3,L4,L5

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction to Block chain and Bit coin,	2	--
I	Introduction to Block chain Platforms	<p>Why Blockchain Platform: Platform types, Public, Private, technology requirements for implementation.</p> <p>Introduction to Ethereum, Hyperledger and Smart Contracts. Case study of blockchain Application.</p> <p>Self-learning Topics: Study different applications of block chain.</p>	6	CO1
II	Public Block chain	<p>Introduction, Characteristics of Public Blockchain, Advantages.</p> <p>Examples of Public Blockchain-Bitcoin: Terminologies and Transaction, Ethereum: Smart contract, Comparison of Bitcoin and Ethereum, Other public Blockchain platforms.</p> <p>Self-learning Topics: Study any one case study on public block chain.</p>	8	CO2, CO3
III	Ethereum Blockchain	<p>Introduction, Ethereum and Its Components: Mining, Gas, Ethereum, Ether, Ethereum Virtual Machine, Transaction, Accounts. Architecture of ethereum, Smart Contract: Remix IDE, Developing smart contract for ethereum blockchain, e-voting applications using smart contract, Dapp Architecture. Types of test-networks used in ethereum, Transferring Ethers Using MetaMask, Mist Wallet, Ethereum Frameworks, Case study of Ganache for ethereum blockchain. Deploying e-voting applications on Ganache framework. Ethereum 2., Concept of Beacon chain, POS (Proof of Stake), Sharding of Chain.</p> <p>Self-learning Topics: Study case study on any ethereum blockchain.</p>	12	CO2, CO3, CO6
IV	Private Blockchain	<p>Introduction, Key Characteristics, Need of Private Blockchain.</p> <p>Consensus Algorithm for private Blockchain (Ex. RAFT and PAXOS), Smart Contract in Private Blockchain, Case Study of E-commerce Website, Design Limitations.</p> <p>Self-learning Topics: Case study on private block chain.</p>	8	CO4

V	Hyperledger Blockchain	<p>Introduction to Hyperledger, tools and frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies, Distributed Ledgers. Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes etc., Transaction Flow, Advantages of Hyperledger Fabric Blockchain, working of Hyperledger Fabric, Creating Hyperledger network, Case Study of Supply chain management using Hyperledger</p> <p>Self-learning Topics: Case study on Hyperledger blockchain.</p>	12	CO5, CO6
VI	Other Blockchain platforms	<p>Corda, Ripple, Quorum and other emerging blockchain platforms, Case Study on any of the blockchain platforms.</p> <p>Developing Blockchain application on Cloud(AWS/Azure)</p> <p>Self-learning Topics: Compare different blockchain platforms.</p>	4	CO5

Text Book:

- 1) Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and MeenaKarthikeyan, Universities press.
- 2) Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.

Reference Books:

- 1) Blockchain for Beginners, Yathish R and Tejaswini N, SPD
- 2) Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
- 3) Blockchain with Hyperledger Fabric, LucDesrosiers, Nitin Gaur, Salman A. Baset, VenkatramanRamakrishna, Packt Publishing

E Books:

- 1) Blockchain By Example, BellajBadr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
- 2) Blockchain for Business, <https://www.ibm.com/downloads/cas/3EGWKGX7>.

Online References:

Sr. No.	Website Name
1.	https://www.hyperledger.org/use/fabric

Assessment:**Continuous Assessment (CA):**

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HBCC701	Block chain Development	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HBCC701	Block chain Development	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand Ethereum Ecosystem.
2	To understand aspects of different programming languages.
3	To explain how to use the solidity programming language to develop a smart contract for blockchain.
4	To demonstrate deployment of smart contracts using frameworks.
5	To understand principles of Hyperledger fabric.
6	To understand challenges to apply blockchain in emerging areas.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	To use Ethereum Components.	L1,L2
2	To Analyse different blockchain programming languages.	L3
3	To implement smart contract in Ethereum using solidity.	L4,L5
4	To analyse different development frameworks.	L4
5	To implement private blockchain network with Hyperledger fabric.	L4,L5
6	To illustrate blockchain integration with emerging technologies and security issues.	L1,L2

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Blockchain cryptocurrency, Blockchain platform	2	--
I	Ethereum Ecosystem	Ethereum components: miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, accounts, swarm and whisper, Ethash, end to end transaction in Ethereum, architecture of Ethereum Self-learning Topics: Emerging blockchain platforms	4	CO1
II	Blockchain Programming	Types of Blockchain Programming, Solidity, GoLang, Vyper, Java, Simplicity, Rholang, Game Theory and Cryptonomics, Comparative study of different blockchain programming languages Decentralized file system-IPFS. Self-learning Topics: Emerging blockchain programming languages	8	CO2
III	Smart Contract	Solidity programming, Smart Contract programming using solidity, mapper function, ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, ICO, STOMetamask (Ethereum Wallet), setting up development environment, use cases of smart contract, smart Contracts: Opportunities, Risks Self-learning Topics: Cryptocurrencies and their security issues, Consensus mechanisms, Digital Signatures	10	CO3

IV	Blockchain Deployment	<p>Ethereum client, Ethereum Network, Introduction to Go Ethereum(Geth), Geth Installation and Geth CLI, Setting up a Private Ethereum Blockchain. Introduction to Truffle, Smart Contract deployment on a Private Blockchain.Introduction to Ganache</p> <p>Introduction to Dapp,Dapp architecture, Daaps Scalability,testing</p> <p>Connecting to the Blockchain and Smart Contract, Web3js, Deployment</p> <p>Self-learning Topics: Smart Contract deployment using Ganache.</p>	10	CO4
V	Hyperledger Application Development	<p>Installing Hyperledger Fabric, Hyperledger Fabric Network ,Building Your First Network,Hyperledger Fabric Demo,Hyperledger Fabric Network Configuration, Certificate Authorities,Chaincode Development and Invocation, Deployment and testing of chaincode on development network, Hyperledger Fabric Transactions</p> <p>Self-learning Topics: Hyperledger sawtooth,Hyperledger caliper</p>	12	CO5
VI	Blockchain integration and Research challenges	<p>Integrating Blockchain with cloud, IoT, AI, ERP, End to end blockchain integration, Risks and Limitations of Blockchain: Privacy & Security. Criminal Use of Payment Blockchains, The “Dark” Side of Blockchain</p> <p>Research challenges in blockchain, Self-learning Topics:Use Cases: Blockchain for Health Insurance,Blockchain in Supply chain management, Blockchain &PropTech, Blockchain in Banking</p>	6	CO6

Text Books:

1. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr.

- Gavin Wood, O'reilly.
2. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press

References:

1. Blockchain enabled Applications, Vikram Dhillon,, Devid Metcalf, Max Hooper, Apress
2. Building Blockchain Projects, Narayan Prusty, Packt

Online References:

Sr. No.	Website Name
1.	https://ethereum.org/en/
2.	https://www.trufflesuite.com/tutorials
3.	https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.html
4.	https://www.blockchain.com/
5.	https://docs.soliditylang.org/en/v0.7.4/

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
HBCSBL601	Private Blockchain Setup Lab(SBL)	--	4	--	--	2	--	02

Course Code	Course Title	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
HBCSBL601	Private Blockchain Setup Lab	--	--	--	--	50	50	100

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To build and test Private Ethereum Blockchain.
2	To learn the concept of the genesis block and Account in the Blockchain.
3	To get familiar with the mining blocks to create a ether.
4	To understand and apply the concepts of keys, wallets.
5	To acquire the knowledge of gateway and desktop application.
6	To analyze the applications & case studies of Blockchain.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of lab, learner/student will be able to:		
1	To understand how blockchain systems (mainly Ethereum) work .	L1,L2
2	To create the genesis block using Puppeth, a CLI tool and account using Smart Contract.	L6
3	To create mining blocks, check the account and PoW.	L6
4	To use cryptocurrency exchanges and wallets safely.	L1,L2,L3
5	To create Gateway to Blockchain Apps.	L6
6	To use Blockchain on Mobile App and on Cloud.	L1,L2,L3

Prerequisite: Expertise in Programming, Basic knowledge of Computer Security, Networking.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. PC i3/i5/i7 Processor or above. 2. 4 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. NodeJs 2. Ethereum 3. Geth 4. Solidity	1. Internet Connection.

DETAILED SYLLABUS:

Note: All practical are to be conducted on Linux platform its Compulsory for this entire practical

Sr. No	Module .	Description	Hours	LO Mapping
1	Build and Test	Install Ethereum network to create a private EthereumBlockchain Self- learning topic :Hyperledger	4	LO1
2	Build and Test	Installation of geth	5	LO1
3	Create the Genesis block	Create the genesis block using Puppeth, a CLI tool	5	LO2
4	Create Account in the blockchain	Smart contract	6	LO2
5	Mining Blocks to create Ether	Mine blocks, check account balance, PoWvsPoA	6	LO3
6	Gateway to Blockchain Apps	Metamask	5	LO4
7	Web and Desktop Application	Solidity programming on remix	6	LO4
8	Application Development	Crypto Exchange and Wallet	4	LO5
9	Application Development	Blockchain Mobile App or Web Application using Dapp	6	LO6
10	Application	Hosting of a private blockchain on	5	LO6

	Development	cloud(AWS/Azure)		
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Text Books:

1. Mastering Ethereum: Building Smart Contracts and Dapps, Andreas Antonopoulos, Gavin Wood, O'Reilly Publication
2. Mastering Blockchain, Second Edition: Distributed ledger technology, decentralization, and smart contracts explained, 2nd Edition, Imran Bashir
3. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, RiteshModi, Packt publication
4. Mastering Blockchain, Imran Bashir, Second Edition ,Packt Publication.

References Books:

1. Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN , 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Blockchain Applications: A Hands-On Approach, by ArshdeepBahga, Vijay Madiseti, Paperback – 31 January 2017.
3. Mastering Blockchain, Imran Bashir, Packt Publication.

Online References:

Sr. No.	Website Name
1.	https://geth.ethereum.org/downloads/
2.	https://medium.com/@agrawalmanas09/how-to-setup-private-ethereum-blockchain-on-windows-10-machine-ab497e03d6b8
3.	https://geth.ethereum.org/docs/dapp/
4.	https://www.edureka.co/blog/ethereum-private-network-tutorial
5.	https://docs.soliditylang.org/en/develop/index.html
6.	https://metamask.io
7.	https://medium.com/publicaio/a-complete-guide-to-using-metamask-updated-version-cd0d6f8c338f
8.	https://docs.aws.amazon.com/blockchain-templates/latest/developerguide/blockchain-templates-create-stack.html

Term Work:

The Term work shall consist of at least 10 to 12 practical based on the above syllabus. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above syllabus.

Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HBCC801	DeFi (Decentralized Finance)	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme								
		Theory Marks						Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam					
		Test 1	Test 2	Avg. of 2 Tests							
HBCC801	DeFi (Decentralized Finance)	30	30	30	10	60	--	--	--	100	

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The basic concepts of Centralized and Decentralized Finance and compare them.
2	The DeFi System and its key categories.
3	The DeFi components, primitives, incentives, metrics and major business models where they are used.
4	The DeFi Architecture and EcoSystem.
5	The DeFi protocols.
6	The real time use cases of DeFi.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the basic concepts of Centralized and Decentralized Finance and compare them.	L1, L2
2	Describe the the DeFi System and its key categories.	L1
3	Discuss the DeFi components, primitives, incentives, metrics and major business models where they are used.	L1, L2
4	Explain the DeFi Architecture and EcoSystem.	L1, L2
5	Illustrate the DeFi protocols.	L1
6	Discuss the real time use cases of DeFi.	L1,L2

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Blockchain & Cryptocurrency,Blockchain Platform, Blockchain Development	02	-
I	Introduction: Centralized and decentralized finance	<p>Difference between Centralized and Decentralized Finance,Traditional Financial Institution- Banks: 1. Payment and Clearance systems, 2.Accessibility,3. Centralization and Transparency,Decentralized Finance Vs Traditional Finance</p> <p>Self-learning Topics: The Potential Impact of Decentralized Finance</p>	06	CO1
II	What is decentralized finance (defi)?	<p>The DeFi Ecosystem, Problems that DeFi Solves How Decentralized is DeFi? Defi key Categories:-Stablecoins, Stable coin and pegging,Lending and Borrowing,Exchanges,Derivations, Fund Management, Lottery,Payments,Insurance</p> <p>Self-learning Topics: How Decentralized Finance Could Make Investing More Accessible.</p>	06	CO2
III	DeFi Primitives and Business Models	<p>3.1 DeFi Components: Blockchain Cryptocurrency The Smart Contract Platform Oracles Stablecoins Decentralized Applications</p> <p>3.2 DeFi Primitives:Transactions Fungible Token: Equity Tokens, Utility Tokens and Governance TokensNFT: NFT Standard, Multi-token standard Custody Supply Adjustment: Burn-Reduce Supply, Mint-Increase Supply, Bonding Curve-Pricing Supply</p> <p>Incentives: Staking Rewards, Slashing, Direct Rewards and Keepers, Fees</p> <p>Swap: Order Book Matching, Automated Market Makers</p> <p>Collateralized Loans Flash Loans (Uncollateralized Loans)</p> <p>3.3 DeFi Key Metrics:Total Value Locked,Daily Active Users,Market Cap</p> <p>3.4 DeFi Major Business Models:Decentralized Currencies ,Decentralized Payment</p>	10	CO3

		<p>Services,Decentralized fundraising,Decentralized Contracting</p> <p>Self-learning Topics: Study any real time Business model.</p>		
IV	DeFi Architecture and EcoSystem	<p>4.1DeFi Architecture:Consumer Layer: Blockchains, Cross-Blockchain networks, Oracles,Digital Asset Layer: Cryptocurrencies,Infrastructure Layer: Wallets and Asset Management, DEXes and Liquidity, Lending and Borrowing, Prediction Markets, Synthetic Assets, Insurance</p> <p>4.2 DeFi EcoSystem and Protocols:On-chain Asset Exchange,Loanable Fund Markets on-chain assets,Stablecoins,Portfolio Management,Derivatives,Privacy-preserving mixers</p> <p>4.3 DeFi Risk and Challenges: Technical Risks,Usability Risks, Centralization Risks,Liquidity Risks,Regulation Risk</p> <p>Self-learning Topics:Study of the Problems which are holding DeFi adoption back</p>	10	CO4
V	DeFi Deep Dive	<p>5.1.Maker DAO:Maker Protocol: Dai Stablecoins, Maker Vaults, Maker Protocol Auctions</p> <p>Maker Actors: Keepers, Price Oracles, Emergency Oracles, DAO Teams,Dai Savings Rate</p> <p>Dai Use case Benefits and Examples</p> <p>5.2.UniSwap:UniSwap Protocol Overview: How UniSwap Works, EcoSystem Participants, Smart Contracts</p> <p>UniSwap Core Concepts: Swaps, Pools, Flash Swaps, Oracles</p> <p>5.3. Compound:Compound Protocol: Supplying Assets, Borrowing Assets, Interest Rate Model</p> <p>Compound Implementation and Architecture: cToken Contracts, Interest Rate Mechanics, Borrowing, Liquidation, Price Feeds, Comptroller, Governance</p> <p>5.4. wBTC:Need for wBTC: Tokenization and common Issues</p> <p>wBTC Implementation and Technology:</p>	10	CO5

		Users, Custodian Wallet Setup, Minting, Burning wBTC Governance, wBTC vs Atomic Swaps, Fees, Legal Binding, Trust Model and Transparency Self-learning Topics: MakerDAO Governance, UniSwap Governance Protocol Math, Compound Protocol Math		
VI	Use Cases	6.1 Decentralized Exchanges 6.2 Decentralized Stablecoins 6.3 Decentralized Money Markets 6.4 Decentralized Synthetix 6.5 Decentralized Insurance 6.6 Decentralized Autonomous Organization (DAO), Self-learning Topics: Stock Exchange Operations, Derivatives, Tether, Ampleforth, How to get stablecoins, Synthetix Network, Token, The Ongoing Impact of The DAO's Rise and Fall, DAO Projects	08	CO6

Text Books:

1. How to DeFi, Darren Lau, Daryl Lau, Teh Sze Jin, Kristian Kho, Erina Azmi, TM Lee, Bobby Ong-1st Edition, March 2020
2. DeFi and the Future of Finance-Campbell R. Harvey
3. DeFi Adoption 2020 A Definitive Guide to Entering the Industry

Reference Books/White Papers:

1. Blockchain disruption and decentralized finance: The rise of decentralized business models-Yan Chen, Cristiano Bellavitis
2. SoK: Decentralized Finance (DeFi)-Sam M. Werner, Daniel Perez, Lewis Gudgeon, Arian Klages-Mundt, Dominik Harz*, ‡, William J. Knottenbelt, Imperial College London, † Cornell University, Interlay
4. Decentralized Finance (DeFi) –A new Fintech Revolution?
5. <https://makerdao.com/da/whitepaper/>
6. <https://uniswap.org/>
7. <https://compound.finance/documents/Compound.Whitepaper.pdf>
8. <https://wbtc.network/assets/wrapped-tokens-whitepaper.pdf>
9. <https://defiprime.com/exchanges>
10. <https://defirate.com/stablecoins/>
11. <https://academy.ivanontech.com/blog/decentralized-money-markets-and-makerdao>
12. <https://www.gemini.com/cryptopedia/nexus-mutual-blockchain-insurance-nxm-crypto>
13. <https://consensus.net/blockchain-use-cases/decentralized-finance/>

14. <https://tokenlon.zendesk.com/hc/en-us/articles/360041114431-DeFi-Explained-Synthetic-Assets>,
<https://www.blockchain-council.org/synthetic/synthetic-snx-the-biggest-ecosystem-in-decentralized-finance/>

Online References:

Sr. No.	Website Name
1.	https://www.udemy.com/
2.	https://www.coursera.org/

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program

(Prepared based on the Guidelines for AICTE and University of Mumbai)

in

Cyber Security

(With effect from AY 2022-2023)

Honours Program in Cyber Security

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute affiliated to University of Mumbai
Accredited by NAAC and NBA, Approved by AICTE, New Delhi

Bachelor of Technology in IT/CE/ET/AI&DS Engineering
(With effect from 2022-23)

Honours* in Cyber Security

Year & Sem	Course Code and Course Title	Teaching Scheme Hours / Week					Examination Scheme and Marks					Credit Scheme
		Theory	Practical	Test -1	Test-2	Average	Internal Assessment	End Sem Exam	Term Work	Oral/ Practical	Total	Credits
TE Sem V	HCSC501: Ethical Hacking	04	--	30	30	30	10	60	--	--	100	04
	Total	04	-	--			100		-	-	100	04

Total Credits = 04

TE Sem. VI	HCSC601: Digital Forensic	04	--	30	30	30	10	60	--	--	100	04
	Total	04	-	-			100		-	-	100	04

Total Credits = 04

BE Sem. VII	HCSC701: Security Information Management	04	--	30	30	30	10	60	--	--	100	04
	HCSSBL601: Vulnerability Assessment Penetration Testing (VAPT) Lab	--	04				--	--	50	50	100	02
	Total	04	04				100		50	50	200	06

Total Credits = 06

BE Sem. VIII	HCSC801: Application Security	04	-	30	30	30	10	60	--	--	100	04
	Total	04	-	-			100		-	-	100	04

Total Credits = 04

Total Credits for Semesters V, VI, VII & VIII = 04+04+06+04=18

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HCSC501	Ethical Hacking	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HCSC501	Ethical Hacking	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To describe Ethical hacking and fundamentals of computer Network.
2	To understand about Network security threats, vulnerabilities assessment and social engineering.
3	To discuss cryptography and its applications.
4	To implement the methodologies and techniques of Sniffing techniques, tools, and ethical issues.
5	To implement the methodologies and techniques of hardware security.
6	To demonstrate systems using various case studies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Articulate the fundamentals of Computer Networks, IP Routing and core concepts of ethical hacking in real world scenarios.	L1,L2
2	Apply the knowledge of information gathering to perform penetration testing and social engineering attacks.	L3
3	Demonstrate the core concepts of Cryptography, Cryptographic checksums and evaluate the various biometric authentication mechanisms.	L1,L2
4	Apply the knowledge of network reconnaissance to perform Network and web application-based attacks.	L3
5	Apply the concepts of hardware elements and endpoint security to provide security to physical devices.	L3
6	Simulate various attack scenarios and evaluate the results.	L4,L5

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Networks, Databases, system security	2	-
I	Introduction to Ethical Hacking	Fundamentals of Computer Networks/IP protocol stack, IP addressing and routing, Routing protocol, Protocol vulnerabilities, Steps of ethical hacking, Demonstration of Routing Protocols using Cisco Packet Tracer Self-learning Topics: TCP/IP model, OSI model	10	CO1
II	Introduction to Cryptography	Private-key encryption, public key-encryption, key Exchange Protocols, Cryptographic Hash Functions & applications, steganography, biometric authentication, lightweight cryptographic algorithms. Demonstration of various cryptographic tools and hashing algorithms Self-learning Topics: Quantum cryptography, Elliptic curve cryptography	08	CO3
III	Introduction to network security	Information gathering, reconnaissance, scanning, vulnerability assessment, Open VAS, Nessus, System hacking: Password cracking, penetration testing, Social engineering attacks, Malware threats, hacking wireless networks (WEP, WPA, WPA-2), Proxy network, VPN security, Study of various tools for Network Security such as Wireshark, John the Ripper, Metasploit, etc. Self-learning Topics: Ransomware(Wannacry), Botnets, Rootkits, Mobile device security	12	CO2
IV	Introduction to web security and Attacks	OWASP, Web Security Considerations, User Authentication, Cookies, SSL, HTTPS, Privacy on Web, Account Harvesting, Web Bugs, Sniffing, ARP poisoning, Denial of service attacks, Hacking Web Applications, Clickjacking, Cross-Site scripting and Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, SSO, Vulnerability assessments, SQL injection, Web Service Security, OAuth 2.0, Demonstration of hacking tools on Kali Linux such as SQLMap, HTTrack, hping, burp suite, Wireshark etc. Self-learning Topics: Format string attacks	10	CO4
V	Elements of Hardware	Side channel attacks, physical unclonable functions, Firewalls, Backdoors and trapdoors,	6	CO5

	Security	Demonstration of Side Channel Attacks on RSA, IDS and Honeypots. Self-learning Topics: IoT security		
VI	Case Studies	Various attacks scenarios and their remedies. Demonstration of attacks using DVWA. Self-learning Topics: Session hijacking and man-in-middle attacks	4	CO6

Text Books:

1. Computer Security Principles and Practice --William Stallings, Seventh Edition, Pearson Education, 2017
2. Security in Computing -- Charles P. Pfleeger, Fifth Edition, Pearson Education, 2015
3. Network Security and Cryptography -- Bernard Menezes, Cengage Learning, 2014
4. Network Security Bible -- Eric Cole, Second Edition, Wiley, 2011
5. Mark Stamp's Information Security: Principles and Practice --Deven Shah, Wiley, 2009

References:

1. UNIX Network Programming –Richard Steven, Addison Wesley, 2003
2. Cryptography and Network Security -- Atul Kahate, 3rd edition, Tata Mc Graw Hill, 2013
3. TCP/IP Protocol Suite -- B. A. Forouzan, 4th Edition, Tata Mc Graw Hill, 2017
4. Applied Cryptography, Protocols Algorithms and Source Code in C -- Bruce Schneier, 2nd Edition / 20th Anniversary Edition, Wiley, 2015

Online Resources:

Sr. No.	Website Name
3.	https://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project
4.	https://dvwa.co.uk/
3.	http://testphp.vulnweb.com/

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HCSC601	Digital Forensic	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HCSC601	Digital Forensic	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the various computer and cyber-crimes in the digital world.
2	To understand a significance of digital forensics life cycle, underlying forensics principles and investigation process.
3	To understand the importance of File system management with respect to computer forensics.
4	To be able to identify the live data in case of any incident handling and application of appropriate tools and practices for the same.
5	To Develop the skills in application of various tools and investigation report writing with suitable evidences.
6	To be able to identify the network and mobile related threats and recommendation of suitable forensics procedures for the same.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and define the class for various computer and cyber-crimes in the digital world.	L1,L2
2	Understand the need of digital forensic and the role of digital evidence.	L1,L2
3	Understand and analyze the role of File systems in computer forensics.	L1,L2,L3
4	Demonstrate the incident response methodology with the best practices for incidence response with the application of forensics tools.	L3
5	Generate/Write the report on application of appropriate computer forensic tools for investigation of any computer security incident .	L5
6	Identify and investigate threats in network and mobile.	L4

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	<p>Computer Hardware: Motherboard, CPU, Memory: RAM, Hard Disk Drive (HDD), Solid State Drive (SSD), Optical drive</p> <p>Computer Networks: Introduction CN Terminology: Router, Gateway, OSI and TCP/IP Layers</p> <p>Operating Systems: Role of OS in file management, Memory management utilities, Fundamentals of file systems used in Windows and Linux.</p>	2	--
I	Introduction to Cybercrime and Computer-crime	<p>1.1 Definition and classification of cybercrimes: Definition, Hacking, DoS Attacks, Trojan Attacks, Credit Card Frauds, Cyber Terrorism, Cyber Stalking.</p> <p>1.2 Definition and classification of computer crimes: Computer Viruses, Computer Worms.</p> <p>1.3 Prevention of Cybercrime: Steps that can be followed to prevent cybercrime, Hackers, Crackers, Phreakers.</p> <p>Self-learning Topics: Steps performed by Hacker</p>	4	CO1
II	Introduction to Digital Forensics and Digital Evidences	<p>2.1 Introduction to Digital Forensics: Introduction to Digital Forensics and lifecycle, Principles of Digital Forensic.</p> <p>2.2 Introduction to Digital Evidences: Challenging Aspects of Digital Evidence, Scientific Evidence, Presenting Digital Evidence.</p> <p>2.3 Digital Investigation Process Models: Physical Model, Staircase Model, Evidence Flow Model.</p> <p>Self-learning Topics: Digital Investigation Process Models comparison and its application, Rules of Digital Evidence.</p>	5	CO2

III	Computer Forensics	<p>3.1 OS File Systems Review: Windows Systems- FAT32 and NTFS, UNIX File Systems, MAC File Systems</p> <p>3.2 Windows OS Artifacts: Registry, Event Logs</p> <p>3.3 Memory Forensics : RAM Forensic Analysis, Creating a RAM Memory Image, Volatility framework, Extracting Information</p> <p>3.4 Computer Forensic Tools: Need of Computer Forensic Tools, Types of Computer Forensic Tools, Tasks performed by Computer Forensic Tools</p> <p>Self-learning Topics: Study of ‘The Sleuth Kit’ Autopsy tool for Digital Forensics</p>	7	CO3
IV	Incident Response Management, Live Data Collection and Forensic Duplication	<p>4.1 Incidence Response Methodology: Goals of Incident Response, Finding and Hiring IR Talent</p> <p>4.2 IR Process: Initial Response, Investigation, Remediation, Tracking of Significant Investigative Information.</p> <p>4.3 Live Data Collection: Live Data Collection on Microsoft Windows,</p> <p>4.4 Forensic Duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tools: Creating a Forensic evidence, Duplicate/Qualified Forensic Duplicate of a Hard Drive.</p> <p>Self-learning Topics: Live Data Collection on Unix-Based Systems</p>	10	CO4
V	Forensic Tools and Report Writing	<p>5.1 Forensic Image Acquisition in Linux : Acquire an Image with dd Tools, Acquire an Image with Forensic Formats, Preserve Digital Evidence with Cryptography, Image Acquisition over a Network, Acquire Removable Media</p> <p>5.2 Forensic Investigation Report Writing: Reporting Standards, Report Style and Formatting, Report Content</p>	10	CO5

		and Organization. Self-learning Topics: Case study on Report Writing		
VI	Network Forensics and Mobile Forensics	6.1 Network Forensics: Sources of Network-Based Evidence, Principles of Internetworking, Internet Protocol Suite, Evidence Acquisition, Analyzing Network Traffic: Packet Flow and Statistical Flow, Network Intrusion Detection and Analysis, Investigation of Routers, Investigation of Firewalls 6.2 Mobile Forensics: Mobile Phone Challenges, Mobile phone evidence extraction process, Android OS Architecture, Android File Systems basics, Types of Investigation, Procedure for Handling an Android Device, Imaging Android USB Mass Storage Devices. Self-learning Topic: Elcomsoft iOS Forensic Toolkit, Remo Recover tool for Android Data recovery	14	CO6

Text Books:

1. Digital Forensics by Dr. Dhananjay R. Kalbande Dr. Nilakshi Jain, Wiley Publications, First Edition, 2019.
2. Digital Evidence and Computer Crime by Eoghan Casey, Elsevier Academic Press, Third Edition, 2011.
3. Incident Response & Computer Forensics by Jason T. Luttgens, Matthew Pepe and Kevin Mandia, McGraw-Hill Education, Third Edition (2014).
4. Network Forensics : Tracking Hackers through Cyberspace by Sherri Davidoff and Jonathan Ham, Pearson Edu, 2012
5. Practical Mobile Forensic by Satish Bommisetty, Rohit Tamma, Heather Mahalik, PACKT publication, Open source publication, 2014 ISBN 978-1-78328-831-1
6. The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory by Michael Hale Ligh (Author), Andrew Case (Author), Jamie Levy (Author), Aaron Walters (Author), Publisher : Wiley; 1st edition (3 October 2014),

References:

1. Scene of the Cybercrime: Computer Forensics by Debra Littlejohn Shinder, Syngress Publication, First Edition, 2002.
2. Digital Forensics with Open Source Tools by Cory Altheide and Harlan Carvey, Syngress Publication, First Edition, 2011.
3. Practical Forensic Imaging Securing Digital Evidence with Linux Tools by Bruce Nikkel, NoStarch Press, San Francisco, (2016)
4. Android Forensics : Investigation, Analysis, and Mobile Security for Google Android by Andrew Hogg, Elsevier Publication, 2011

Online References:

Sr. No.	Website Name
1.	https://www.pearsonitcertification.com/articles/article.aspx?p=462199&seqNum=2
2.	https://flylib.com/books/en/3.394.1.51/1/
3.	https://www.sleuthkit.org/autopsy/
4.	http://md5deep.sourceforge.net/md5deep.html
5.	https://tools.kali.org/
6.	https://kalilinuxtutorials.com/
7.	https://accessdata.com/product-download/ftk-imager-version-4-3-0
8.	https://www.amazon.in/Art-Memory-Forensics-Detecting-Malware/dp/1118825098

Research Papers: Mobile Forensics/Guidelines on Cell Phone Forensics

1. Computer Forensics Resource Center: NIST Draft Special Publication 800-101 :
<https://csrc.nist.gov/publications/detail/sp/800-101/rev-1/final>
2. <https://cyberforensicator.com/category/white-papers>
3. <https://www.magnetforensics.com/resources/ios-11-parsing-whitepaper/>
4. Samarjeet Yadav , Satya Prakash , Neelam Dayal and Vrijendra Singh, "Forensics Analysis WhatsApp in Android Mobile Phone", Electronic copy available at: <https://ssrn.com/abstract=3576379>

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HCSC701	Security Information Management	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HCSC701	Security Information Management	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The course is aimed to focus on cybercrime and need to protect information.
2	Understand the types of attacks and how to tackle the amount of risk involved.
3	Discuss the role of industry standards and legal requirements with respect to compliance.
4	Distinguish between different types of access control models, techniques and policy.
5	Awareness about Business Continuity and Disaster Recovery.
6	Awareness about Incident Management and its life cycle.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the scope of policies and measures of information security to people.	L1,L2
2	Interpret various standards available for Information security.	L1,L2
3	Apply risk assessment methodology.	L3
4	Apply the role of access control to Identity management.	L3
5	Understand the concept of incident management, disaster recovery and business continuity.	L1,L2
6	Identify common issues in web application and server security.	L3

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Vulnerability Assessment for Operating Systems, Network (Wired and Wireless). Tools for conducting Reconnaissance.	2	--
I	Basics of Information Security	1.1 What is Information Security & Why do you need it? – 1.2 Basics Principles of Confidentiality, Integrity 1.3 Availability Concepts, Policies, procedures, Guidelines, Standards 1.4 Administrative Measures and Technical Measures, People, Process, Technology, IT ACT 2000, IT ACT 2008 Self-learning Topics: Impact of IT on organizations, Importance of IS to Society	6	CO1, CO2
II	Current Trends in Information Security	2.1 Cloud Computing: benefits and Issues related to information Security. 2.2 Standards available for InfoSec: Cobit, Cadbury, ISO 27001, OWASP, OSSTMM. 2.3 An Overview, Certifiable Standards: How, What, When, Who. Self-learning Topics: Cloud Threats, Impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.	8	CO2
III	Threat & Risk Management	3.1 Threat Modelling: Threat, Threat-Source, Vulnerability, Attacks. 3.2 Risk Assessment Frameworks: ISO 31010, NIST-SP-800-30, OCTAVE 3.3 Risk Assessment and Analysis: Risk Team Formation, Information and Asset Value, Identifying Threat and Vulnerability, Risk Assessment Methodologies 3.4 Quantification of Risk, Identification of Monitoring mechanism, Calculating Total Risk and Residual Risk. Self-learning Topics: Risk management trends today and tomorrow.	8	CO3
IV	Identity and Access Management	4.1 Concepts of Identification, Authentication, Authorization and Accountability. 4.2 Access Control Models: Discretionary, Mandatory, Role based and Rule-based. 4.3 Access Control Techniques: Constrained User, Access control Matrix, Content-dependent, Context – dependent 4.4 Access Control Methods: Administrative, Physical, Technical, Layering of Access control	10	CO4

		<p>4.5 Access Control Monitoring: IDS and IPS and anomaly detection.</p> <p>4.6 Accountability: Event-Monitoring and log reviews. Log Protection</p> <p>4.7 Threats to Access Control: Various Attacks on the Authentication systems.</p> <p>Self-learning Topics: challenges and solutions in identity and access management</p>		
V	Operational Security	<p>5.1 Concept of Availability, High Availability, Redundancy and Backup.</p> <p>5.2 Calculating Availability, Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR)</p> <p>5.3 Incident Management: Detection, Response, Mitigation, Reporting, Recovery and Remediation</p> <p>5.4 Disaster Recovery: Metric for Disaster Recovery, Recovery Time Objective (RTO), Recovery Point Objective (RPO), Work Recovery Time (WRT), Maximum Tolerable Downtime (MTD), Business Process Recovery, Facility Recovery (Hot site, Warm site, Cold site, Redundant site), Backup & Restoration</p> <p>Self-learning Topics: Challenges and Opportunities of Having an IT Disaster Recovery Plan</p>	10	CO5
VI	Web Application, Windows, and Linux security	<p>6.1 Types of Audits in Windows Environment</p> <p>6.2 Server Security, Active Directory (Group Policy), Anti-Virus, Mails, Malware</p> <p>6.3 Endpoint protection, Shadow Passwords, SUDO users, etc.</p> <p>6.4 Web Application Security: OWASP, Common Issues in Web Apps, what is XSS, SQL injection, CSRF, Password Vulnerabilities, SSL, CAPTCHA, Session Hijacking, Local and Remote File Inclusion, Audit Trails, Web Server Issues, etc.</p> <p>Self-learning Topics:, Network firewall protection, Choosing the Right Web Vulnerability Scanner</p>	8	CO6

Textbooks:

1. Shon Harris, Fernando Maymi, CISSP All-in-One Exam Guide, McGraw Hill Education, 7th Edition, 2016.
2. Andrei Miroshnikov, Introduction to Information Security - I, Wiley, 2018
3. Ron Lepofsky, The Manager's Guide to Web Application Security, Apress; 1st ed. edition, 2014

References:

1. Rich-Schiesser, IT Systems Management: Designing, Implementing and Managing World - Class Infrastructures, Prentice Hall; 2 edition, January 2010.
2. NPTEL Course: - Introduction to Information Security – I (URL: <https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-cs03/>)
3. Dr. David Lanter – ISACA COBIT – 2019 Framework - Introduction and Methodology
4. Pete Herzog, OSSTMM 3, ISECOM
5. NIST Special Publication 800-30, Guide for Conducting Risk Assessments, September 2012

Online References:

Sr. No.	Website Name
1.	https://www.ultimatewindowssecurity.com/securitylog/book/Default.aspx
2.	http://www.ala.org/acrl/resources/policies/chapter14
3.	https://advisera.com/27001academy/what-is-iso-27001/
4.	https://nvlpubs.nist.gov/nistpubs/legacy/sp/nistspecialpublication800-30r1.pdf
5.	http://www.diva-portal.org/smash/get/diva2:1117263/FULLTEXT01.pdf

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
HCSSBL601	Vulnerability Assessment Penetration Testing (VAPT) Lab	--	4	--	--	2	--	02

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HBCC501	Bit coin and Crypto currency	30	30	30	10	60	--	--	--	100

Course Code	Course Title	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
HCSSBL601	Vulnerability Assessment Penetration Testing (VAPT) Lab (SBL)	--	--	--	--	50	50	100

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To identify security vulnerabilities and weaknesses in the target applications.
2	To discover potential vulnerabilities which are present in the system in network using vulnerability assessment tools.
3	To identify threats by exploiting them using penetration test attempt by utilizing the vulnerabilities in a system
4	To recognize how security controls can be improved to prevent hackers gaining access controls to database.
5	To test and exploit systems using various tools and understands the impact in system logs.

6	To write a report with a full understanding of current security posture and what work is necessary to both fix the potential threat and to mitigate the same source of vulnerabilities in the future
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Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of lab, learner/student will be able to:		
1	Understand the structure where vulnerability assessment is to be performed.	L1,L2
2	Apply assessment tools to identify vulnerabilities present in the system in network.	L3
3	Evaluate attacks by executing penetration tests on the system or network.	L4
4	Analyse a secure environment by improving security controls and applying prevention mechanisms for unauthorised access to database.	L5
5	Create security by testing and exploit systems using various tools and remove the impact of hacking in system.	L6
6	Formation of documents as per applying the steps of vulnerabilities of assessment and penetration testing.	L3, L4, L5

Prerequisite: Computer Networks, Basic of Network Security.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. Intel PIV Processor 2. 4 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Windows or Linux Desktop OS 2. Security Software and tools	1. Internet Connection.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Network, Basics of Network Security, Ethical Hacking, Digital Forensics	2	
I	Human Security (Social Engineering)	Visibility Audit: Collecting information through social media and internet. Collecting contact details (like phone number, email ID, What's App ID, etc)	8	LO1

	Assessment	<p>Active Detection Verification: Test if the phone number, email id etc are real by test message. Test whether the information is filtered at point of reception. Test if operator / another person assistance can be obtained.</p> <p>Device Information: IP Address, Port details, Accessibility, Permissions, Role in business</p> <p>Trust Verification: Test whether the information can be planted in form of note / email / Message (Phishing)</p> <p>Test Subjects: College Staff, Reception, PA to Director / Principal.</p> <p>To conduct information gathering to conduct social engineering audit on various sections in your college.</p> <p>Self-Learning Topics: Networking Commands</p>		
II	Network & Wireless Security Assessment	<p>Network Discovery: Using various tools to discover the various connected devices, to get device name, IP Address, relation of the device in network, Detection of Active port, OS Fingerprinting, Network port and active service discovery</p> <p>Tools: IP Scanner, Nmap etc</p> <p>Network Packet Sniffing: Packet Sniffing to detect the traffic pattern, Packet capturing to detect protocol specific traffic pattern, Packet capturing to reassemble packet to reveal unencrypted password</p> <p>Tools: Wireshark</p> <p>Self-Learning Topics: Learning the CVE database for vulnerabilities detected.</p>	8	LO2
III	Setting up Pentester lab	<p>Including an attacker machine preferably Kali and in the same subnet victim machines either DVWA/ SEEDlabs/ multiple VULNHUB machines as and when required. Understanding Categories of pentest and legalities/ ethics.</p> <p>Installed Kali machine on VM environment with some VULNHUB machines and we can find out vulnerability of Level 1-VULNHUB machine like deleted system files, permissions of files.</p> <p>Self learning Topics: Vulnerability exploitation for acquire root access of the Kioptrix machine</p>	9	LO3
IV	Database and Access Control Security Assessment	<p>Database Password Audit: Tool based audit has to be performed for strength of password and hashes.</p> <p>Tools: DBPw Audit</p> <p>Blind SQL Injection: Test the security of the Database for SQL Injection</p> <p>Tools: BSQL Hacker</p> <p>Password Audit: Perform the password audit on the Linux / Windows based system</p> <p>Tools: Cain & Able, John the ripper, LCP Password Auditing tools for Windows.</p> <p>Active Directory and Privileges Audit: Conduct a review of the Active Directory and the Group Policy to assess the level of access privileges allocated.</p> <p>Tools: SolarWinds</p> <p>Self-Learning Topics: Federated Database security</p>	9	LO4

		challenges and solutions.		
V	Log Analysis	<p>Conduct a log analysis on Server Event Log / Firewall Logs / Server Security Log to review and obtain insights</p> <p>Tools: graylog, Open Audit Module.</p> <p>Self-Learning Topics: Python and R-Programming scripts</p>	6	LO5
VI	Compliance and Observation Reporting	<p>License Inventory Compliance:</p> <p>Identify the number of licenses and its deployment in your organization.</p> <p>Tools: Belarc Advisor, Open Audit Report</p> <p>Writing: NESSUS tool</p> <p>Report should contain:</p> <ol style="list-style-type: none"> Vulnerability discovered The date of discovery Common Vulnerabilities and Exposure (CVE) database reference and score; those vulnerabilities found with a medium or high CVE score should be addressed immediately A list of systems and devices found vulnerable Detailed steps to correct the vulnerability, which can include patching and/or reconfiguration of operating systems or applications Mitigation steps (like putting automatic OS updates in place) to keep the same type of issue from happening again <p>Purpose of Reporting: Reporting provides an organization with a full understanding of their current security posture and what work is necessary to both fix the potential threat and to mitigate the same source of vulnerabilities in the future.</p> <p>Self-Learning Topics: Study of OpenVAS, Nikto, etc.</p>	10	LO6

Text & Reference Books and Links:

1. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws Paperback – Illustrated, 7 October 2011 by Dafydd Stuttard
2. Hacking: The Art of Exploitation, 2nd Edition 2nd Edition by Jon Erickson
3. Important links of Vulnhub: Vulnhub Kioptrix

Download Link: <https://www.vulnhub.com/entry/basic-pentesting-1,216/>

<https://www.vulnhub.com/entry/kioptrix-level-1-1,22/>

Installation Video: <https://youtu.be/JupQRHtfZmw>

Walkthrough/solutions Video: <https://youtu.be/Qn2cKYZ6kBI>

4. OWASP Broken Web Application Projects

<https://sourceforge.net/projects/owaspbwa/>

5. Mastering Modern Web Penetration Testing By Prakhar Prasad, October 2016, Packt Publishing.
6. Kali Linux Revealed: Mastering the Penetration Testing Distribution – June 5, 2017 by Raphael Hertzog (Author), Jim O'Gorman (Author), Offsec Press Publisher

Term Work:

The Term work shall consist of at least 10 to 12 practical based on the above syllabus. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above syllabus.

Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HCSC801	Application Security	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HCSC801	Application Security	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The terms and concepts of application Security, Threats, and Attacks
2	The countermeasures for the threats wrt Application security.
3	The Secure Coding Practices
4	The Secure Application Design and Architecture
5	The different Security Scanning and testing techniques
6	The threat modeling approaches

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Enumerate the terms of application Security, Threats, and Attacks	L1
2	Describe the countermeasures for the threats with respect to Application security.	L1
3	Discuss the Secure Coding Practices.	L2
4	Explain the Secure Application Design and Architecture.	L2
5	Review the different Security Scanning and testing techniques.	L2
6	Discuss the threat modeling approaches.	L2

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Operating System, DBMS, Computer Network, Web Programming, OOP	02	-
I	Introduction to Application Security, Threats, and Attacks	<p>Introduction to Web Application Reconnaissance, Finding Subdomains, API Analysis, Identifying Weak Points in Application Architecture</p> <p>Offense: Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), XML External Entity (XXE) Injection, Injection Attacks, Denial of Service (DoS), Cross-Origin Resource Sharing Vulnerabilities</p> <p>Self-learning Topics: Simulate the attacks using open-source tools in virtual environment</p>	05	CO1
II	Defence and tools	<p>Securing Modern Web Applications, Secure Application Architecture, Reviewing Code for Security, Vulnerability Discovery, Defending Against XSS Attacks, Defending Against CSRF Attacks, Defending Against XXE, Defending Against Injection attacks, Defending Against DoS, Defending against CORS based attacks</p> <p>Self-learning Topics: Implement the countermeasures to the attacks using open-source tools</p>	09	CO2
III	Secure Coding Practices	Security Requirements, Encryption, Never Trust System Input, Encoding and Escaping, Third-Party Components, Security Headers: Seatbelts for Web Apps, Securing Your Cookies, Passwords, Storage, and Other Important Decisions, HTTPS Everywhere, Framework Security Features, File Uploads, Errors and Logging, Input Validation and Sanitization, Authorization and Authentication, Parameterized Queries, Least	09	CO3

		Privilege, Requirements Checklist Self-learning Topics: OWASP Secure Coding Practices		
IV	Secure Application Design and Architecture	Secure Software Development Lifecycle Averting Disaster Before It Starts, Team Roles for Security, Security in the Software Development Lifecycle, Design Flaw vs. Security Bug, Secure Design Concepts, Segregation of Production Data, Application Security Activities Self-learning Topics: Secure Hardware architecture	09	CO4
V	Security Scanning and testing	Testing Your Code, Testing Your Application, Testing Your Infrastructure, Testing Your Database, Testing Your APIs and Web Services, Testing Your Integrations, Testing Your Network, Dynamic Web Application Profiling Self-learning Topics: Open-source Application Security Tools, IAST, RASP and WAF, Selenium	09	CO5
VI	Threat Modeling	Objectives and Benefits of Threat Modeling, Defining a Risk Mitigation Strategy, Improving Application Security, Building Security in the Software Development Life Cycle Existing Threat Modeling Approaches Security, Software, Risk-Based Variants Threat Modeling Within the SDLC Building Security in SDLC with Threat Modeling, Integrating Threat Modeling Within the Different Types of SDLCs,	09	CO6

		Self-learning Topics: The Common Vulnerability Scoring System (CVSS)		
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Text Books:

1. Alice and Bob Learn Application Security, by Tanya Janca Wiley; 1st edition (4 December 2020)
2. Web Application Security, A Beginner's Guide by Bryan Sullivan McGraw-Hill Education; 1st edition (16 January 2012)
3. Web Application Security: Exploitation and Countermeasures for Modern Web Applications by Andrew Hoffman Shroff/O'Reilly; First edition (11 March 2020)
4. The Security Development Lifecycle by Michael Howard Microsoft Press US; 1st edition (31 May 2006)
5. Risk Centric Threat Modeling Process for Attack Simulation And Threat Analysis, Tony Ucedavélez and Marco m. Morana, Wiley
6. Iron-Clad Java: Building Secure Web Applications (Oracle Press) 1st Edition by Jim Manico

References:

1. Software Security: Building Security In by Gary McGraw Addison-Wesley Professional; 1st edition (January 23, 2006)
2. A Guide to Securing Modern Web Applications by Michal Zalewski
3. Threat Modeling: A Practical Guide for Development Teams by Izar Tarandach and Matthew J. Coles Dec 8, 2020

Online References:

Sr. No.	Website Name
1.	https://owasp.org/www-project-top-ten/
2.	https://owasp.org/www-pdf-archive/OWASP_SCP_Quick_Reference_Guide_v2.pdf
3.	https://pentesterlab.com/
4.	https://app.cybrary.it/browse/course/advanced-penetration-testing
5.	https://www.udemy.com/
6.	https://www.coursera.org/

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program

(Prepared based on the Guidelines for AICTE and University of Mumbai)

in

Data Science

(With effect from AY 2022-2023)

(With effect from 2022-23)

BE Se m VII	HDSC701 : Data Science for Health and Social Care	04	--	30	30	30	1 0	6 0	--	--	10 0	04
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	HDSC701 : Data Science for Health and Social Care Lab	--	04				--	--	50	50	100	02
	Total	04	04				100	50	50	200	06	
Total Credits = 06												
BE Sem VII I	HDSC801 : Text, Web and Social Media Analytics	04	-	30	30	30	10	60	--	--	100	04
	Total	04	-	-		100			-	-	100	04
Total Credits = 04												
		Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04 = 18										

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC501	Mathematics for Data Science	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HDSC501	Mathematics for Data Science	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
1	Applied Mathematics, Discrete Mathematics
Course Objectives:	
1	To build an intuitive understanding of Mathematics and relating it to Data Analytics.
2	To provide a strong foundation for probabilistic and statistical analysis mostly used in varied applications in Engineering.
3	To focus on exploring the data with the help of graphical representation and drawing conclusions.
4	To explore optimization and dimensionality reduction techniques.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Use linear algebra concepts to model, solve, and analyze real-world problems.
2	Apply probability distributions and sampling distributions to various business problems.
3	Select an appropriate graph representation for the given data analysis.
4	Apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization
5	Analyze various optimization techniques for data analysis.
6	Describe Dimension Reduction Algorithms in analytics

Module No.		Topics	Hrs.
1.0		Linear Algebra	05
	1.1	Vectors and Matrices, Solving Linear equations, The four Fundamental Subspaces, Eigenvalues and Eigen Vectors, The Singular Value Decomposition (SVD).	
2.0		Probability and Statistics	09
	2.1	Introduction, Random Variables and their probability Distribution, Random Sampling, Sample Characteristics and their Distributions, Chi-Square, t-, and F-Distributions: Exact Sampling Distributions, Sampling from a Bivariate Normal Distribution, The Central Limit Theorem.	

3.0		Introduction to Graphs	10
	3.1	Quantitative vs. Qualitative data, Types of Quantitative data: Continuous data, Discrete data, Types of Qualitative data: Categorical data, Binary data, Ordinary data, Plotting data using Bar graph, Pie chart, Histogram, Stem and Leaf plot, Dot plot, Scatter plot, Time-series graph, Exponential graph, Logarithmic graph, Trigonometric graph, Frequency distribution graph.	
4.0		Exploratory Data Analysis	09
	4.1	Need of exploratory data analysis, cleaning and preparing data, Feature engineering, Missing values, understand dataset through various plots and graphs, draw conclusions, deciding appropriate machine learning models.	
5.0		Optimization Techniques	10
	5.1	Types of optimization-Constrained and Unconstrained optimization, Methods of Optimization-Numerical Optimization, Bracketing Methods-Bisection Method, False Position Method, Newton's Method, Steepest Descent Method, Penalty Function Method.	
6.0		Dimension Reduction Algorithms	05
	6.1	Introduction to Dimension Reduction Algorithms, Linear Dimensionality Reduction: Principal component analysis, Factor Analysis, Linear discriminant analysis.	
	6.2	Non-Linear Dimensionality Reduction: Multidimensional Scaling, Isometric Feature Mapping. Minimal polynomial	
		Total	48

Text Books:	
1	Linear Algebra for Everyone,
2	Gilbert Strang, Wellesley Cambridge Press.
3	An Introduction to Probability and Statistics, Vijay Rohatgi, Wiley Publication
4	An introduction to Optimization, Second Edition, Wiley-Edwin Chong, Stanislaw Zak.
5	Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press.
6	Exploratory Data Analysis, John Tukey, Princeton University and Bell Laboratories.
References:	
1	Introduction to Linear Algebra, Gilbert Strang.
2	Advanced Engineering Mathematics, Erwin Kreyszig
3	Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. Foundations of Machine Learning. MIT Press, 2018.
4	Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014
5	Last updated on Sep 9, 2018.
6	Mathematics and Programming for Machine Learning with R, William B. Claster, CRC Press, 2020
Useful Links:	
1	https://math.mit.edu/~gs/linearalgebra/
2	https://www.coursera.org/learn/probability-theory-statistics
3	https://nptel.ac.in/courses/111/105/111105090/
4	https://onlinecourses.nptel.ac.in/noc21_ma01/preview
5	https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/
Assessment:	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC601	Statistical Learning for Data Science	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HDSC601	Statistical Learning for Data Science	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
1	Engineering Mathematics, Probability and Statistics
Course Objectives:	
1	To understand basic statistical foundations for roles of Data Scientist.
2	To develop problem-solving skills.
3	To infer about the population parameters using sample data and perform hypothesis testing.
4	To understand importance and techniques of predicting a relationship between data and determine the goodness of model fit.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Develop various visualizations of the data in hand.
2	Analyze a real-world problem and solve it with the knowledge gained from sampling and probability distributions.
3	Analyze large data sets and perform data analysis to extract meaningful insights.
4	Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
5	Fit a regression model to data and use it for prediction.

Module No.		Topics	Hrs.
1.0		Introduction	08
	1.1	Data and Statistics: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Cross-Sectional and Time Series Data, Descriptive Statistics, Statistical Inference, Descriptive Statistics: Tabular and Graphical Summarizing Categorical Data, Summarizing Quantitative Data, Cross Tabulations and Scatter Diagram.	

	1.2	Descriptive Statistics: Numerical Measures: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and Detecting Outliers, Box Plot, Measures of Association Between Two Variables	
2.0		Probability	08
	2.1	Probability : Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Baye's theorem	
	2.2	Discrete Probability Distributions Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution, Poisson Probability Distribution	
	2.3	Continuous Probability Distributions: Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution, Computing Probabilities for Any Normal Probability Distribution	
3.0		Sampling and Sampling Distributions	05
	3.1	Sampling from a Finite Population, Sampling from an Infinite Population, Other Sampling Methods, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling	
	3.2	Interval Estimation: Population Mean: Known, Population Mean: Unknown, Determining the Sample Size, Population Proportion	
4.0		Hypothesis Tests	05
	4.1	Developing Null and Alternative Hypotheses, Type I and Type II Errors, Population Mean: Known Population Mean: Unknown Inference About Means and Proportions with Two Populations-Inferences About Population Variances, Inferences About a Population Variance, Inferences About Two Population Variances	
	4.2	Tests of Goodness of Fit and Independence, Goodness of Fit Test: A Multinomial Population, Test of Independence	
5.0		Regression	08
	5.1	Simple Linear Regression: Simple Linear Regression Model, Regression Model and Regression Equation, Estimated Regression Equation, Least Squares Method, Coefficient of Determination, Correlation Coefficient, Model Assumptions, testing for Significance, Using the Estimated Regression Equation for Estimation and Prediction Residual Analysis: Validating Model Assumptions, Residual Analysis: Outliers and Influential Observations	
	5.2	Multiple Regression: Multiple Regression Model, Least Squares Method, Multiple Coefficient of Determination, Model Assumptions, Testing for Significance, Categorical Independent Variables, Residual Analysis	
6.0		Time Series Analysis and Forecasting	05
	6.1	Time Series Patterns, Forecast Accuracy, Moving Averages and Exponential Smoothing, Trend Projection, Seasonality and Trend and Time Series Decomposition	
	6.2	Nonparametric Methods Sign Test, Wilcoxon Signed-Rank Test, Mann-Whitney-Wilcoxon Test, Kruskal-Wallis Test, Rank Correlation	
		Total	48

Text Books:	
1	https://static1.squarespace.com/static/5ff2adbe3fe4fe33db902812/t/6009dd9fa7bc363aa822d2c7/1611259312432/ISLR+Seventh+Printing.pdf
2	Data Science from Scratch, FIRST PRINCIPLES WITH PYTHON, O'Reilly, Joel Grus,
3	Data Science from Scratch (oreillystatic.com)
4	Practical Time Series Analysis, Prediction with statistics and Machine Learning, O'Reilly, Aileen Nielsen [DOWNLOAD] O'Reilly Practical Time Series Analysis PDF (lunaticai.com)
5	R for data science: Import, Tidy, Transform, Visualize, And Model Data, O'Reilly , Garrett

	Grolemund, Hadley Wickham	
6	Python for Data Analysis, 2nd Edition, O'Reilly Media, Wes McKinney.	
7	https://static1.squarespace.com/static/5ff2adbe3fe4fe33db902812/t/6009dd9fa7bc363aa822d2c7/1611259312432/ISLR+Seventh+Printing.pdf	
References:		
1	Data Science for Dummies Paperback, Wiley Publications, Lillian Pierson	
2	Storytelling with Data: A Data Visualization, Guide for Business Professionals, Wiley Publications, Cole Nussbaumer Knaflie	
3	Probability and Statistics for Engineering and the Sciences, Cengage Publications Jay L. Devore.	
Assessment:		
Continuous Assessment (CA): The distribution of Continuous Assessment marks will be as follows –		
1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks
Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.		
Internal Assessment(IA) (10 marks): Marks will be allotted as per designed rubrics.		
End Semester Theory Examination will be of 60-Marks with Three hour duration.		

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC701	Data Science for Health and Social Care	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme								
		Theory Marks						Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam					
		Test 1	Test 2	Avg. of 2 Tests							
HDSC701	Data Science for Health and Social Care	30	30	30	10	60	--	--	--	100	

Course Prerequisites:	
Artificial Intelligence, Machine Learning	
Course Objectives: The course aims	
1	To gain perspective of Data Science for Health and Social Care.
2	To understand different techniques of Biomedical Image Analysis.
3	To learn NLP techniques for processing Clinical text.
4	To understand the role of social media analytics for Healthcare data .
5	To learn advanced analytics techniques for Healthcare Data.
6	To investigate the current scope, potential, limitations, and implications of data science and its applications for healthcare.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Identify sources and structure of healthcare data.
2	Apply structured lifecycle approach for handling Healthcare data science projects.
3	Analyze the data, create models, and identify insights from Healthcare data.
4	Apply various data analysis and visualization techniques for Healthcare and social media data.
5	Apply various algorithms and develop models for Healthcare data science projects.
6	To Provide data science solutions for solving problems of Health and Social Care.

Module No.		Topics	Hrs.
1.0		Data Science for Healthcare	05
	1.1	Introduction, Healthcare Data Sources and Data Analytics for Healthcare, Applications and Practical Systems for Healthcare.	

	1.2	Electronic Health Records(EHR), Components of EHR, Benefits of EHR, Barriers to Adopting EHR, Challenges of using EHR data, Phenotyping Algorithms	
2.0		Biomedical Image Analysis	06
	2.1	Biomedical Imaging Modalities, Object detection ,Image segmentation, Image Registration, Feature Extraction	
	2.2	Mining of Sensor data in Healthcare, Challenges in Healthcare Data Analysis	
	2.3	Biomedical Signal Analysis, Genomic Data Analysis for Personalized Medicine.	
3.0		Data Science and Natural Language Processing for Clinical Text	06
	3.1	NLP, Mining information from Clinical Text, Information Extraction, Rule Based Approaches, Pattern based algorithms, Machine Learning Algorithms.	
	3.2	Clinical Text Corpora and evaluation metrics, challenges in processing clinical reports, Clinical Applications.	
4.0		Social Media Analytics for Healthcare	06
	4.1	Social Media analysis for detection and tracking of Infectious Disease outbreaks.	
	4.2	Outbreak detection, Social Media Analysis for Public Health Research, Analysis of Social Media Use in Healthcare.	
5.0		Advanced Data Analytics for Healthcare	08
	5.1	Review of Clinical Prediction Models, Temporal Data Mining for Healthcare Data	
	5.2	Visual Analytics for Healthcare Data, Information Retrieval for Healthcare- Data Publishing Methods in Healthcare.	
6.0		Data Science Practical Systems for Healthcare	08
	6.1	Data Analytics for Pervasive Health, Fraud Detection in Healthcare	
	6.2	Data Analytics for Pharmaceutical discoveries, Clinical Decision Support Systems	
	6.3	Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.	
		Total	48

Textbooks:	
1	Chandan K. Reddy and Charu C Aggarwal, “Healthcare data analytics”, Taylor & Francis, 2015.
2	Hui Yang and Eva K. Lee, “Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.
References:	
1	Madsen, L. B. (2015). Data-driven healthcare: how analytics and BI are transforming the industry. Wiley India Private Limited
2	Strome, T. L., & Liefer, A. (2013). Healthcare analytics for quality and performance improvement. Hoboken, NJ, USA: Wiley
3	McNeill, D., & Davenport, T. H. (2013). Analytics in Healthcare and the Life Sciences: Strategies, Implementation Methods, and Best Practices. Pearson Education.
4	Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
5	Joel Grus, Data Science from Scratch: First Principles with Python, O’Reilly Media
6	EMC Education Services,”Data Science and Big Data Analytics”,Wiley
Assessment:	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC801	Text, Web and Social Media Analytics	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HDSC801	Text, Web and Social Media Analytics	30	30	30	10	60	--	--	--	100

Course Prerequisites:	
Python, Data Mining	
Course Objectives: The course aims	
1	To have a strong foundation on text, web and social media analytics.
2	To understand the complexities of extracting the text from different data sources and analysing it.
3	To enable students to solve complex real-world problems using sentiment analysis and Recommendation systems.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Extract Information from the text and perform data pre-processing
2	Apply clustering and classification algorithms on textual data and perform prediction.
3	Apply various web mining techniques to perform mining, searching and spamming of web data.
4	Provide solutions to the emerging problems with social media using behaviour analytics and Recommendation systems.
5	Apply machine learning techniques to perform Sentiment Analysis on data from social media.

Module No.		Topics	Hrs.
1.0		Introduction	06
	1.1	Introduction to Text Mining: Introduction, Algorithms for Text Mining, Future Directions	
	1.2	Information Extraction from Text: Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction	
	1.3	Text Representation: tokenization, stemming, stop words, NER, N-gram modelling	
2.0		Clustering and Classification	10
	2.1	Text Clustering: Feature Selection and Transformation Methods, distance based Clustering Algorithms, Word and Phrase based Clustering, Probabilistic document Clustering	
	2.2	Text Classification: Feature Selection, Decision tree Classifiers, Rule-based Classifiers,	

		Probabilistic based Classifiers, Proximity based Classifiers.	
	2.3	Text Modelling: Bayesian Networks, Hidden Markovian Models, Markov random Fields, Conditional Random Fields	
3.0		Web-Mining:	05
	3.1	Introduction to Web-Mining: Inverted indices and Compression, Latent Semantic Indexing, Web Search,	
	3.2	Meta Search: Using Similarity Scores, Rank Positons	
	3.3	Web Spamming: Content Spamming, Link Spamming, hiding Techniques, and Combating Spam	
4.0		Web Usage Mining:	05
	4.1	Data Collection and Pre-processing, Sources and types of Data, Data Modelling, Session and Visitor Analysis, Cluster Analysis and Visitor segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigational Patterns, Classification and Prediction based on Web User Transactions.	
5.0		Social Media Mining:	05
	5.1	Introduction, Challenges, Types of social Network Graphs	
	5.2	Mining Social Media: Influence and Homophily, Behaviour Analytics, Recommendation in Social Media: Challenges, Classical recommendation Algorithms, Recommendation using Social Context, Evaluating recommendations.	
6.0		Opinion Mining and Sentiment Analysis:	08
	6.1	The problem of opinion mining,	
	6.2	Document Sentiment Classification: Supervised, Unsupervised	
	6.3	Opinion Lexicon Expansion: Dictionary based, Corpus based	
	6.4	Opinion Spam Detection: Supervised Learning, Abnormal Behaviours, Group Spam Detection.	
		Total	48

Textbooks:

1	Daniel Jurafsky and James H. Martin, "Speech and Language Processing," 3rd edition, 2020
2	Charu. C. Aggarwal, Cheng Xiang Zhai, Mining Text Data, Springer Science and Business Media, 2012.
3	BingLiu, "Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data", Springer, Second Edition, 2011.
4	Reza Zafarani, Mohammad Ali Abbasiand Huan Liu, "Social Media Mining- An Introduction", Cambridge University Press, 2014

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSSBL701	Data Science for Health and Social Care: Lab	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HXXSBL701	Data Science for Health and Social Care: Lab						50	50	100

Course Prerequisites:	
Python	
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Students will be able to, Identify sources of data, suggest methods for collecting, sharing and analyzing Healthcare data.
2	Students will be able to Clean, integrate and transform healthcare data.
3	Students will be able to apply various data analysis and visualization techniques on healthcare data.
4	Students will be able to apply various algorithms and develop models for healthcare data Analytics .
5	Students will be able to implement data science solutions for solving healthcare problems.

Suggested Experiments:	
Sr. No.	Name of the Experiment
	Introduction
1	Clean, Integrate and Transform Electronic Healthcare Records.
2	Apply various data analysis and visualization techniques on EHR.
3	Bio Medical Image Preprocessing, Segmentation.
4	Bio Medical Image Analytics.
5	Text Analytics for Clinical Text Data.
6	Diagnose disease risk from Patient data.
7	Social Media Analytics for outbreak prediction/ Drug review analytics.

8	Visual Analytics for Healthcare Data.
9	Implement an innovative Data Science application based on Healthcare Data.
10	Documentation and Presentation of Mini Project.

Useful Links:	
1	http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=MachineLearning
2	http://www.cse.wustl.edu/~kilian/cse517a2010/
3	https://datarade.ai/data-categories/electronic-health-record-ehr-data
4	https://www.cms.gov/Medicare/E-Health/EHealthRecords
5	https://onlinecourses.nptel.ac.in/noc20_ee40
Term Work:	
1	Term work should consist of 8 experiments and a Mini Project.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 10-Marks, Mini Project-10 Marks, Attendance Theory & Practical: 05-marks)
Oral & Practical exam	
1	Based on the entire syllabus of Data Science for Health and Socialcare



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program

(Prepared based on the Guidelines for AICTE and University of Mumbai)

in

Augmented and Virtual Reality

(With effect from AY 2022-2023)

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute affiliated to University of Mumbai
Accredited by NAAC and NBA, Approved by AICTE,
New Delhi

Bachelor of Technology in IT/CE/ET/AI&DS Engineering
(With effect from 2022-23)

Honours* in Augmented and Virtual Reality

										Total
Credits = 04										

			Total
Credits = 04			

			Total Credits = 06

		Total Credits = 04
		Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04 = 18

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HVARC501	Virtual Reality	04	--	--	04	--	--	04

Course Code	Course Title	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HVARC501	Virtual Reality	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand primitives of computer graphics fundamental.
2	To analyze various Hardware devices suitable for VR.
3	To analyze visual physiology and issues related to it.
4	To apply the knowledge of Visual rendering.
5	To evaluate problems faced due to audio scattering in VR.
6	To create different interface in VR environment.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Solve Computer Graphics Problems.	L1
2	Analyze application of VR hardware and software components.	L1, L2, L3
3	Identify issues related to visual physiology.	L1, L2
4	Integrate various shading and rendering techniques.	L6
5	Solve problems due to Audio distortions.	L5
6	Create User Interface for VR.	L6

Prerequisite:

Basic C programming

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Functioning of human sensory organs – EYE, Ear, Touch etc. Light and Lenses Basic functioning of camera Matrix multiplication	02	--
I	Geometry of Virtual World	Geometric Modeling, 2D transformations, Homogenous coordinate system, 3D rotation and 6 degree of freedom, Viewport Transformation Self: Eye Transformation, demo of 2D transformation	10	CO1
II	Introduction to VR	Introduction to VR and definitions and its components., Hardware components: Display devices: LCD, OLED Audio: Speakers, Earphones, Bone conduction Touch: Haptic Device GPU and CPU, Input devices like game controller, data gloves, Joysticks Tracking Hardware: Industrial measurement Unit-IMU, Gyroscope, accelerometer Software component: Java3D, VRML Self: Feedback mechanisms in VR environment	07	CO2
III	Visual Physiology, perception and tracking	Functioning of Eye with photoreceptors, Resolution for VR, Eye movements and issues with it in VR, Neuroscience of vision, Depth and motion perception, Frame rates and display, Orientation tracking, tilt and yaw drift correction, Tracking with camera Self: Light House approach	08	CO3

IV	Visual Rendering	Overview, shading models, rendering pipelines, rasterization, pixel shading, Distortion shading, post rendering image wrap Self: Rendering for VR application	09	CO4
V	Audio	Physics of Audio, Auditory Perception, localization, rendering, Problems due to scattering of audio Self: Study reaction of audio and other senses for VR environment	10	CO5
VI	Interfaces	Locomotion, Manipulation, system control, social interaction using open-source tool like Gopro VR etc. Self: Explore tools for UI in VR	06	CO6

Text Books:

1. Hearn and Baker, "Computer Graphics- C version", 2nd edition, Pearson, 2002.
2. R. K Maurya, "Computer Graphics with Virtual Reality", 3rd Edition, Wiley India, 2018.
3. Steven M. LaVelle, "Virtual Reality", Cambridge University press, 2019
4. Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley India, 2003
5. Vince, "Virtual Reality Systems", 1st Edition, Pearson Education, 2002

References:

1. George Mather, "Foundations of Sensation and Perception", Psychology Press book; 3rd Edition, 2016
2. Tony Parisi, "Learning Virtual Reality", 1st edition, O'Reilly, 2015
3. Alan Craig and William Sherman, "Understanding virtual reality: Interface, application and design", 2nd Edition, Morgan Kaufmann Publisher, 2019
4. Peter Shirley, Michael Ashikhmin, and Steve Marschner, "Fundamentals of Computer Graphics", A K Peters/CRC Press; 4th Edition, 2016.

Online Resources:

Sr. No.	Website Name
5.	https://nptel.ac.in/courses/121/106/121106013/#
6.	http://msl.cs.uiuc.edu/vr/
3.	http://lavalle.pl/vr/

Assessment:**Continuous Assessment (CA):**

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks)

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HVARC601	AR and Mix Reality	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HVARC601	AR and Mix Reality	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the concepts of Augmented Reality and related technologies.
2	To understand the AR tracking system and use of computer vision in AR/MR.
3	To describe the technology for multimodal user interaction and authoring in AR.
4	To use different AR toolkits and apply them to develop AR applications.
5	To demonstrate AR Applications using Mobile AR Toolkits and SDKs.
6	To understand the use of AR/MR in interdisciplinary immersive applications.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and compare different Augmented Reality and Mixed Reality Technologies.	L1, L2
2	Apply concepts of Computer Vision for tracking in AR and MR Systems.	L3
3	Model different interfaces and authoring in AR/MR.	L3
4	Design AR/MR applications using open source platforms and toolkits.	L6
5	Design Mobile based AR Applications.	L6
6	Apply insights of AR/MR in different applications.	L3

Prerequisite: Programming Language, Computer Graphics, Virtual Reality

DETAILED SYLLABUS:

Module	Title	Description	Hours	CO
0	Pre-requisite	Basics of Computer Graphics, Coordinate Systems, VR Introduction, Tracking in VR	02	--
I	Introduction to Augmented Reality and Mixed Reality	<p>Definition and Scope, A Brief History of Augmented Reality, AR Architecture, Related Fields of AR (like Mixed Reality, Virtual Reality, Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality</p> <p>Self-Learning Topics: How AR/MR are related to Ubiquitous Computing, Multidimensional Systems.</p>	06	CO1
II	Tracking and Computer Vision for AR and MR	<p>Multimodal Displays; Visual Perception; Spatial Display Model; Visual Displays; Tracking, Calibration and Registration; Coordinate Systems; Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking; Multiple Camera Infrared Tracking; Natural Feature Tracking by Detection; Incremental Tracking; Simultaneous Localization and Tracking; Outdoor Tracking</p> <p>Self-Learning Topics: Indoor Tracking, Full Body Tracking</p>	07	CO2
III	Interaction, Modeling and Annotation and Authoring	<p>Output Modalities, Input Modalities, Tangible Interfaces, Virtual User Interfaces on Real Surfaces, Multi-view Interfaces, Haptic Interaction, Multimodal Interaction, Specifying Geometry, Specifying Appearance, Semi-automatic Reconstruction, Free-form Modeling, Annotation, Requirement of AR Authoring, Elements of Authoring, Stand-alone Authoring Solutions, Plug-in Approaches, Web Technology</p> <p>Self-Learning Topics: Case Study on Object Annotation in Real Time, Avatar Modeling.</p>	08	CO3

IV	Software Architecture in AR and AR Development Toolkits	AR Application Requirements, Software Engineering Requirements, Distributed Object Systems, Data Flow, Scene Graphs; Developer Support: Parameter Configuration, Declarative Scripting, Procedural Scripting, Mixed Language Programming, Runtime Reconfiguration, Choosing an AR Platforms and Toolkits; AR Non-programming Frameworks, AR Programming Frameworks, Programming AR using ARToolkit. Self-Learning Topics: Commercial AR Frameworks, AR Related Markup Languages	10	CO4
V	Mobile AR	Types of Mobile Apps, AR Browsers for Smartphones, Point of Interests (POI) in Mobile AR, POI Authoring and Publishing Tools, AR Applications for Android, AR Games for Android, Mobile AR Toolkits and SDKs, Developing Mobile AR Applications, AR Application Development for Android Smartphone Self-Learning Topics: AR Applications for iOS, AR Games for iOS, AR Application Development for iOS Smartphone	10	CO5
VI	Applications of AR/MR and Human Factors, Legal and Social Considerations	Applications of AR/MR in: Edutainment, Medical, Military, Production and Manufacturing, Navigation, Astronomical Observation, E-commerce; What are Human Factors, Physical Side Effects, Visual Side Effects, Legal Considerations, Moral and Ethical Considerations. Self-Learning Topics: Applications of AR/MR in Civil Construction and Architecture, Collaboration, Information Control and Big Data Visualization	07	CO6

Textbooks:

1. Dieter Schmalsteig and Tobias Hollerer, “Augmented Reality- Principles and Practice”, Pearson Education, Inc. 2016 Edition.
2. Chetankumar G Shetty, “Augmented Reality- Theory, Design and Development”, Mc Graw Hill, 2020 Edition.

3. Alan B. Craig, “Understanding Augmented Reality – Concepts and Applications”, Morgan Kaufmann, Elsevier, 2013 Edition.

References:

1. Borko Furht, “Handbook of Augmented Reality”, Springer, 2011 Edition.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, “Creating Augmented and Virtual Realities- Theory and Practice for Next-Generation Spatial Computing”, O’Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, “Augmented Reality for Android Application Development”, PACKT Publishing, 2013 Edition.

Online Resources:

Sr. No.	Website Name
1.	www.nptel.ac.in
2.	www.coursera.org

Assessment:**Continuous Assessment (CA):**

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks)

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HVARC701	ARVR Application-I	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HVARC701	ARVR Application-I	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the underlying concepts of Virtual Reality, Augmented Reality and related technologies.
2	To analyse the principles of VR design, prototype.
3	To analyse the principles of AR design, prototype.
4	To design Graphical User interface using VR
5	To identify trends in XR, key issues in XR and XR Tools.
6	To analyse privacy, ethical, social concern on AR/VR problem.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply modelling techniques on Augmented Reality applications..	L1, L2, L3
2	Gets an overview of guidelines, methods, tools and pick design problems in Virtual Reality.	L1, L2
3	Gets an overview of guidelines, methods, tools and pick design problems in Augmented Reality.	L1, L2
4	Evaluate designs based on theoretical frameworks and build Graphical User interface using VR, Tools	L3, L4
5	Apply the appropriate XR development Approach on problem	L3
6	Analyse main concerns with respect to designed solutions and discuss the privacy, ethical, social concerns.	L3, L4

Prerequisite: Programming Language, Computer Graphics, Virtual Reality

DETAILED SYLLABUS:

Module	Title	Description	Hours	CO
0	Prerequisite	Fundamental Concept and Components of Virtual Reality, Augmented Reality and Mixed Reality Technologies, Authoring in AR	02	--
I	AR/VR Concepts and Technologies	<p>Difference between AR and VR , Rendering for VR/AR, Challenges with AR, AR systems and functionality</p> <p>Augmented Reality Application Development :Types of Augmented Reality Application (Location Based AR Apps Marker-Based AR Applications), three-dimensional modeling and computer vision ,displays & tracking technologies</p> <p>Self-learning Topic: Case study on Retail shopping using AR</p>	08	CO1
II	VR Design Overview	<p>Principles of VR design, Overview of guidelines, methods, tools & design problem, Physical Prototyping for VR- Physical prototype of potential solution, Digital Prototyping for VR- tool choices, digital prototype of (key aspects of) solution</p> <p>Self-learning Topic: Study of 3D navigation , layout and contents</p>	09	CO2
III	AR Design Overview	<p>Principles of AR design, Overview of guidelines, methods, tools & design problem, Physical Prototyping for AR - Physical prototype of potential solution, Digital Prototyping for AR- tool choices, digital prototype of (key aspects of) solution.</p> <p>Self-learning Topic: Use of Anchors in AR</p>	09	CO3
IV	3 D interaction with VR	<p>3 D interaction Overview and types, Navigation in VR, Object interaction, Graphical User interface using VR, Challenges in VR interaction, Tools</p> <p>Self-learning Topic: Case study of Mobile applications using 3D interface</p>	10	CO4
V	XR Application Development	<p>XR overview, XR development Approach, XR design process, Trends in XR, key issues in XR, Tools</p> <p>Self-learning Topic: Difference between, AR, VR, MR and XR</p>	10	CO5

VI	Privacy and security	Privacy, Ethical, and Social Implications, and the Future of AR/VR Self-learning Topic: Case study on Privacy and security issues using AR and VR	04	CO6
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Textbooks:

1. John Vince, “Virtual Reality Systems”, Pearson publication
2. Tony Parisi, “Learning Virtual Reality”, O’REILLY’
3. Dieter Schmalstieg and Tobias Hollerer, “Augmented Reality- Principles and Practice”, Pearson Education, Inc. 2016 Edition.
4. Chetankumar G Shetty, “Augmented Reality- Theory, Design and Development”, Mc Graw Hill, 2020 Edition.
5. Alan B. Craig, “Understanding Augmented Reality – Concepts and Applications”, Morgan Kaufmann, Elsevier, 2013 Edition.

References:

1. Borko Furht, “Handbook of Augmented Reality”, Springer.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, “Creating Augmented and Virtual Realities- Theory and Practice for Next-Generation Spatial Computing”, O’Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, “Augmented Reality for Android Application Development”, PACKT Publishing.

Online Resources:

Sr. No.	Website Name
3.	www.nptel.ac.in
4.	www.coursera.org

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks)

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
HVARSB L601	ARVR Lab (SBL)	--	2	--	--	1	--	01

Course Code	Course Title	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test2	Avg. of 2 Tests				
HVARSB L601	ARVR Lab (SBL)	--	--	--	--	50	50	50

Lab Objectives:

Sr. No.	Lab Objectives
The lab course aims:	
1	To Understand the definition and significance of the VR,AR and MR.
2	To Design various applications in VR .
3	To Examine various audio tools for audio embedded in scene
4	To Explore AR and MR applications in real world
5	To develop interface for VR and AR applications
6	To Explore the interconnection and integration of the physical world and able to design & develop Mobile applications.

Lab Outcomes

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Adapt different tools to implement VR,AR and MR.	L1,L2
2	Demonstrate the working of VR background design.	L1,L2
3	Apply audio tools and developed real world application.	L1,L2,L3
4	Adapt different techniques for Integrating AR and MR concepts in applications.	L5
5	Create interface for selected application	L6
6	Create application and interface for mobile application /desktop version	L6

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. PC i3/i5/i7 Processor or above. 2. 4 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Unity 2. Python 3. OpenCV 4. Solidity	1. Internet Connection.

Prerequisite: VR, AR and MR concepts

Suggested List of Experiments

ARVR lab will describe the Designing of VR and AR applications using different Tools. It starts with installation of software and then learner learn how to design background of various application. Now a day's audio implementation in VR scenes is also getting lots of attention so this aspect is also covered in the lab experiments. AR and MR are important concepts where learner design the applications for desktop as well as mobile environment.

Sr. No.	Detailed Content	LO Mapping
1	To install Open source software /Unity with its functionality	LO1
2	Select real world application and design background for the same	LO2
3	To add sound in the selected application using Open source software /Unity software	LO3
4	To study interface requirements and apply for the selected application	LO3
5	Creating Your Digital Prototype of your objects/environment – (WebVR/ Sketchup / Blender/Unity/Keynote/Figma)	LO6
6	To implement a depth map with Python and OpenCV and using Unity	LO5
7	Identify multiple surfaces and move objects between them using ARCore	LO3
8	To study Interact with AR objects and detect collisions.	LO2
9	Marker less Object Placement - WebAR	LO4
10	In a group of three to five students develop one real world application in VR/ AR or MR with object details and sound with good user interface	LO6

Text Books/ References:

1. Hearn and Baker, "Computer Graphics- C version", 2nd edition, Pearson, 2002.
2. R. K Maurya, "Computer Graphics with Virtual Reality", 3rd Edition, Wiley India, 2018.
3. Dieter Schmalstieg and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc. 2016 Edition.
4. Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition.
5. Alan B. Craig, "Understanding Augmented Reality – Concepts and Applications", Morgan Kaufmann, Elsevier, 2013 Edition.

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/121/106/121106013/#
2.	http://msl.cs.uiuc.edu/vr/
3.	http://lavalle.pl/vr
4.	http://nptel.ac.in
5.	www.coursera.org

Term Work:

The Term work shall consist of at least 10 to 12 practical based on the above syllabus. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above syllabus.

Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HVARC801	Game Development with VR	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HVARC801	Game Development with VR	30	30	30	10	60	--	--	--	100

Course Objectives

Sr. No.	Course Objectives
The course aims:	
1	The different genres of game and explain the Unity UI Basics.
2	The use of navigation and cursor control to create a game environment.
3	How to import assets, interact with them using action objects and manage object states.
4	To build transitions by scripting events ,using physics, particle systems, and other Unity functionality action sequences with UnityGUI design.
5	To build the game project together by handling mecanim ,using dialogue trees,creating and setting up the game environment and menus for the game.
6	The VR development in Unity.

Course Outcomes

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify the different genres of game and explain the Unity UI Basics	L1,L2
2	Make use of navigation and cursor control to create a game environment	L3
3	Apply how to import assets ,interact with them using action objects and manage object states	L3
4	Build transitions by scripting events ,using physics, particle systems, and other Unity functionality action sequences with UnityGUI design	L3
5	Build the game project together by handling mecanim ,using dialogue trees,creating and setting up the game environment and menus for the game	L3

6	Explain VR development in Unity	L2
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Prerequisite: Basics of VR

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	VR Basic concepts	02	-
I	Game Development and Unity UI Basics	<p>The Adventure Genre, Fast Forward to Real-Time, What Draws People to This Genre? Designing Your Game: Defining a Style, Compartmentalizing Environments, First-Person or Third? Animation, Basic Human Characteristics Make for Fun? Managing Your Project, Tips for Completing the Game, Real Time vs. Pre-render. AI in Gaming-AI Guidelines, a simple workflow.</p> <p>Unity UI: The Layout, Toolbar, Menus, Creating Simple Objects, Selecting and Focusing, Transforming Objects In 3D, Snaps, Scene Gizmo, Lights, 3D Objects, Materials</p> <p>Scripting: What is a script? Components of a Script, Picking an Object in the Game, Conditionals and State, Order of Evaluation</p> <p>Self-learning Topics: Understanding the role of AI in gaming</p>	08	CO1
II	Navigation and Cursor Control	<p>Creating Environments, Navigation-Arrow Navigation and Input, Fun with Platforms, Collision Walls, Cursor visibility, Custom cursors, GUI Texture Cursor, Hardware Cursor, UnityGUI Cursor, Object-to-Object Communication, Mouseover Cursor Changes, Object Reaction to Mouseover</p> <p>Self-learning Topics: Multimodal Gaming for Navigation Skills in Players Who Are Blind</p>	06	CO2
III	Imported Assets, Objects &	Imported Assets: 3D Art Assets, Setting Up Materials, Shadows.	09	CO3

	Managing states	<p>Action Objects:Colliders,Triggering Animation,Adding Sound F/X,</p> <p>Managing States:Identifying the Action Objects,Developing a State Machine,Lookup Table,Scripting in Unity,Picking a script Editor,Fundamentals of scripting in Unity.The Object Lookup Script,Action-Related Messages</p> <p>Self-learning Topics:Study the new Asset Import Pipeline: Solid foundation for speeding up asset imports,Effects of scripting on dialogues.</p>		
IV	Transitions, Text Management	<p>Processing the Auxiliary Objects,Handling Object Visibility,Ensuring Player Focus,</p> <p>Adding New Assets,Physics,Combining Physics and Keyframe Animation,Particle systems,</p> <p>GUI Skin,Text Visibility,Using Layers,Creating the Inventory Screen,Adding Inventory Icons,Managing the inventory.</p> <p>Self-learning Topics:Importance of effective Text management in Gaming</p>	09	CO4
V	Game Deployment	<p>Dialogue Trees,The Scenario,Starting a Conversation,Mecanim and Characters,Game Environment,Setting up the game,Menus and levels</p> <p>Self-learning Topics: Branching dialogue trees and its effect in Gaming.Study of different UI designs for Menus in Games.</p>	09	CO5
VI	XR development in Unity	<p>Unity platform and services, XR Getting started with AR development in Unity, Getting started with VR development in Unity, XR Plug-in Framework, Configuring your Unity Project for XR, Universal Render Pipeline compatibility in XR, XR API reference, Single Pass Stereo rendering (Double-Wide rendering), VR Audio Spatializers, VR frame timing ,Unity XR SDK, Open-source repositories using Bitbucket, Asset Store Publishing, use of unity as library in other application.</p> <p>Self-learning Topics: Study any open source tool for VR Development</p>	09	CO6

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Text Books:

1. Beginning 3D Game Development with Unity 4 All-in-one Multi-platform Game development, 2nd Edition, Apress, Sue Backman
2. Game Development with Unity 2nd Edition, Michelle Menard and Bryan Wagstaff
3. Unity Game development Essentials, Will Goldstone, PACKT Publishing
4. Unity Game Development Cookbook-Essentials for every Game, O'reilly, Paris Buttfield-Addison, Jon Manning-Tim Nugent.

Reference Books:

1. Introduction to Gam Development, Second Edition, Steve Rabin, CENGAGE Learning
2. Sams Teach Yourself Unity Game Development in 24 Hours-Mike Geig

Online References:

Sr. No.	Website Name
1.	https://docs.unity3d.com/Manual/VROverview.html
2.	https://www.coursera.org/
3.	https://www.udemy.com/

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA) (10 marks)

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks.



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Honours Degree Program

(Prepared based on the Guidelines for AICTE and University of Mumbai)

in

Internet of Things

(With effect from AY 2022-2023)

Internet of Things for Honours Degree Program

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute affiliated to University of Mumbai
Accredited by NAAC and NBA, Approved by AICTE, New Delhi
Bachelor of Technology in IT/CE/ET/AI&DS Engineering
(With effect from 2022-23)

Honours* in Internet of Things

Year & Sem	Course Code and Course Title	Teaching Scheme Hours / Week					Examination Scheme and Marks					Credit Scheme
		Theory	Practical	Test-1	Test-2	Average	Internal Assessment	End Sem Exam	Term Work	Oral/Practical	Total	Credits
TE Sem V	HIoTC501: IoT Sensor Technologies	04	--	30	30	30	10	60	--	--	100	04
	Total	04	-	--		100			-	-	100	04
Total Credits = 04												
TE Sem. VI	HIoTC601: IoT System Design	04	--	30	30	30	10	60	--	--	100	04
	Total	04	-	-			100		-	-	100	04
Total Credits = 04												
BE Sem. VII	HIoTC701: Dynamic Paradigm in IoT	04	--	30	30	30	10	60	--	--	100	04
	HIoTSBL601: Interfacing & Programming with IoT Lab	--	04				--	--	50	50	100	02
	Total	04	04				100		50	50	200	06
Total Credits = 06												
BE Sem. VIII	HIoTC801: Industrial IoT	04	-	30	30	30	10	60	--	--	100	04
	Total	04	-	-			100		-	-	100	04
Total Credits = 04												
Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04=18												

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HIoTC501	IoT Sensor Technologies	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HIoTC501	IoT Sensor Technologies	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide in depth knowledge about the sensing mechanism.
2	To make students understand about the use of sensors in design of IoT based systems.
3	To familiarize students various types of sensors used to measure the physical quantities.
4	To develop reasonable level of competence in the design, construction and development of sensor suitable to the system requirements.
5	To Introduce students the current state of the art in sensor technology.
6	To familiarize students with electronics used to interface with sensors.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the sensing mechanism and structural details of sensors.	L1, L2
2	Explain principles and working of the sensors.	L1,L2
3	Evaluate the performance of various types of sensors.	L5
4	Select the sensor suitable to system requirements.	L5
5	Interface the sensors with microcontrollers and Arduino	L6
6	Understand the current state of the art in sensor technology.	L2

DETAILED SYLLABUS:

Sr. No .	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	1. Basics of Electrical and Electronics Engineering 2. Applied Mechanics 3. Applied Physics, Applied Chemistry	2	CO 1, CO2, CO3, CO4, CO5
I	Sensor Fundamentals and Properties	Sensor Fundamentals and Properties: Introduction to IoT, Need for sensors in IoT, Data Acquisition – sensor characteristics – electric charges, fields, potentials – capacitance – magnetism – inductance – resistance – piezoelectric – pyroelectric – Hall effect thermoelectric effects – sound waves – heat transfer – light – dynamic models of sensors. Need of actuators, all types of actuators and their working. Identification of sensor and actuator for real-time application Self-learning Topics: IoT Systems, Transfer function and modelling of sensors	8	CO1, CO2
II	Optical, radiation and Displacement sensors	Optical, radiation and Displacement sensors Photosensors: Photodiode, phototransistor and photo resistor, imaging sensors, UV detectors, Basic Characteristics of radiation sensors, Thermal infrared sensors, X-ray and Nuclear Radiation Sensors, Fibre Optic Sensors, Capacitive and Inductive Displacement Sensor, Electromagnetism and Inductance, Magnetic Field Sensors Self-learning Topics: Optical sources and detectors, Sensors based on polymer optical fibers, Micro-structured and solid fibers	8	CO1, CO2, CO3, CO4
III	Presence, force, Pressure, Flow Sensors	Presence, force, Pressure, Flow Sensors Potentiometric Sensors, Piezoresistive Sensors, Capacitive Sensors for presence, Inductive and Magnetic Sensors, Strain gages, Pressure sensitive films, piezoelectric force sensor, Piezoelectric Cables, Concept of Pressure, Mercury Pressure Sensor, Bellows, Membranes, and Thin Plates, Piezo resistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Pressure Sensors, Indirect Pressure Sensor, Vacuum Sensors, Basics of Flow Dynamics, Pressure Gradient Technique, Thermal Transport Sensors, Ultrasonic Sensors, Level Sensors Self-learning Topics: Vibration energy harvesting with Piezoelectric, MEMS systems. Develop a sensor system for force measurement using piezoelectric transducer. Develop Resistance Temperature Detector	9	CO1, CO2, CO3, CO4

IV	Humidity, Moisture Chemical and Biological Sensors	<p>Humidity, Moisture Chemical and Biological Sensors</p> <p>Microphones: Characteristics, Resistive, condenser, Electret, Optical, Pizoelectric, Dynamic,</p> <p>Concept of humidity, Capacitive Humidity Sensors, Resistive Humidity Sensors, Thermal Conductivity Sensors, Optical Hygrometers, Oscillating Hygrometer, Soil Moisture</p> <p>Chemical Sensor Characteristics, Electrical and Electrochemical Sensors, Photoionization Detectors, Physical Transducers, Spectrometers, Thermal Sensors, Optical Transducers, Multi-sensor Arrays</p> <p>Artificial Microsystems for Sensing Airflow, Temperature, and Humidity by Combining MEMS and CMOS Technologies</p> <p>Self-learning Topics: Biosensors for biomedical applications</p>	8	CO1, CO2, CO3, CO4, CO5
V	Interface Electronic Circuits	<p>Interface Electronic Circuits</p> <p>Introduction, Signal Conditioners, Sensor Connections, Excitation Circuits, Analog to Digital Converters, Integrated Interfaces, Data Transmission, Noise in Sensors and Circuits, Batteries for Low-Power Sensors, Types of Single board computers, various sensor interfacing with Arduino, Embedded C Programming. data communication protocol interfacing, study the properties of LDR, Build a simple LED light intensity controller, Linux on Raspberry Pi, Interfaces, and Programming.</p> <p>Self-learning Topics: Python Programming to interface sensors</p>	8	CO1, CO2, CO5
VI	Current Trends in sensors and Technology	<p>Current Trends in sensors and Technology</p> <p>Smart Sensors: Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, The Automation</p> <p>Sensor Technologies: Introduction, Film Sensors, Thick Film Sensors, Thin Film Sensors, Semiconductor IC Technology—Standard Methods, Microelectromechanical Systems (MEMS), Nano-sensors</p> <p>Sensor Applications: Onboard Automobile sensors, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring</p> <p>Self-learning Topics: Energy Harvesting, Self-powered Wireless Sensing in ground, Ground</p>	9	CO1, CO2, CO3, CO4, CO5, CO6

Text Books:

1. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014

References:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, “Internet of Things Challenges, Advances, and Application”, CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser, “Optical Fiber Communications”, 2017, 5th edition, McGraw-Hill Science, Delhi.
4. John G Webster, Halit Eren, “Measurement, Instrumentation and sensor Handbook”, 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
6. Nathan Ida, “Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Online References:

Sr. No.	Website Name
7.	https://nptel.ac.in/courses/108/108/108108123/
8.	https://nptel.ac.in/courses/108/108/108108098/
3.	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee41/
4.	https://nptel.ac.in/courses/108/106/108106165/

Assessment:**Continuous Assessment (CA):**

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
HloTC601	IoT System Design	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HIoTC601	IoT System Design	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
	The course aims:
1	To learn basic principles, concepts, and technologies for internet of things.
2	To understand various architectures of IOT.
3	To train the students to build IoT systems using sensors, single board computers and open source IoT platform for given application.
4	To learn and implement various networking and communication protocols.
5	To design and analyze IoT for given applications.
6	To Evaluate performance of given IoT system.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
	On successful completion, of course, learner/student will be able to:	
1	Able to explain principles, concepts, and technologies for internet of things.	L1, L2
2	Able to identify various building blocks of IoT system	L1,L2
3	Able to analyze and evaluate various networking and communication protocols used in IoT system	L3,L4
4	Able to select appropriate interface for given application	L3
5	Able to design and analyze IoT system for given application	L4,L5
6	Able to evaluate performance of given IOT System	L5

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Comment (Prerequisite syllabus should not be considered for paper setting) Basics of Embedded System, IoT Sensors, Digital design	2	--
I	Overview of IoT System	What is IoT System? IoT Impact, Current Trends in IoT , IoT Challenges, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack How are IoT Systems different from traditional system Values and Uses of IoT Functional View and Infrastructure view of IoT Systems Self-learning Topics: <i>Understanding the Issues and Challenges of a More Connected World</i>	6	CO1, CO2
II	Networking Protocols	OSI Model for the IoT/M2M System Lightweight M2M Communication Protocols, Internet based Communications, IP addressing in IoT, Network Model, TCP & UDP, Client-Server architecture Self-learning Topics: <i>How to choose correct protocol for our network.</i>	8	CO3
III	Communication Protocols	IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols.M2M Communication Protocols , Bluetooth BR/EDR and Bluetooth low energy .RFID IoT System , RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), Message Communication protocols for connected devices Data exchange formats: JSON & XML, Node-Red, Flow control using Node-Red, learning the different nodes of Node-RED for implementing the Communication Protocols Self-learning Topics: <i>Types of Communication</i>	10	CO3,CO4
IV	Sensor Interfaces	Digital Interfaces : UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi Self-learning Topics: <i>SMART SENSOR INTERFACES</i>	10	CO4
V	Design principles for prototyping	Design solution for ubiquitionos and utility, Interface design for user experience, Designing for data privacy, Interfacing – Apps & Webs, Designing for Affordability, Cost v/s Ease of	8	CO5

		Prototyping, Prototypes and Production, Selection of embedded platform, Prototype and Mass personalization, Open Source v/s Closed Source ,Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration Self-learning Topics: <i>Principles for Prototyping and moving towards Product Development</i>		
VI	IoT, case studies	Arduino Programming for Ethernet and Wifi connectivity , Networking and Datalogging with Raspberry Pi Applications-Agriculture, Medical,Fire detection, Air pollution prediction, Earthquake early detection; for smart environmental care, smart traveling, Home Automation Self-learning Topics: <i>IoT enabled Business solution in Supply Chain</i>	8	CO6

Text Books:

1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
2. Adrian McEwen and Hakim Cassimally, —Designing the Internet of Things, John Wiley and Sons Ltd, UK, 2014.
3. Milan Milenkovic, Internet of Things: Concepts and System Design, Springer International Publishing,May 2020cation
4. Dr.Raj Kamal,Internet of Things(IoT) , Architecture and Design Principles.McGraw Hill Education.

References:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
3. Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research and Innovation to Market
4. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HIoTC701	Dynamic Paradigm in IoT	03	--	--	03	--	--	03

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Inter nal Asses sment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HIoTC701	Dynamic Paradigm in IoT	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To explore the role of the cloud in Internet of Things deployment.
2	To introduce the usage of different machine learning algorithms on IoT Data.
3	To explore data analytics and data visualization on IoT Data.
4	To explore the role of Fog computing in Internet of Things.
5	To explore design issues and working principles of various security measures and various standards for secure communication in IoT.
6	To develop the ability to integrate IoT with Dev-ops.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify the need for the cloud in IoT deployment and describe different Cloud provider's architecture.	L1,L2
2	Use and correlate machine learning techniques on IoT Data.	L3,L4
3	Apply IoT analytics and data visualization.	L3
4	Recognize the use of Fog Computing in the Internet of things.	L1,L2
5	Explain the need of security measures in the Internet of Things.	L4
6	Apply the knowledge of Dev-ops in IoT applications.	L3

DETAILED SYLLABUS:

Sr. No .	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of Cloud Computing, Basics of Machine learning and primitives of cryptography	2	--
I	IoT and CLOUD	<p>Cloud Computing Concept, Grid/SOA and Cloud Computing, Cloud Middleware</p> <p>NIST's SPI Architecture and Cloud Standards, The Cloud of Things--The Internet of Things and Cloud Computing</p> <p>The Cloud of Things Architecture-- Four Deployment Models, Vertical Applications, Fifteen Essential Features, Four Technological Pillars, Three Layers of IoT Systems, Foundational Technological Enabler</p> <p>Cloud Providers and Systems -- Microsoft Azure IoT, Amazon Web Services, Google's cloud IoTs.</p> <p>Self-learning Module: IBM Watson Cloud</p>	10	CO1
II	IoT and Machine Learning	<p>Advantages of IoT and Machine Learning Integration, Implementation of Supervised Algorithm- Regression (Linear and Logistic), SVM for IoT-Neural Network on case study: Agriculture and IoT, Smart Home etc.</p> <p>Self-Learning Module: Regression, SVM</p>	6	CO2
III	IoT and Data Analytics	<p>Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud-Microsoft Azure overview– Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets, Managing Data lakes, The data retention strategy.</p> <p>Communicating with Others- Visualization and Dash boarding- Designing visual analysis for IoT data, creating a dashboard –creating and visualizing alerts.</p> <p>Self-learning Topics: Study real time case study on IoT Analytics.</p>	8	CO3
IV	IoT and Fog Computing	<p>Fog computing Basics, The Hadoop philosophy for Fog computing, Fog Computing versus Edge Computing versus cloud computing, Open Fog Reference Architecture Application services-- Application support, Node management and software backplane, Hardware virtualization, Open Fog node security, Network Accelerators Compute, Storage Hardware platform infrastructure, Protocol abstraction, Sensors, actuators, and control systems, Fog Topology.</p>	8	CO4

		Self-learning Module: Amazon Green grass and Lambda (implementation)		
V	IoT and it's Security	<p>Cyber security vernacular Attack and threat terms, Defense terms, Anatomy of IoT cyber attacks – Mirai, Stuxnet, Chain Reaction, Physical and hardware security, Root of Trust, Key management and trusted platform modules, Processor and memory space, Storage security, Network stack – Transport Layer Security, Software defined perimeter, Software-Defined Perimeter architecture,</p> <p>Self-learning Module: OWASP-Existing Security attacks and its prevention methods.</p>	8	CO5
VI	IoT and Devops	<p><u>Introduction to DevOps, DevOps application - business scenarios, DevOps process -- Source Code Management (SCM), Code review, Configuration Management, Build management, Artifacts repository management, Release management, Test automation, Continuous integration, Continuous delivery, Continuous deployment, Infrastructure as Code, Routine automation, Key application performance monitoring/indicators. DevOps frameworks-- DevOps maturity life cycle, DevOps maturity map, DevOps progression framework/readiness model, DevOps maturity checklists, Agile framework for DevOps process projects, Agile ways of development</u></p> <p>Tool for IoT—Chef and Puppet, Setting up Chef and Puppet, Multi-tier Application Deployment, NETCONF-YANG Case Studies- Steps for IoT device management with NETCONF-YANG, Managing Smart irrigation IoT system with NETCONF-YANG, Managing Home Intrusion Detection IoT system with NETCONF-YANG</p> <p>Self-learning Topics: Compare different tool of IoT.</p>	10	CO6

Text Books:

1. The Internet of Things in the Cloud A Middleware Perspective, [Honbo Zhou](#) – CRC Publication.
2. Analytics for the Internet of Things (IoT), [Andrew Minter](#), Packt Publication 2017
3. Internet of Things- Hands on Approach, Arshdeep Bagha, Vijay Mediseti, Published by Arshdeep Bagha and Vijay Mediseti, 2014.
4. Hands-on DevOps, Sricharan Vadapalli, Packt Publication, 2017
5. Internet of things For Architects, Perry Lea Packt Publication, 2018

References:

1. Enterprise Cloud Computing, Gautam Shroff, Cambridge, 2010
2. Mastering Cloud Computing -Foundations and Applications Programming, Raj Kumar Buyya, Christian Vecchiola, S. Thamarai Selvi, MK Publication, 2013.
3. Machine Learning in Action, Peter Harrington, DreamTech Press
4. Introduction to Machine Learning, Ethem Alpaydin, MIT Press
5. Learning AWS IoT- Effectively Manage Connected Devices on the AWS Cloud Using Services Such as AWS Greengrass, AWS Button, Predictive Analytics and Machine Learning, [Agus Kurniawan](#), Packt Publication, 2018
6. Practical Dev-Ops, Joakim Verona, Packt Publication, 2016

Online References:

Sr. No.	Website Name
1.	https://hub.packtpub.com/25-datasets-deep-learning-iot/
2.	https://data.world/datasets/iot
3.	https://dashboard.healthit.gov/datadashboard/data.php
4.	https://www.data.gov/
5.	https://dev.socrata.com/data/
6.	https://www.kaggle.com/

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
HIoTSBL601	Interfacing & Programming with IoT Lab	--	4	--	--	2	--	02

Course Code	Course Title	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
HIoTSBL601	Interfacing & Programming with IoT Lab (SBL)	--	--	--	--	50	50	100

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To Understand the definition and significance of the Internet of Things.
2	To Discuss the architecture, operation, and business benefits of an IoT solution.
3	To Examine the potential business opportunities that IoT can uncover.
4	To Explore the relationship between IoT, cloud computing, and DevOps.
5	To Identify how IoT differs from traditional data collection systems.
6	To Explore the interconnection and integration of the physical world and able to design & develop IOT Devices.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of lab, learner/student will be able to:		
1	Adapt different techniques for data acquisition using various IoT sensors for different applications.	L6
2	Demonstrate the working of actuators based on the collected data.	L2
3	Use different IoT simulators and correlate working of IoT protocols.	L3
4	Adapt different techniques for Integrating IoT services to other third-party Clouds.	L6
5	Execute DevOps methodologies for continuous integration and continuous deployment of IoT application.	L3
6	Implement IoT protocols like MQTT for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.	L3

Prerequisite:**IoT introduction course: Basics of IoT, Introduction to Embedded systems****Hardware & Software Requirements:**

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. Intel PIV Processor 2. 4 GB RAM 3. 500 GB Harddisk 4. Network interface card 5. Sensors 6. IoT Kit (Arduino/ARM/Raspberry Pi)	1. Windows or Linux Desktop OS 2. DeVops 3. Python 4. IoT Simulator/Emulator (open source)	1. Internet Connection for installing additional packages if required

This lab will describe the market around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Divided into four main modules, we will learn by doing. We will start with simple examples and integrate the techniques we learn into a class project in which we design and build an actual IoT system. The client will run in an emulated ARM environment, communicating using common IoT protocols with a cloud enabled backend system with DevOps integration.

Suggested List of Experiments

Sr. No.	Detailed Content	Hours	LO Mapping
1	To study and implement interfacing of different IoT sensors with Raspberry Pi/Arduino/NodeMCU...	4	LO1
2	To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper motor)	4	LO2
3	To study and demonstrate Contiki OS for RPL (like Create 2 border router and 10 REST clients, Access border router from other network (Simulator))	4	LO3
4	To study and demonstrate use of IoT simulators (like Beviswise) on any real time device (LED/stepper motor)	4	LO3
5	Select any one case study (in a group of 2-3) and perform the experiments 5 to 10. The sample case studies can be as follows: 1. Smart home automation system 2. Healthcare management system	8	LO4

	3. Smart traffic management system & so on... Write a program on Raspberry Pi to push and retrieve the data from cloud like thingspeak, thingsboard, AWS, Azure etc.		
6	To install MySQL database on Raspberry Pi and perform basic SQL queries for analysis data collected.	6	LO4
7	To study and implement IoT Data processing using Pandas.	4	LO4
8	To study and implement Continuous Integration using Jenkins on IoT data and also perform interfacing of Raspberry Pi into Jenkins.	6	LO6
9	To study and implement Continuous Deployment (Infrastructure as a code) for IoT using Ansible.	6	LO6
10	To study MQTT Mosquitto server and write a program on Arduino/Raspberry Pi to publish sensor data to MQTT broker.	6	LO5

Books / References:

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly publication, 2016
2. Joakim Verona, "Practical DevOps", PACKT publishing, 2016
3. Honbo Zhou, "The internet of things in the cloud", CRC press, Taylor and Francis group, 2012
4. Perry Lea, "Internet of things for architects", PACKT publishing, 2018

Online Resources:

Sr. No.	Website Name
1.	https://spoken-tutorial.org/watch/Arduino/Introduction+to+Arduino/English/
2.	https://pythonprogramming.net/introduction-raspberry-pi-tutorials/
3.	https://iotbytes.wordpress.com/basic-iot-actuators/
4.	http://www.contiki-os.org/
5.	https://www.bevywise.com/iot-simulator/
6.	https://mqtt.org/

Term Work:

The Term work shall consist of at least 10 practical based on the above list. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above list.

Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
HIoTC801	Industrial IoT	04	--	--	04	--	--	04

Course Code	Course Title		Examination Scheme							
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			Internal Assessment	End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests						
HIoTC801	Industrial IoT	30	30	30	10	60	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the concepts of Industry 4.0 and IIOT.
2	To learn reference Architecture of IIOT.
3	To learn Industrial Data Transmission and Industrial Data Acquisition.
4	To learn middleware and WAN technologies.
5	To learn IIOT Block chain and Security.
6	To learn different applications and securities in IIOT.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom’s Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the concepts of Industry 4.0 and IIOT.	L1,L2
2	Understand reference Architecture of IIOT.	L1,L2
3	Understand Industrial Data Transmission and Industrial Data Acquisition.	L1,L2
4	Understand middleware and WAN technologies in IIOT.	L1,L2
5	Understand the concepts of Blockchain and Security in IIOT.	L1,L2
6	Apply security in IIOT applications.	L3

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	IOT Concepts, Sensor Technology, IOT Stack and Protocols, Design IoT systems, WSN etc.	02	--
I	Introduction	<p>Overview of Industry 4.0 and Industrial Internet of Things, Industry 4.0: Industrial Revolution: Phases of Development, Evolution of Industry 4.0, Environment impacts of industrial revolution, Industrial Internet, Basics of CPS, CPS and IIOT, Design requirements of Industry 4.0, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Cyber security, Impacts of Industry 4.0, Industrial Internet of Things: Basics, IIOT and Industry 4.0, Industrial Internet Systems, Industrial Sensing, Industrial Processes, IIOT Challenges – Identifying Things within the internet, Discovering Things and the Data they possess, Managing massive amount of data, Navigating Connectivity Outages, IIOT Edge - Leveraging the Power of Cloud Computing, Communicating with Devices on the Edge, Determining a Request/Response Model</p> <p>Self-learning Topics: Study real time IIoT challenges in industry.</p>	06	CO1
II	IIOT Reference Architecture	<p>The IIC Industrial Internet Reference Architecture - Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints -Functional, Operational, Information Application and Business Domain of IIAF.</p> <p>The Three-Tier Topology, Key Functional Characteristics of Connectivity.</p> <p>Software Architectural Style for the Industrial Internet of Things - Software Architecture Practice, Advanced Architectural Styles, Systems of Systems, Challenges of Software Engineering in IIoT, Principles for Software Architecture design in IIoT, The Principled Decomposition, The Architectural Style</p>	08	CO2

		Self-learning Topics: Study IIoT Architecture.		
III	Industrial Data Transmission and Industrial Data Acquisition	<p>Introduction, (Features and Components of - Foundation Fieldbus, Profibus, HART, Interbus, Bitbus, CC-Link, Modbus, Batibus, DigitalSTROM, Controller Area Network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa and LoRaWAN) NB-IoT, IEEE 802.11AH, Distributed Control System, PLC, SCADA</p> <p>Self-learning Topics: Study SCADA, PLC in detail.</p>	10	CO3
IV	IIOT Middleware and WAN Technologies	<p>(From Industrial Application Perspective)</p> <p>Examining Middleware Transport Protocols (TCP/IP, UDP, RTP, CoAP), Middleware Software Patterns (Publish Subscribe Pattern, Delay Tolerant Networks),</p> <p>Software Design Concepts – Application Programming Interface – A Technical Perspective, Why Are APIs Important for Business? Web Services,</p> <p>IIOT Middleware Platforms – Middleware Architecture</p> <p>IIOT WAN Technologies and Protocols - IIoT Device Low-Power WAN Optimized Technologies for M2M, SigFox, LoRaWAN, nWave, Dash7 Protocol, Ingénue RPMA, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio</p> <p>Self-learning Topics: Study different IIoT Middleware and WAN Technologies.</p>	10	CO4
V	IIOT Blockchain and Security	<p>Blockchains and cryptocurrencies in IoT, Bitcoin (blockchain-based), IOTA-distributed ledger (directed a cyclical graph-based), Government regulations and intervention, US Congressional Bill –Internet of Things (IoT) Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security.</p>	08	CO5

		Self-learning Topics: Case study on IIoT Block chain and Security.		
VI	IIOT Applications and Securities	<p>The IoT Security Lifecycle-</p> <p>The secure IoT system implementation lifecycle, Implementation and integration, IoT security CONOPS document, Network and security integration, System security verification and validation (V&V), Security training, Secure configurations, Operations and maintenance, Managing identities, roles, and attributes, Security monitoring, Penetration testing, Compliance monitoring, Asset and configuration management, Incident management, Forensics, Dispose, Secure device disposal and zeroization, Data purging, Inventory control, Data archiving and records management</p> <p>Securing the Industrial Internet - Security in Manufacturing, PLCs and DCS, Securing the OT (Operation Technology), Network, System Level: Potential Security Issues, Identity Access Management</p> <p>Develop New Business Models –</p> <p>Adopt Smart Architectures and Technologies, Sensor-Driven Computing, Industrial Analytics, Intelligent Machine Applications, Transform the Workforce</p> <p>Case Studies –</p> <p>Healthcare Applications in Industries – Challenges associated with Healthcare, Introduction, Smart Devices, Advanced technologies used in Healthcare.</p> <p>Inventory Management and Quality Control – Introduction, Inventory Management and IIOT, Quality Control</p> <p>Manufacturing Industry, Automotive Industry and Mining Industry</p> <p>Self-learning Topics: Study real time IIoT application.</p>	08	CO6

Text Books:

1. “Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress)
2. “Introduction to Industrial Internet of Things and Industry 4.0”, by Sudip Misra, Chandana Roy And Anandarup Mukherjee, CRC Press (Taylor & Francis Group)
3. “Internet of Things Principles and Paradigms”, by Rajkumar Buyya, Amir Vahid Dastjerdi, ELSEVIER Inc.
4. Internet of things For Architects, Perry Lea Packt Publication, 2018

References:

1. “Practical Internet of Things Security”, by Brian Russell, Drew Van Duren (Packt Publishing)
2. “Industrial Internet of Things and Communications at the Edge”, by Tony Paine, CEO, Kepware Technologies
3. “Architectural Design Principles For Industrial Internet of Things”, Hasan Derhamy, Luleå University of Technology, Graphic Production

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2.	https://www.coursera.org/specializations/developing-industrial-iiot
3.	https://www.coursera.org/lecture/advanced-manufacturing-enterprise/the-industrial-internet-of-things-iiot-59EvI
4.	https://www.coursera.org/lecture/industrial-iiot-markets-security/segment-12-blockchains-l4aG9

Assessment:**Continuous Assessment (CA):**

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	30 marks
2.	Class Test 2	30 marks
3.	Internal Assessment	10 marks

Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with Three hour duration.



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Autonomy Scheme-II

Internship Manual

**(Prepared based on the Guidelines of AICTE
and University of Mumbai)**

(With effect from AY 2022-2023)



SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Academic Year 2022-23

INTERNSHIP MANUAL

AICTE-INTERNSHIP POLICY STATES THAT:

- The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge.
- Developing an internship policy is an impactful strategy for creating a future talent pool for the industry.
- The Internship program not only helps fresh pass-outs in gaining professional know-how but also benefits, corporate on fresh perspectives on business issues and even discovering future business leaders.
- Competition in the job sector is rising exponentially and securing entry-level jobs is getting very difficult, as the students passing out from technical institutions lack the experience and skills required by industry.
- The main aim of this initiatives is enhancement of the employability skills of the students passing out from Technical Institutions.

OBJECTIVES & EXPECTED OUTCOMES:

Following are the intended objectives of internship training:

1. Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
3. Exposure to the current technological developments relevant to the subject area of training.
4. Experience gained from the 'Industrial Internship' in the classroom will be used in classroom discussions.
5. Create conditions conducive to quest for knowledge and its applicability on the job.
6. Learn to apply the Technical knowledge in real industrial situations.
7. Gain experience in writing Technical reports/projects.
8. Expose students to the engineer's responsibilities and ethics.
9. Familiarize yourself with various materials, processes, products and their applications along with relevant aspects of quality control.
10. Promote academic, professional and/or personal development.
11. Expose the students to future employers.
12. Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.
13. Understand the psychology of the workers and their habits, attitudes and approach to problem solving

BENEFITS OF INTERNSHIP:

Benefits to Students:

1. An opportunity to get hired by the Industry/ organization.
2. Practical experience in an organizational setting.
3. Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom teaching.
4. Helps them decide if the industry and the profession is the best career option to pursue.
5. Opportunity to learn new skills and supplement knowledge.
6. Opportunity to practice communication and teamwork skills.
7. Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
8. Opportunity to meet new people and learn networking skills.
9. Makes a valuable addition to their resume.
10. Enhances their candidacy for higher education.
11. Creating networks and social circles and developing relationships with industry people.
12. Provides opportunity to evaluate the organization before committing to a full time position.

Benefits to the Institute:

- Build industrial relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry/ students.
- Improvement in teaching learning process.

Benefits to the Industry:

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.
- Quality candidate's availability for temporary or seasonal positions and projects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective work force not requiring a long-term employer commitment.
- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to the educational enterprise.

STANDARD OPERATING PROCEDURE (SOP) FOR INTERNSHIP:

The general procedure for arranging internship is given below:

- Step 1:** Request Letter/ Email from the Dean, IIC/ HOD and/or IIC members of resp. depts. of the college shall be send to industry to allot various slots of 4-6 weeks during summer vacation as internship periods for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the training. (Sample attached)
- Step 2:** Industry will confirm the training slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the training themselves the confirmation letter will be submitted by the students to Dean, IIC/ HOD and/or IIC members of resp. depts. Based on the number of slots agreed to by the Industry, Dean, IIC/ HOD and/or IIC members will allocate the students to the Industry. In addition, the internship slots may be conveyed through Telephonic or Written Communication (by Fax, Email, etc.) by the Dean or other members of the IIC who are particularly looking after the Internship of the students.
- Step 3:** Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.
- Step 4:** Students undergo industrial training at the concerned Industry / Organization. In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted to Department IIC Member with the consent of Industry persons/ Trainers.
- Step 5:** Students will submit a training report after completion of internship.
- Step 6:** Training Certificate to be obtained from industry.
- Step 7:** List of students who have completed their internship successfully certificate will be issued by Departments, Sections, Professional bodies, Cells, Committees in collaboration with IIC cell.
- Step 8:** In addition to Step 1 to Step 7, Departments, Sections, Professional bodies, Cells, Committees of KJSIEIT may organize in house / Industry collaborated internship of 1/2/3/4 weeks duration for students with the same procedure as stated above, with in Principal approval from Principal.

GUIDELINES FOR THE STUDENTS:

Internship/ Placement is a student centric activity. Therefore, the major role is to be played by the students. Deans, IIC/HOD may also include involvement of the student in the following activities:

- Design and Printing of Internship / Placement Brochure – Soft copy as well as Hard copy.
- Preparing list of potential recruiters / Internship providers and past recruiters.
- Internship/ Placement Presentation at various organizations, if required.
- For allotment of internship slots all the students will be required to submit “student internship program application” before the prescribed date

SOP FOR INTERNSHIP REPORT :

STUDENT’S DIARY/ DAILY LOG:

The main purpose of writing a daily diary is to cultivate the habit of documenting and to encourage the students to search for details. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should

contain the sketches & drawings related to the observations made by the students. The diary should also be shown to the Faculty Mentor from time to time. Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed, if any. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

After completion of Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The training report should be signed by the Internship Supervisor (from Industry/Organisation, if applicable), Faculty Incharge and HOD. The Internship report will be evaluated on the basis of following criteria:

- Originality.
- Adequacy and purposeful write-up.
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience.
- Practical applications, relationships with basic theory and concepts taught in the course. The industrial training of the students will be evaluated in three stages:
- Evaluation by Industry
- Evaluation by faculty supervisor on the basis of site visit(s).
- Evaluation through seminar presentation/viva-voce at the Institute.

EVALUATION BY INDUSTRY:

The industry will evaluate the students based on the Punctuality, eagerness to learn, Maintenance of Daily Diary and skill test in addition to any remarks.

EVALUATION THROUGH SEMINAR PRESENTATION/VIVA-VOCE AT THE INSTITUTE:

The student will give a seminar based on his/her internship/ training report, as decided by the institute. The evaluation will be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report. Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build communication skills and confidence in students.

EXAMINATION AND EVALUATION FOR AWARD OF INTERNSHIP COMPLETION CERTIFICATE

Internship Completion certificate will be awarded to graduating students on completion of minimum 5 Internship modules from Semester 2 to Semester 8 as per the internship policy document.

COMPLIANCES FOR INTERNSHIP COMPLETION CERTIFICATION :

1. Completion of 1 internship module will reflect addition of 2 credits so total credits earned will be 2 credits x 7 internship modules = 14 credits across Semester 2 to Semester 8.
2. Mandatory to complete minimum 5 internship modules across Semester 2 to Semester 8 for award of Internship Certificate.
3. On completion of 5 Internship modules credit earned = 10
4. On completion of 6 Internship modules credit earned = 12
5. On completion of 7 Internship modules credit earned = 14
6. No credits will be awarded AND / OR No Internship Completion Certificate will be issued for less than 10 credits earned throughout the degree.
7. Internship evaluation will be as per Internship module assessment process defined in Internship Manual course contents, for every individual student across Semester 2 to Semester 8.
8. Departments will submit Internship completion report and credits assigned sheet of every student signed by Department internship coordinator, Class teachers and Head of the Department to Exam Cell during 8th Semester ESE time duration of respective batch to generate the internship completion certificate along with the regular grade sheet.
9. No further queries will be entertained if not meeting above compliances and not following the internship modules designed under the guidelines of AICTE Internship policy.

Internship Scheme & Structure under KJSIEIT Autonomy Scheme-II wef 2022-23 for Bachelor of FY/SY/TY/LY (CE/IT/AI/ET Technology) Semester- II-VIII

Note:

As per guidelines and suggestions by AICTE-Internship policy

- 1 Credit = 40 - 45 hours of Internship
- Total 600-700 hour of spending under Internship module courses to be completed for award of Internship Completion Certification along with regular passing gradesheet. (e.g. Total 15 weeks of 5 days/week of 8 hrs/day spent=600hrs for complete degree duration)
- Total weeks of Internship shall be considered based on Hrs spent/Day
- For Internship course, No load to be allotted for mentors in faculty load distribution sheet.

Internship Modules & Contents Across Semester 2 to Semester 8

FY: (Sem II)			
Internship Code	Course Name	Hours/Duration	Credits
INT21	Internship-I	80-120 hrs (2-3 Weeks) Winter Vacation After SEM-I & during SEM-II of FY	02
Prerequisite:	Fundamental knowledge of Engineering and Technology		
Internship Objectives:	1. To get acquainted with institute level technical activities and initiatives. 2. To participate in department/Institute level technical learning and training initiatives through Professional cells/clubs/committees/bodies.		
Internship Outcomes:	Upon completion of the course, students will be able to: 1. Get practical experience of institutional setting. 2. Meet and interact with new people and learn networking, innovation and entrepreneurial skills. 3. Promote academic, professional and/or personal development.		
Activity- Inter/Intra Institutional Activities	Supporting Activities to be completed under Internship		
	• Attending Industry Workshops organised by departments		
	• Working in consultancy or research project initiated by department		
	• Technical festival (participation)		
	• Working in IIC Cell, Entrepreneurship Cell, NISP, IPR cell and/or any other technical professional body/cell/committee/club of the institute		
	• Activities related to Incubation or Innovation		
	• Learning in departmental Labs, Tinkering Lab		
Term Work Assessment:			
Duration to be considered for assessment:			
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)			
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and		

	<p>authenticated by Dean Students Welfare.</p> <ol style="list-style-type: none"> HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. For department Lab learning, FY HOD will circulate Term End report to all faculty mentors with list of student's undergone innovative learning, verified by department academic coordinator. Students will submit evaluation sheet by attaching Xerox copies of Internship & other participation certificates & faculty mentor will verify the Xerox from original copy for assessment purpose.
TW Marks (25) & Certificate :	<p>Assessment & evaluation based on rubrics :</p> <p>Hours Spent for Internship: max 20 marks</p> <p>Achievement/Recognition: max 05 marks</p> <p>&</p> <p>Internship and Activity Completion/Participation Certificates and Evaluating Report</p>

SY (Sem III)			
Internship Code	Internship Name	Hours/Duration	Credits
INT32	Internship-II	80-120 hrs (2 -3 Weeks) Summer Vacation After SEM-II & during SEM-III of SY	02
Prerequisite:	Fundamental knowledge of program specific tools, instruments, devices and programming languages etc.		
Internship Objectives:	<ol style="list-style-type: none"> To get the exposure to Innovation/IPR/ Entrepreneurship/ Startup initiatives To participate & experience Incubation, Innovation & Business development culture 		
Internship Outcomes:	<p>Upon completion of the course, students will be able to:</p> <ol style="list-style-type: none"> Learn innovation and entrepreneurial skills to supplement engineering knowledge. Integrate theoretical aspects learned in classes with the practical world Develop an innovative idea to be processed as a start-up 		
Activity-Innovation/	Supporting Activities to be completed under Internship		
	<ol style="list-style-type: none"> Participation in Innovation related competitions e.g. Hackathons etc. 		
	<ol style="list-style-type: none"> Awareness & knowledge sessions about Development of new product/Business Plan/Registration of Start-up 		

IPR/ Entrepreneurship	3. Participation in all activities of IIC Cell, E-Cell, NISP, IPR Cell like <ul style="list-style-type: none"> ● IPR workshop/ ● Leadership Talk ● Idea Design ● Innovation/Business Competition
Term Work Assessment: Duration to be considered for assessment: Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)	
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. Department IIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIC for AICTE-CII survey data 6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.
TW Marks (25) & Certificate :	Assessment & evaluation based on rubrics: Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks & Internship and Activity Completion /Participation Certificates and Evaluating Report

SY (Sem IV)			
Internship Code	Internship Name	Hours/Duration	Credits
INT43	Internship-III	80-120 hrs (2 - 3 Weeks) Winter Vacation After SEM-III & during SEM-IV of SY	02
Prerequisite: Skill sets of engineering and technology specific tools, instruments, devices and programming languages etc.			

Internship Objectives:	1. To get the industrial environment expose for creating competent professionals for the industry.		
	2. To understand the psychology of the workers and their habits, attitudes and approach to problem solving.		
Internship Outcomes:	Upon completion of the course, students will be able to:		
	1. Get an expose to work with the future employers.		
	2. Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control in product development lifecycle.		
Activity- Internship	Supporting Activities to be completed under Internship		
	Internships in the field of:		
	● Industries		
	● Government Sector		
	● Non-governmental Organization (NGO)		
	● MSMEs		
	● Rural Internship		
Term Work Assessment:			
Duration to be considered for assessment:			
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)			
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year.		
	2. Students will submit the participation certificate of the activities to the faculty mentors.		
	3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare.		
	4. HOD will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities.		
	5. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data		
	6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.		
TW Marks (25) & Certificate :	Assessment & evaluation based on rubrics: Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks & Internship and Activity Completion/Participation Certificates and Evaluating Report		
TY (Sem V)			
Internship Code	Internship Name	Hours/Duration	Credits

INT54	Internship-IV	80-160 hrs (2 - 4 Weeks) Summer Vacation After SEM-IV & during SEM-V of TY	02
Prerequisite:	List of probable industries and organizations offering internships in Engineering and Technology. Awareness about problem areas in rural India		
Internship Objectives:	1. To get the awareness about engineer’s responsibilities and ethics. 2. Opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.		
Internship Outcomes:	Upon completion of the course, students will be able to:		
	1. Get an opportunity to practice communication and teamwork skills. 2. Get an opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.		
Activity- Rural Internships &/ Internships	Supporting Activities to be completed under Internship		
	1. Long Term Goal under Rural Development Internships or		
	2. Mandatory internship for developing project with:		
	● Industries		
	● Government Sector		
	● Non-governmental Organization (NGO)		
	● MSMEs		
Term Work Assessment:			
Duration to be considered for assessment:			
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)			
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HOD will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data 6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.		
TW Marks (25) & Certificate :	Assessment & evaluation based on rubrics: Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks		

	& Internship and Activity Completion/Participation Certificates and Evaluating Report
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TY (Sem VI)			
Internship Code	Internship Name	Hours/Duration	Credits
INT65	Internship-V	80-160 hrs (2-4 Weeks) Winter Vacation After SEM-V & during SEM-VI of TY	02
Prerequisite:	List of probable industries and organizations offering internships on live projects. Awareness about probable solutions for identified problem areas in rural India		
Internship Objectives:	1. To understand the social, economic and administrative considerations of working environment in industries, government, NGOs and private organizations. 2. Learn to apply the Technical knowledge for solving real life problems.		
Internship Outcomes:	Upon completion of the course, students will be able to: 1. Get an opportunity to get hired by the Industry/ organization. 2. Decide if working in the industry or set up a start-up would be best career option to pursue.		
Activity- Rural Internships & Internships	Supporting Activities to be completed under Internship		
	1. Long Term Goal under Rural Development Internships or		
	2. Mandatory internship for developing project with:		
	● Industries		
	● Government Sector		
	● Non-governmental Organization (NGO)		
	● MSMEs		
Term Work Assessment:			
Duration to be considered for assessment:			
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)			
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. Department IIIC Cell coordinator will collect, maintain each student		

	<p>proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIC for AICTE-CII survey data</p> <p>6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.</p>
TW Marks (25) & Certificate :	<p>Assessment & evaluation based on rubrics:</p> <p>Hours Spent for Internship: max 20 marks</p> <p>Achievement/Recognition: max 05 marks</p> <p>&</p> <p>Internship and Activity Completion/Participation Certificates and Evaluating Report</p>

LY (Sem VII)			
Internship Code	Internship Name	Hours/Duration	Credits
INT76	Internship-VI	80-160 hrs (2-4 Weeks) Summer Vacation of TY and during SEM-VII of LY	02
Prerequisite:	<p>In depth knowledge about societal/research/innovation/entrepreneurial problems and appropriate applicable solutions available through use of technology.</p>		
Internship Objectives:	<p>1. To gain the experience in preparing and writing Technical documentation/ reports for product/projects.</p> <p>2. To Identify and analyse the societal/research/entrepreneurial problem in detail to define its scope with problem specific data.</p> <p>3. To develop clarity of presentation based on communication, teamwork and leadership skills.</p>		
Internship Outcomes:	<p>Upon completion of the course, students will be able to:</p> <p>1. Apply the engineering and technical knowledge for problem identification, analysis, design and developing solutions.</p> <p>2. Present and demonstrate the real time problem solution across national/international project competitions and conference.</p>		
Activity- PBL-Major Project A-Work/Seminars	Supporting Activities to be completed under Internship		
	For Sem VII PBL Course-Major Project-A, selected topic:		
	1. Review literature through reference papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old.		
	2. Participate in multiple Project Competitions presenting the Project A solution		
	3. Participation in International Conferences presenting the literature		

	review and/or hypothesis for innovative solution.
	4. Participation at institute annual International Conference on Advances in Science and Technology-ICAST & other Conferences /Journals.
Term Work Assessment:	
Duration to be considered for assessment: Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)	
Guidelines:	<ol style="list-style-type: none"> 1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data 4. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.
TW Marks (25) & Certificate :	Assessment & evaluation based on rubrics: Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks & Certificate Based on : <ol style="list-style-type: none"> 1. Project Competition certificate, 2. Participation in Conferences/Publications and/or proof of ICAST participation & presentation.

LY (Sem VIII)			
Internship Code	Internship Name	Hours/Duration	Credits
INT87	Internship-VII	80-160 hrs (2-4 Weeks) Winter Vacation of Sem VII and During SEM-VIII of LY	02
Prerequisite:	In depth knowledge about filling IPR/ copywriting a product/solution.		
Internship Objectives:	<ol style="list-style-type: none"> 1. To gain the knowledge of filling patent and Copy write. 2. Presenting technology solutions across worldwide problems through competitions and publications. 		
Internship Outcomes:	Upon completion of the course, students will be able to: <ol style="list-style-type: none"> 1. National and international recognition through IPR and/or copy writes and paper publications. 		

	2. Convert problem solution as a business plan for entrepreneurial product.
Activity- PBL Major Project B Work/Conference Presentation	Supporting Activities to be completed under Internship
	For Sem VIII PBL Course-Major Project-B, selected topic:
	1. File for Project solution Copyright and/or File for Project topic IRP/Patent
	2. Participate at Institute Annual Project Competition-INTECH
	3. Publish the project solution at reputed International Journals, preference should be given to UGC care list and/or SCI indexed journals.
Term Work Assessment: Duration to be considered for assessment: Week Ends and during Semester	
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. Department IIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIC for AICTE-CII survey data 4. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.
TW Marks (25) & Certificate :	Assessment & evaluation based on rubrics: Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks & Certificate Based on : 1. Project Copyright/ Project IRP 2. Project Competition certificate (INTECH) 3. International Journal Publication proof



Dr. S.K Ukarande
Principal