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K J Somaiya Institute of Engineering and Information Technology
An Autonomous Institute affiliated to University of Mumbai

<u>**Autonomy Syllabus Scheme-II (2022-23)**</u>

Bachelor of Technology
in
Electronics Engineering

(Last Year)
(Semester-VII and Semester-VIII)

<u>**(With effect from AY 2022-23)**</u>

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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 offered a wide range of elective courses — grouped into core and inter-disciplinary domains. At par with international engineering education, it followed 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 instil 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

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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. S. K. Ukarande
Principal and Chairman - Academic Council

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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

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Preface by Board of Studies in Electronics Engineering:

We, the members of Board of Studies of B.Tech in Electronics Engineering (ETRX) are very happy to present a syllabus of Last Year of B. Tech in ETRX with effect from the Academic Year 2022-23. We are assured that you will discover this syllabus interesting and challenging.

There are nine emerging technology thrust areas declared by AICTE, as an Electronics Engineer he/she should have knowledge about all the emerging technologies which will rules the industries in future so we have touched almost every emerging areas while deciding the courses and contents there in. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. Program Educational Objectives are considered while deciding different courses. It is envisioned to deliver a modern, industry-oriented education in Electronics Engineering. It aims at creating skilled engineers who can successfully acquaint with the demands of the industry worldwide. They obtain skills and experience in up-to-date knowledge to analysis, design, employ, technologies, software and systems.

For holistic development of students Foreign and Regional Indian language and other skill based courses introduced first time in this new scheme. We have included internships under Autonomy Syllabus Scheme-II from SEM-VII to SEM-VIII of B.Tech ETRX. At the beginning of every course we have added two theory lectures for prerequisites and course outline and at the end one theory lecture added for coverage of course conclusion which includes recap of modules, outcomes, applications, and summarization. We have mapped Course outcomes, PBL outcomes, Skills outcomes, Activity outcomes and TBL outcomes module wise throughout the syllabus. Faculty in this program adopted collaborative, co-operative and online teaching learning techniques during coverage of the course; this will help students to understand each course in depth. The designed syllabus promises to achieve the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

We would like to show our appreciation to the faculties, students, industry experts and stakeholders assisting us in the design of this syllabus.

Boards of Studies in Electronics Engineering are,

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. Milind U. Nemade	Head of the Department concerned (Chairman)	9	Prof. Pankaj Deshmukh	Member
2	Dr. Tushar Jadhav	Experts from outside parent university nominated by Academic council	10	Prof. Medha Asurlekar	Member
3	Mr. Anil Anant Kulkarni		11	Prof. Sejal Shah	Member
4	Dr. Sudhakar Mande	One expert to be nominated by the Vice- Chancellor	12	Prof. Vidya Sagvekar	Member
5	Mr. Saurabh Srivastava	One Representative from Industry/Corporate Sector/ Allied area relating to Placement	13	Prof. Sheetal Jagtap	Member
6	Dr. Vaishali Wadhe	Member	14	Prof. Sarika Mane	Member
7	Prof. Vrinda Ullas	Member	15	Prof. G.R. Phadke	Member
8	Prof. Ganesh Wadmare	Member	16	Prof. Devanand Bathe	Member

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Program Structure for Last Year UG Technology (ETRX)

Semester- VII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) (TH – P – TUT)	Total (Hrs.)	Credit Assigned (TH – P – TUT)	Total Credits	Course Category
ETC701	Power Electronics	3–0–0	03	3–0–0	03	PC
ETC702	Internet of Things	3–0–0	03	3–0–0	03	PC
ETDLC703X	Department Level Elective-3	3–0–0	03	3–0–0	03	DLE
ETDLC704X	Department Level Elective-4	3–0–0	03	3–0–0	03	DLE
ILC705X	Institute Level Elective-1	3–0–0	03	3–0–0	03	ILE
ETL702	Internet of Things Lab	0–2–0	02	0–1–0	01	PC
ETDLL703X	Department Level Elective-3 Lab	0–2–0	02	0–1–0	01	DLE
ETDLL704X	Department Level Elective-4 Lab	0–2–0	02	0–1–0	01	DLE
ETPR75	Project Based Learning- Major Project Lab-A	0–6**–0	06*	0–3–0	03	PBL
INT76	Internship-6	--	--	--	--	INT
Total		**15-12-0**	**27**	**15-6-0**	**21**	

** PBL Major -PR-A- (Preparation for Conference paper, TPP, participation in competitions, startup, innovation along with contents as per curriculum for consideration of Termwork)
*Load of learner, not the faculty

Semester- VII-Examination Scheme

Course Code	Course Name	Examination Scheme Marks									
		CA				ESE	TW	O	P	P&O	Total
		T1	T2	Average (T-1 & T-2)	IA						
ETC701	Power Electronics	30	30	30	10	60	--	--	--	--	100
ETC702	Internet of Things	30	30	30	10	60	--	--	--	--	100
ETDLC703X	Department Level Elective-3	30	30	30	10	60	--	--	--	--	100
ETDLC704X	Department Level Elective-4	30	30	30	10	60	--	--	--	--	100
ILC705X	Institute Level Elective-1	30	30	30	10	60	--	--	--	--	100
ETL702	Internet of Things Lab	--	--	--	--	--	25	25	--	--	50
ETDLL703X	Department Level Elective-3 Lab	--	--	--	--	--	25	25	--	--	50
ETDLL704X	Department Level Elective-4 Lab	--	--	--	--	--	25	25	--	--	50
ETPR75	Project Based Learning- Major Project Lab-A	--	--	--	--	--	25	--	--	50	75
INT76	Internship-6	--	--	--	--	--	--	--	--	--	--
Total		**--**	**--**	**150**	**50**	**300**	**100**	**75**	**--**	**50**	**750**

Major Project A and B:
- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load: In Semester VII – ½ hour per week per project group
                  In Semester VIII – 1 hour per week per project group

Department Level Elective-3			
Group A: Data Storage and Technology	Group B: Electronics Core	Group C: Artificial Intelligence and Data Science	Group D: Computer Domain
ETDLC7032	ETDLC7031	ETDLC7033	ETDLC7034
Graphic Processor and Parallel Computing	Mixed Signal VLSI Design	Artificial Intelligence	Advanced Networking Technologies
Department Level Elective-4			
Group A: Data Storage and Technology	Group B: Electronics Core	Group C: Artificial Intelligence and Data Science	Group D: Computer Domain
ETDLC7041	ETDLC7043	ETDLC7044	ETDLC7042
Data Compression	Robotics	Data Science and Applications	Cloud Computing
Institute Level Elective-1			
ILC7051	**ILC7052**	**ILC7053**	**ILC7054**

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Product Life Cycle Management	Reliability Engineering	Management Information System	Design of Experiments
ILC7055	**ILC7056**	**ILC7057**	**ILC7058**
Operations Research	Cyber Security and Laws	Disaster Management and Mitigation Measures	Energy Audit and Management
ILC7059			
Development Engineering			

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Program Structure for Last Year UG Technology (ETRX)

Semester- VIII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) (TH –P–TUT)	Total (Hrs.)	Credit Assigned (TH–P–TUT)	Total Credits	Course Category
ETC801	Industrial Automation	3–0–0	03	3–0–0	03	PC
ETDLC802X	Department Level Elective-5	3–0–0	03	3–0–0	03	DLE
ETDLC803X	Department Level Elective-6	3–0–0	03	3–0–0	03	DLE
ILC804X	Institute Level Elective-2	3–0–0	03	3–0–0	03	ILE
ETL801	Industrial Automation Lab	0–2–0	02	0–1–0	01	PC
ETDLL802X	Department Level Elective-5 Lab	0–2–0	02	0–1–0	01	DLE
ETDLL803X	Department Level Elective-6 Lab	0–2–0	02	0–1–0	01	DLE
ETPR86	Project Based Learning-Major Project Lab-B	0-12**-0	12*	0–6–0	06	PBL
INT87	Internship-7	--	--	--	--	INT
Total		**12-18-0**	**30**	**12- 9- 0**	**21**	

** PBL Major -PR-B Conference /Journal Publication, Filling Patent, Creation of Product & Licensing, Startup, SIH, Participation etc) along with contents as per curriculum and for the grant of TW.

\# 1 Credit = 40 - 45 hours of Internship (Refer Internship document)

*Load of learner, not the faculty

Semester- VIII-Examination Scheme

Course Code	Course Name	CA T1	CA T2	CA Average (T-1 & T-2)	IA	ESE	TW	O	P	P&O	Total
ETC801	Industrial Automation	30	30	30	10	60	--	--	--	--	100
ETDLC802X	Department Level Elective-5	30	30	30	10	60	--	--	--	--	100
ETDLC803X	Department Level Elective-6	30	30	30	10	60	--	--	--	--	100
ILC804X	Institute Level Elective-2	30	30	30	10	60	--	--	--	--	100
ETL801	Industrial Automation Lab	--	--		--	--	25	25	--	--	50
ETDLL802X	Department Level Elective-5 Lab	--	--	--	--	--	25	25	--	--	50
ETDLL803X	Department Level Elective-6 Lab	--	--	--	--	--	25	25	--	--	50
ETPR86	Project Based Learning-Major Project Lab-B	--	--	--	--	--	50	--	--	100	150
INT87	Internship-7	--	--	--	--	--	--	--	--	--	--
Total		**--**	**--**	**120**	**40**	**240**	**125**	**75**	**--**	**100**	**700**

Major Project A and B: Students can form groups with minimum 2 and not more than 4

Faculty Load: In Semester VII – ½ hour per week per project group

In Semester VIII – 1 hour per week per project group

Department Level Elective-5			
Group A: Data Storage and Technology	**Group B: Electronics Core**	**Group C: Artificial Intelligence and Data Science**	**Group D: Computer Domain**
ETDLC8021	**ETDLC8024**	**ETDLC8023**	**ETDLC8022**
Microelectromechanical Systems (MEMS)	Virtual Instrumentation	Advanced Power Electronics	Web Design

Department Level Elective-6			
Group A: Data Storage and Technology	**Group B: Electronics Core**	**Group C: Artificial Intelligence and Data Science**	**Group D: Computer Domain**
ETDLC8034	**ETDLC8033**	**ETDLC8032**	**ETDLC8031**
Integrated Circuit Technology	System On Chip	Industrial Internet of Things	Next Generation Networks

Institute Level Elective-2			
ILC8041	**ILC8042**	**ILC8043**	**ILC8044**
Project Management	Finance Management	Entrepreneurship Development and Management	Human Resource Management
ILC8045	**ILC8046**	**ILC8047**	**ILC8048**
Professional Ethics and CSR	Research Methodology	IPR and Patenting	Digital Business Management
ILC8049			
Environmental Management			

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Course Code	Course Name	Credits (TH+P+TUT)
ETC701	**Power Electronics**	**(3+0+0)**

Prerequisite:	Electrical Network Analysis and Synthesis Electronic Devices and Circuits-I Electronic Devices and Circuits-II
Course Objectives:	1. To teach power electronic devices and their characteristics. 2. To highlight power electronics based rectifiers, inverters and choppers.
Couse Outcomes:	After successful completion of the course, student will be able to 1. Analyse behaviour of semiconductor devices as power switches. 2. Design different triggering circuits for SCR 3. Analyse various single phase controlled rectifiers 4. Analyse various DC-AC inverter circuits. 5. Simulate various DC-DC converter circuits 6. Analyse AC voltage controllers and Cyclo-converters

Module No. & Name	Sub Topics	CO mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Power semiconductor devices	1.1 Principle of operation of SCR, static and dynamic characteristics, gate Characteristics	CO1	02	03
	1.2 Principle of operation, characteristics, ratings and applications of: TRIAC, DIAC		01	
2. SCR: Triggering, commutation and Protection Circuits	2.1 Methods of turning ON SCR (types of gate signal), firing circuits (using R, RC, UJT, Ramp and pedestal, inverse cosine)	CO2	02	06
	2.2 Design of commutation circuits		02	
	2.3 Protection of SCR		02	
3. Single-phase Controlled Rectifiers	3.1 Introduction to uncontrolled rectifiers, Half wave controlled rectifiers with R, RL load, effect of free-wheeling diode	CO3	02	08
	3.2 Full wave fully controlled rectifiers (centre-tapped, bridge configurations), full-wave half controlled (semi-converters) with R, RL load, effect of freewheeling diode and effect of source inductance.		03	
	3.3 Calculation of performance parameters, input performance parameters (input power factor, input displacement factor (DF), input current distortion factors (CDF), input current harmonic factor (HFD), Crest Factor (CF)), output performance parameters.		03	
4. Inverters	4.1 Introduction to basic and improved series/parallel inverters, limitations.	CO4	02	08

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	4.2 Introduction, principle of operation, performance parameters of Single phase half / full bridge voltage source inverters with R and R-L load		03	
	4.3 Voltage control of single phase inverters using PWM techniques, harmonic neutralization of inverters, applications		03	
5. DC-DC converters	5.1 Basic principle of step up and step down DC-DC converters, DC-DC switching mode regulators: Buck, Boost, Buck-Boost, Cuk Regulators(CCM mode only)	CO5	03	08
	5.2 Voltage commutated, current commutated and load commutated DC-DC converters		03	
	5.3 Applications in SMPS, Battery charging systems.		02	
6. AC Voltage Controllers and Cyclo-convertors	6.1 Principle of On-Off control, Principle of phase control, single phase bidirectional control with R and RL load	CO6	03	06
	6.2 Introduction, single phase and three phase Cyclo-converters applications		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1.M. H. Rashid, "Power Electronics", Prentice-Hall of India 2. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Pvt. Ltd 3.Ned Mohan, "Power Electronics", Undeland, Robbins, John Wiley Publication
Reference Books	1. P. S. Bhimbra, "Power Electronics", Khanna Publishers, 2012 2. M.D. Singh and K. B. Khanchandani, "Power Electronics ", Tata McGraw Hill 3. Ramamurthy, "Thyristors and Their Applications " 4. P. C. Sen, "Modern Power Electronics", Wheeler Publication.
Useful Links:	
1.https://www.coursera.org/specializations/power-electronics	
2.https://nptel.ac.in/courses/108/102/108102145/	
1.https://onlinecourses.nptel.ac.in/noc21_ee01/preview	

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ETC702	**Internet of Things**	**(3+0+0)**

Prerequisite:	1.Micro-controllers and Applications 2.Embedded Systems and RTOS 3.Computer Communication Network 4.Wireless Communication
Course Objectives:	The objectives of this course are to: 1.Understand the design features of Internet of Things(IoT) 2.Understand importance of data handling in IoT Way. 3.Introduce multiple ways of data communication and networking. 4.Understand design issue in IoT
Couse Outcomes:	On successful completion of the course the students will be able to: 1.Explain the concepts of Internet of Things. 2.Analyze basic multiple way of data communication and networking in IoT 3.Apply design methodology for solving IoT case studies. 4.Analyze data handling in IoT. 5.Implementation of IoT Devices. 6.Illustrate various IoT case studies.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to IoT	1.1 Introduction;-Defining IoT, Characteristics of IoT, Physical design of IoT, Logicaldesign of IoT, Functional blocks of IoT	CO1	04	08
	1.2 IoT and M2M:- IoT/M2M System layers and Design Standardization, M2M, Difference between IoT and M2M		01	
	1.3 IoT Levels:-IoT Levels and Deployment Templates		03	
2. Network & Communication aspects	2.1 Design Principles & Web Connectivity:, Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets, (Publish – Subscribe),MQTT, AMQP, CoAP Protocols	CO2	04	08
	2.2 Internet Connectivity: Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals :LORA, NBIoT, CAT LTE M1,SIGFOX		04	
3. IoT Design Methodology	Introduction, Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device andComponent Integration	CO3	03	05

4. Data Handling in IoT	4.1 Data Acquiring, Organizing, Processing: - Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	CO4	03	06
	4.2 Data Collection and Storage:- Cloud Computing Paradigm for Data Collection,storage and computing, Cloud Service Models, Xively, Nimbits		03	
5. Components of IoT DHT	5.1 Exemplary Devices: Arduino Boards, Arduino Interfacing, ESP8266, DHT Sensor, Ultrasonic Sensor, IR Sensor	CO5	05	08
	5.2 Raspberry Pi, R-Pi Interfaces, Programming R-Pi,		03	
6. IoT Case Studies	Home Automation- Smart Lighting, Home Intrusion Detection, Smart Cities- Smart Parking, Environment- Weather monitoring, Weather Reporting Bot, Forest Fire Detection, Agriculture: Smart Irrigation	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press. 2. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, First edition 3. David Hanes, Gonzalo salgueiro"IoT Fundamentals Networking Technologies,Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition 4. Andrew Minteer , "Analytics for the Internet of Things(IoT)",Kindle Edition
Reference Books	1. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback,First Edition 2. Yashavant Kanetkar , Shrirang Korde :Paperback "21 Internet of Things (IOT) Experiments" BPB Publications

Useful Links:

https://onlinecourses.nptel.ac.in/noc21_cs17/preview

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (P+TU)
ETL702	**Internet of Things Lab**	**(1+0)**

Lab Prerequisite:	1.Micro-controllers and Applications 2.Embedded Systems and RTOS 3.Computer Communication Network 4.Wireless Communication
Lab Objectives:	1. Understand Arduino IDE for IoT practical. 2. Implementation of Arduino board and Nodemcu interfacing with LED, IR, Ultrasonic, DHT sensors. 3. Demonstration of IoT based case study. 4. Implementation of data storage using AWS cloud. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.
Lab Outcomes (LOs):	After completing practical student will be able to: 1. Use Arduino IDE for IoT based practical. 2. Implement interfacing of Arduino board and nodemcu with LED, IR, Ultrasonic, DHT sensors. 3. Demonstrate IoT based case study. 4. Implement storing of data to AWS. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	LED and IR sensor interfacing with Nodemcu.	LO1, LO5, LO6	02
2.	Ultrasonic sensor interfacing with Nodemcu for distance measurement.	LO1, LO5, LO6	02
3.	Temperature/Humidity monitoring using Blynk App.	LO1, LO5, LO6	02
4.	DHT sensor interfacing with Nodemcu and communication of data using MQTT protocol	LO1, LO5, LO6	02
5.	To study the MQTT and ThingSpeak and upload the DHT sensor data on ThingSpeak	LO1, LO5, LO6	02
6.	To study Amazon Web Service Platform.	LO4, LO5, LO6	02
7.	Study of IoT based industrial process monitoring and control system	LO3, LO5, LO6	02
8.	Case Study for IoT Application	LO3, LO5, LO6	04

Virtual Lab Links:
1. https://aws.amazon.com/
2. https://thingspeak.com/
3. https://blynk.io/
Term work:

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- Term work should consist of a minimum of 8 experiments.
- Journal must include at least 2 assignments on content of theory and practical of the course "Internet of Things Lab".
- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
- Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral/Practical/P&O:

- P&O examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7031	**Mixed Signal VLSI Design**	**(3+0+0)**

Prerequisite:	1.Electronic Devices and Circuits I 2.Digital Circuit Design 3.Electronic Devices and Circuits II 4.Linear Integrated Circuits 5.VLSI Design
Course Objectives:	1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits. 2. To highlight the issues associated with the CMOS analog VLSI circuit design. 3. To emphasize upon the issues related to mixed signal layout design.
Couse Outcomes:	After successful completion of the course student will be able to 1. Discuss tradeoffs involved in analog VLSI Circuits. 2. Explain single stage amplifier, differential amplifier. 3. Explain MOS operational amplifier. 4. Explain Mixed signal circuits, oscillators and phase locked loop. 5. Discuss verifications of issues involved in analog and mixed signal circuits. 6. Describe about Data converters fundamentals and architecture.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Analog building blocks	1.1 Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks, current mirror.	CO1	04	08
	1.2 Voltage References: Band Gap References, General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing		04	
2.Amplifier Fundamentals	2.1 Single Stage Amplifiers: Basic concepts, Gain Bandwidth (GBW),Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage.	CO2	04	10
	2.2 Differential Amplifiers: Single ended and differential operation, Basic differential pair, large signal and small signal behaviours, Common-mode response, Differential pair with MOS loads.		03	
	2.3 Noise: Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages),noise in differential pairs, noise bandwidth, noise figure, noise temperature.		03	

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3. MOS Operational Amplifiers	3.1 Stability and Frequency Compensation: General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps	CO3	02	06
	3.2 Op-amp Design: General Considerations, performance parameters, One- stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations (ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps		04	
4. Mixed Signal Circuits	4.1 Basic Concepts: AMS design flow, ASIC, Full custom design, Semi- custom design, System on Chip, System in package, Hardware software co-design, and mixed signal layout issues.	CO5	03	07
	4.2 Oscillators: General considerations, Ring oscillators, LC oscillators,VCO,		02	
	4.3 Phase-Locked Loop: Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits		02	
5. Data Converter Fundamentals and Architectures	5.1 Fundamentals: Analog versus discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	CO6	03	08
	5.2 DAC architectures: Digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC ADC architectures: Flash, Two Step Flash, Pipeline ADC, Integrating ADCs, Successive approximation ADCs		05	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1.B Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 1st Edition. 2.R. Jacaob Baker, Harry W. Li, David E. Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley, Student Edition
Reference Books	1. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", Oxford University Press, 3rd Edition. 2. Gray, Meyer, Lewis, Hurst, "Analysis and design of Analog Integrated Circuits", Willey, 5th Edition

Useful Links:
1.https://nptel.ac.in/courses/117/101/117101105/
2.https://www.coursera.org/lecture/vlsi-cad-layout/basics-1MtuT

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.

- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7031	**Mixed Signal VLSI Design Lab**	**(1+0)**

Lab Prerequisite:	1.Electronic Devices and Circuits I 2.Digital Circuit Design 3.Electronic Devices and Circuits II 4.Linear Integrated Circuits 5.VLSI Design
Lab Objectives:	1. To study building blocks of CMOS Analog VLSI Circuits. 2. To design different types of CMOS analog VLSI circuit. 3. To generate layout of various CMOS analog VLSI circuits. 4. To emphasis upon the issues related to mixed signal layout design.
Lab Outcomes (LOs):	After successful completion of the course student will be able to 1. Explain different types of analog VLSI Circuits. 2. Design building blocks of CMOS analog VLSI circuits 3. Generate Layout of analog and mixed signal circuits 4. Write accurate documentation for experiments performed. 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Study analog VLSI circuits	LO1, LO4, LO5	02
2.	Analysis of MOSFETs for analog performance	LO2, LO4, LO5	02
3.	Design and simulate various types of current mirror circuits		02
4.	Design and simulate various common source amplifier circuits		02
5.	Design and simulate various types of single stage amplifiers		02
6.	Design and simulate differential amplifier		02
7.	Design and simulate operational transconductance amplifier		02
8.	Design and simulate switch capacitor circuits		02
9.	Design and simulate various types of oscillators		02
10..	Design and simulate mixed mode circuit		02
11..	Generate layout for the simple and cascode current mirror	LO3, LO4. LO5	02
12.	Generate layout for common source amplifier		02
13.	Generate layout for the differential amplifier		02
14.	Generate layout for the Oscillator		02
15.	Generate layout for Phase Detector		02

Virtual Lab Links:

https://vlsi-iitg.vlabs.ac.in/index.html

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Mixed Signal VLSI Design Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.

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4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)
Oral/Practical/P&O:
• P&O examination will be based on experiment list and performance of experiment. .

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7032	**Graphic Processor and Parallel Computing**	**(3+0+0)**

Prerequisite:	1. Computer Architecture and Organization. 2. Data Structures.
Course Objectives:	1. To understand the basics of GPU architectures. 2. To write programs for massively parallel processors. 3. To understand the issues in mapping algorithms for GPUs. 4. To introduce different GPU programming models.
Couse Outcomes:	1. Analyze performance trade-offs in computer design. 2. Analyze pipeline data-path for performance enhancement. 3. Describe data level parallelism and GPU architectures. 4. Describe issues related to instruction level parallelism. 5. Elaborate on multiprocessors and shared memory architectures. 6. Develop programs for GPU hardware.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Brief overview of data structures and computer organization fundamentals	---	02	02
1.Parallelism	Description of architecture, micro-architecture and instruction set architectures, Pipelining Review - basic concept of pipeline, Pipeline CPI, Processor Pipeline Hazards, Computer Architecture, Tech Trends, Processor Speed, Cost, Power, Measuring Performance, Benchmarks Standards, Iron Law of Performance, Moore's Law, Amdahl's Law	CO1, CO2	07	07
2. Instruction-Level Parallelism and Its Exploitation	Instruction-Level Parallelism: Data Hazards, Dynamic Scheduling, Hardware-Based Speculation, Multiple Issue, and Speculation, Multithreading	CO4	07	07
3. Data-Level Parallelism in Vector, SIMD, and GPU Architectures	Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Loop-Level Parallelism, Mobile versus Server GPU	CO3	07	07
4. Thread-Level Parallelism	Centralized Shared-Memory Architectures, Symmetric Shared-Memory Multiprocessors, Distributed Shared-Memory and Directory-Based Coherence, Synchronization, Models of Memory Consistency	CO5	06	06
5. Introduction to CUDA programming	NVIDIA and CUDA, GPU Hardware Alternatives to CUDA. PC architecture, GPU Hardware	CO3, CO6	06	06
6. Parallel programming in CUDA C	Parallel programming, thread cooperation, shared memory and synchronization	CO6	06	06

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II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:

Text Books	1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann, 1998.
	2. Cook, Shane. CUDA programming: a developer's guide to parallel computing with GPUs. Newnes, 2012.
	3. Sanders, Jason, and Edward Kandrot. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional, 2010.
Reference Books	1. Wilt, Nicholas. The cuda handbook: A comprehensive guide to gpu programming. Pearson Education, 2013.
	2. Pacheco, Peter. An introduction to parallel programming. Elsevier, 2011.
	3. Maurice Herlihy, and NirShavit, "The Art of Multiprocessor Programming, Revised Reprint", Morgan Kaufmann, 2012

Useful Links:

https://docs.nvidia.com/cuda/cuda-c-programming-guide/

https://course.fast.ai/start_colab#Using-a-GPU

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7032	**Graphic Processors and Parallel Computing Lab**	**(1+0)**

Lab Prerequisite:	Knowledge of C, C++, Data Structures
Lab Objectives:	1. To develop parallel GPU programs. 2. To compare performance of GPU and CPU. 3. To implement machine learning algorithms on GPU.
Lab Outcomes (LOs):	1.To write programs for matrix and vector operations on GPU. 2.To analyse performance of GPU with respect to CPU. 3.To perform array operations on GPU. 4.To perform multithreading on GPU. 5.To perform Machine learning algorithms on GPU. 6.To complete the work as per directions and on time.

The following programs may be implemented using Google Colab. At least 4 experiments to be performed and a machine learning case study on Colab.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Function to add the elements of two arrays	LO3	02
2.	Vector addition in CUDA	LO1	02
3.	Matrix multiplication algorithm in CUDA C		02
4.	Odd even sorting of arrays	LO3	02
5.	Synchronizing threads	LO4	02
6.	Performance analysis of CPU and GPU	LO2	02
7.	Histogram algorithms on GPU	LO5	02
8.	Parallel Implementation of the K nearest Neighbors Classifier		02

Virtual Lab Links:

https://colab.research.google.com/notebooks/intro.ipynb

https://in.mathworks.com/solutions/gpu-computing/getting-started.html?#generate_cuda

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Graphic Processors and Parallel Computing".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks) .

Oral/Practical/P&O :

- Oral/Practical /P&O examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7033	**Artificial Intelligence**	**(3+0+0)**

Prerequisite:	1. Basic mathematics (Statistics, Probability) 2**.** Knowledge of any programming language 3**.** Algorithms
Course Objectives:	1. To create appreciation and understanding of both the achievements of AI and the theory underlying those achievements. 2. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems. 3. To create an understanding of the basic issues of knowledge representation and Logic and blind and heuristic search, as well as an understanding of other topics such as minimal, resolution, etc. that play an important role in AI programs.
Couse Outcomes:	1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents. 2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game-based techniques to solve them. 3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing. 4. Attain the capability to represent various real life problem domains using logic-basedtechniques and use this to perform inference or planning. 5. Formulate and solve problems with uncertain information using Bayesian approaches. 6. Apply concept Natural Language processing to problems leading to understanding ofcognitive.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subt opic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Artificial Intelligence (AI)	1.1 Introduction and Definition of Artificial Intelligence.	CO1	01	03
	1.2 Intelligent Agents: Agents and Environments, Rationality, Nature of Environment, Structure of Agent, types of Agents		02	
2. Problem Solving	2.1 Problem Solving Agent, Formulating Problems, Example Problems	CO2, CO3, CO4	02	10
	2.2 Uninformed Search Methods: Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Method: A* Search		04	
	2.3 Optimization Problems: Hill climbing Search, Simulated annealing, Genetic algorithm		04	
3. Knowledge, Reasoning and Planning	3.1 Knowledge based agents	CO4, CO5	01	10
	3.2 First order logic: syntax and Semantic, Knowledge Engineering in FOL Inference in FOL: Unification, Forward Chaining, Backward Chaining and Resolution		05	

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	3.3 Planning Agent, Types of Planning: Partial Order, Hierarchical Order, Conditional Order		04	
4. Artificial Neural Network	4.1 Introduction – Fundamental concept– Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron	CO5	02	04
	4.2 Neural Network Architecture: Perceptron, Single layer Feed Forward ANN, Activation functions		02	
5. Supervised, Unsupervised and Reinforcement learning	5.1 Supervised Learning: Delta learning rule, Back Propagation algorithm.	CO5	04	08
	5.2 Un-Supervised Learning algorithm: Self-Organizing Maps		04	
6. Applications of Artificial Intelligence	6.1 Language Models, Natural Language for Communication:	CO6	02	04
	6.2 Architectures of expert system, hybrid, NLP, cognitive computing and Robotics		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. Stuart J. Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach" Prentice Hall, 4th edition, 1994. 2. S. Rajasekaran and G. A. Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning. 3. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition 4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication. 5. Steven Bird, Ewan Klein, Edward Loper "Natural Language Processing with Python: Text with the Natural Language Toolkit. 1st edition.
Reference Books	1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education. 2. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.

Useful Links:

1. www.youtube.com/watch?v=XCPZBD9lbVo&list=PLbMVogVj5nJQu5qwm-HmJgjmeGhsErvXD

2. www.youtube.com/watch?v=TMLyKcBtHuo&ab_channel=nptelhrdnptelhrdVerified

3. www.youtube.com/watch?v=wTbrk0suwbg&t=34s&ab_channel=SimplilearnSimplilearnVerified

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7033	**Artificial Intelligence Lab**	**(1+0)**

Lab Prerequisite:	Knowledge of programming language (C/ JAVA/ PYTHON)
Lab Objectives:	1. To impart basic proficiency in representing difficult real-life problems in a state space representation so as to solve them using AI techniques. 2. To make students understand various AI methods like searching and game playing and how to apply them to solve real applications 3. To explain to students the basic issues of knowledge representation and Logic so as to build inference engines.
Lab Outcomes (LOs):	1. Design the building blocks of an Intelligent Agent using PEAS representation. 2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game-based techniques to solve them. 3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing 4. Attain the capability to represent various real life problem domains using logic-based techniques and use this to perform inference or planning. 5. Formulate and solve problems with uncertain information using Bayesian approaches. 6. Apply concept Natural Language processing and cognitive computing for creation of domain specific ChatBots.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Identify the problem, PEAS (Performance measure, Environment, Actuator, Sensor) Description, Problem formulation	LO1, LO2	02
2.	Introduction to AI programming Language	LO2	02
3.	Start Implementation, Knowledge Representation and Create Knowledge Base	LO2, LO3	02
4.	Implement search algorithms to reach goal state	LO4	02
5.	Implement Mc-Culloch Pitts Model for a problem		02
7.	To implement Basic Supervised / Unsupervised Neural Network learning rules for a problem	LO5	02
8.	Case study on Hybrid Systems	LO6	02
9.	Case study of an AI application		02

Virtual Lab Links:

1. ps.iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

2. ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

3. ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

4. cse22.iiith.vlabs.ac.in/exp_perceptron/Tutorial.html?domain=Computer%20Science&lab=Artificial%20Neural%20Networks

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5. cse22.iiith.vlabs.ac.in/exp_tsp/Tutorial.html?domain=Computer%20Science&lab=Artificial%20Neural%20Networks

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Artificial Intelligence Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7034	**Advanced Networking Technologies**	**(3+0+0)**

Prerequisite:	Computer Communication Networks
Course Objectives:	1.Understand the characteristic features of Various Wireless networks. 2.Understand Optical networking and significance of DWDM. 3.Introduce the need for network security and safeguards. 4.Understand the principles of network management.
Course Outcomes:	On successful completion of the course the students will be able to: 1. Appreciate the need for IEEE 802.11 standards. 2. Explain the features of emerging wireless networks: Bluetooth, Zigbee, WSN. 3. Analyze the importance of Optical networking. 4. Demonstrate knowledge of network design layers. 5. Identify Enterprise Network Security methods. 6. Determine the network performance using different monitoring tools and manage network.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction: Fundamentals of Wireless Communication, Advantages, limitations and application, wireless media, Frequency Spectrum: Radio and Infrared; OSI Model and TCP/IP model	---	02	02
1.Wireless LAN and WAN Technologies	1.1 Introduction to Wireless networks: Infrastructure networks, Ad-hoc networks, IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA Physical Layer, 802.11 Security considerations	CO1	03	07
	1.2 Wireless LANs: i. 802.11 Physical Layer (PHY) Techniques ii Diffused Infrared, iii FHSS, iv DSSS, Orthogonal Frequency Division Multiplexing (OFDM), MIMO, 802.11—11 Mbps and Beyond, 802.11b, 802.11a, ac, ax, 802.11g,Comparing 802.11 Standards		04	
2. Wireless Technologies	2.1 Wireless Personal Area Network(WPAN): WPAN 802.15.1 architecture ,Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	CO2	04	09
	2.2 802.15.3- Ultra Wide Band , 802.15.4- Zigbee ,		03	

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	RFID			
	2.3 Wireless Sensor Networks: Introduction and Applications, Wireless Sensor Network Model, Sensor Network Protocol Stack		02	
3.Optical Networking	3.1 SONET: SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	CO3	05	08
	3.2 WDM and DWDM: WDM, Frame format, DWDM architecture, Optical Amplifier, Optical cross connect Performance and design considerations		03	
4.Network Design	Three tier Network design layers: Application layer, Access layer, Backbone layers, Ubiquitous computing and Hierarchical computing	CO4	04	04
5.Network Security	5.1 Network Security: Security goal, Security threats, security safeguards, Firewalls, Types of firewalls	CO	02	07
	5.2 Enterprise Network security: DMZ, NAT, SNAT, DNAT, Port forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 filtering		05	
6.Network management and Control	6.1 Network Management definitions, Functional Areas(FACPS), SNMP, RMON	CO	02	04
	6.2 Designing a network management solutions, Monitoring and control of network activity and network project management		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition. 2. Darren L. Spohn , "Data Network Design" , McGraw Hill Education ,Third edition.
Reference books	1. William Stallings, "Wireless Communications and Networks", Pearson Ed., 2nd Edition. 2. Vijay Garg , "Wireless Communication and networking" , Morgan Kaufmann Publishers. 3. Prof. Dayanand Ambawade, Dr. Deven Shah, Prof. Mahendra Mehra, Prof. Mayank Agarwal, "Advance computer networks", Wiley Publications.
Useful Links:	
1.https://www.nptel.ac.in	

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2. https://swayam.gov.in

3. https://www.coursera.org/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7034	**Advanced Networking Technologies Lab**	**(1+0)**

Lab Prerequisite:	Computer Communication Networks
Lab Objectives:	1.To make students familiar with wireless technologies and how to use them to: Design, Implement, Operate, Manage enterprise networks. 2.To introduce the different networking scenarios using simulation software
Lab Outcomes:	On successful completion of the course the students will be able to: 1.Monitor the network performance using different monitoring tools and manage the network. 2.Design personal firewalls for network security. 3.Simulate the different networking scenarios using simulation software. 4.Design and configure a campus area network. 5.Write clear documentation for and interpret the results of the performed experiments. 6.Stick to a timeline and follow the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Network scanning: using NMAP	LO1	02
2.	Evaluation of home/campus network	LO4	02
3.	Network Visualization using Etherape	LO1	02
4.	Firewall Design using IP Tables	LO2	02
5.	Bluetooth protocol implementation	LO3	02
6.	ZigBee protocol implementation		02
7.	Wi-Fi protocol implementation		02
8.	Study of SNMP	LO1	02
9.	Remote Login service	LO4	02
10.	Packet Grab Analysis using Wireshark	LO1	02

Virtual Lab Links:

1.https://www.youtube.com/watch?v=m_F98NZ6K3

2.http://vlabs.iitkgp.ernet.in/ant/2/

3.http://vlabs.iitkgp.ernet.in/ant/5/

4.http://vlabs.iitkgp.ernet.in/ant/8/

5.http://vlabs.iitkgp.ernet.in/ant/9/

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Advanced Networking Technologies".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7041	Data Compression	(3+0+0)
Prerequisite:	1. Digital Communication 2. Digital Signal Processing 3. Signals and Systems	
Course Objectives:	1.Students will understand types, need and significance of modelling and coding in data compression 2. Students will study different source coding techniques of data compression. 3. Students will study different image, audio and video compression techniques. 4. Students will learn vector quantization and types of vector quantization.	
Couse Outcomes:	1. Students will be able to apply appropriate data model and coding scheme to different applications. 2. Students will be able to apply Huffman and Arithmetic coding methods to solve data compression problems. 3. Students will be able to apply Dictionary methods to text compression. 4. Students will be able to apply image and video compression techniques for different signal processing applications. 5. Students will be able to apply audio and vector quantization to solve signal processing problems.	

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction to Data Compression	1.1 Introduction, Need of data compression, Compression techniques, Measure of performance, Significance of Modelling and Coding	CO1	02	06
	1.2 RLE Text compression, RLE Image compression, Lossy image compression, Conditional Image RLE, Move to front coding.		02	
	1.3 Models: Physical Models, Probability Models, Markov Models, Composite Source Model		02	
2. Huffman and Arithmetic Coding	2.1 Variable size codes, Prefix codes, The Golomb Code, The Kraft-MacMillan Inequality Criteria.	CO2	03	12
	2.2 Minimum Variance Huffman Code, Extended Huffman Codes, Ternary Huffman codes, Canonical Huffman codes, Adaptive Huffman Coding, Huffman Decoding, Rice Codes, Tunstall Codes		06	
	2.3 Difficulties in Huffman Coding, Arithmetic Coding and Decoding: Tabular and Tag generation methods		03	
3. Dictionary Methods	3.1 Static Dictionary, Digram coding, Adaptive Dictionary: LZ77 (Sliding Window), LZSS, LZ78, LZW	CO3	04	07

	3.2 GIF Images, Zip and Gzip, PNG, XML compression, Context Based Compression: PPM, The Burrows- Wheeler Transform		03	
4.Image and Video Compression	4.1 Approaches to Image compression, Gray codes, Error Metrics, CALIC, DCT, JPEG, JPEG–LS, JBIG, Differential Lossless Compression, DPCM, JPEG – 2000 Standards, Multi-resolution Approaches, Facsimile Encoding	CO4	06	08
	4.2 Analog Video, Digital Video, Video compression methods, MPEG 4, Protocols, H–264 Encoder		02	
5. Audio Compression	Sound, Digital Audio, The Human Auditory System, μ-Law and A-Law Companding, ADPCM Audio compression, MLP Audio, MPEG Audio coding-Layer 1, 2 and 3 (MP3 Format), The MDCT Audio compression	CO5	03	03
6. Vector Quantization	Advantages of Vector Quantization over Scalar Quantization, The Linde-Buzo-Gray Algorithm, Tree structured Vector Quantizers, Structured Vector Quantizers.		03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. Mark Nelson, Jean-Loup Gailly, The Data Compression Book, BPB Publications, SecondEdition, 1995. 2.Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann Publishers, Second Edition, 2006. 3.Timothy C, Text Compression, Bell Prentice Hall, First Edition, 1990.
Reference Books	1. David Salomon, Data Compression: The Complete Reference, Springer, Third Edition, 2005. 2. Drozdek, Elements of Data Compression, Cengage Learning, First Edition, 2001.

Useful Links:
1. http://www.nptelvideos.com/video.php?id=989
2. https://www.coursera.org/lecture/algorithms-part2/introduction-to-data-compression-OtmHU
3. https://nptel.ac.in/courses/106102064/19
4.http://www.iitk.ac.in/karmaa/DownloadTools/MCIT_DataCompressionProject/Data_Compression_Techniques_for_E-Learning.html
5. http://www.digimat.in/nptel/courses/video/106106182/L191.html

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETLDLL7041	**Data Compression Lab**	**(1+0)**

Lab Prerequisite:	1. Digital Communication
	2. Digital Signal Processing
	3. Signals and Systems
Lab Objectives:	1. Students will understand how to use statistical methods for data compression
	2. Students will understand use of dictionary techniques for text compressions.
	3. Students will understand the concept of quantization and audio compression.
	4. Students will be able to understand use of image compression techniques.
Lab Outcomes (LOs):	1.Students will able to program statistical coding techniques for data compression.
	2.Student will be able to program for RLE and dictionary techniques of data compression
	3.Students will be able to apply audio, image and vector quantization compression methods for signal processing.
	4. Students will be able to write clear documentation for and interpret the results of the performed experiments
	5. Students will be able to stick to a timeline and follow rules of the laboratory.
	6.Student will able to communicate clearly and effectively

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Encode and decode the given messages and find code efficiency using Huffman coding method.	LO1, LO4, LO5, LO6	02
2.	Encode and decode the given messages and find code efficiency using Arithmetic coding method.		02
3.	Encode and decode the given text information using Run Length Encoding technique of text compression.	LO2, LO4, LO5, LO6	02
4.	Implement Discrete Cosine Transform for image compression a) One Dimensional DCT b) Two Dimensional DCT		02
5.	Study the effect of Delta Modulation and Demodulation on a given sinusoidal signal. Also show slope overload cases.	LO3, LO4, LO5, LO6	02
6.	Study the effect of Uniform and Non uniform quantization on the given speech signal.		02
7.	Implement PCM technique for audio compression.		02
8.	Implement DPCM method for audio compression		02
9.	Encode and decode dictionary contents using LZ 77/LZ 78/ LZW compression Techniques.	LO2, LO4, LO5, LO6	02

Virtual Lab Links:
1. https://www.ldrp.ac.in/images/syllabus/BE-Computer-CBCS/IT603-N%20Data%20Compression.pdf
2. http://www.nitttrc.edu.in/nptel/courses/video/105107160/lec14.pdf
3. http://www.digimat.in/nptel/courses/video/106106182/L191.html

4. http://www.iitk.ac.in/karmaa/DownloadTools/ MCIT_DataCompressionProject /Data_Compression _Techniques_for_E-Learning.html
Term work:
1. Term work should consist of a Minimum of 8 experiments.   2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Compression Lab".   3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.   4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).
Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7042	**Cloud Computing**	**(3+0+0)**

Prerequisite:	1. Operating System 2. Computer Communication Networks
Course Objectives:	1. To understand basics of cloud computing. 2. To discuss about Key concepts of virtualization. 3. To discuss Cloud programming. 4. Describe Amazon Web Services
Couse Outcomes:	1. Define Cloud Computing and memorize the different Cloud service and deployment models 2. Describe importance of virtualization along with their technologies. 3. Use and examine different cloud computing services 4. Analyze the components of open stack & Google Cloud platform 5. Discuss about mobile computing architecture. 6. Describe the key components of Amazon web Service

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction	1.1 Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud Computing	CO1	02	04
	1.2 Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models, Cloud computing architecture, Advantages and Disadvantages of Cloud Computing.		02	
2. Virtualization	2.1 Concept of Virtualization, Characteristics of virtualized environment, Understanding the importance of Hypervisors, Type I & Type II Hypervisors	CO2	02	07
	2.2 Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization of CPU		02	
	2.3 Memory and I/O Devices, Virtualization and Cloud Computing, Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware and HyperV		03	
3. Cloud Computing Services	3.1 Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, Infrastructure as a service, anything as a service or Eeverything as a service (XaaS), Security as a Service.	CO1, CO3	01	05

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	3.2 Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service, Compliance as a Service, Monitoring as a Service		02	
	3.3 Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.		02	
4. Cloud Implementation	4.1 Open Stack Cloud Architecture: Feature of Open Stack, Components of Open stack, mode of operations.	CO4	03	06
	4.2 Programming support for Google apps engine-GFS, Big tables, Chubby, Google APIs		03	
5.Mobile Cloud Computing	5.1 Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing	CO5	01	05
	5.2 Architecture of Edge-computing		01	
	5.3 Architecture of fog computing		01	
	5.4 Comparison between MCC and CC		01	
	5.5 Role of Cloud Computing in IoT and Big Data Application.		01	
6.Exploring the Components of Amazon Web Services	AWS cloud computing Platforms like: 6.1 Elastic Compute Cloud (EC2): Compute Basics, Instance types, Life cycle of instances.	CO6	01	12
	6.2 Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3.		02	
	6.2 Elastic Block Storage (EBS):Basics and Types of EBS Volumes		01	
	6.3 Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP)		02	
	6.4 Elastic Network Interfaces (ENIs) & Security groups & ACL.		02	
	6.5 Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling.		02	
	6.6 Amazon AWS IoT Core Services		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:

Text Books	1. Barrie Sosinsky,"Cloud Computing Bible", Wiley Publication. 2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah,"Cloud Computing" Black Book", Dreamtech Press. 3. Joe Baron et.al, "AWS Certified Solution Architect", Sybex Publication. 4. Mastering Cloud Computing, Rajkumar Buyya, MGH Publication

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Reference Books	1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Thomas Erl, Robert Cope, Amin Naserpour, "Cloud Computing Design Patterns", Pearson Publication. 2. Judith Hurwitz, "Cloud Computing for Dummies", Wiley Publication.

Useful Links:

1. https://nptel.ac.in/courses/106/105/106105167/

2 https://www.coursera.org/specializations/cloud-computing

3 https://www.edx.org/course/introduction-to-cloud-computing-6

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7042	**Cloud Computing Lab**	**(1+0)**

Lab Prerequisite:	1. Object Oriented Programming with Java
	2. Operating System
	3. Computer Communication Networks
Lab Objectives:	To get familiar with: Key concepts of virtualization & different types of Hypervisors used in virtualization along with implementation
	1. Concept of On demand Application Delivery like SaaS using Ulteo
	2. Various Cloud services provided by Amazon Web Services
	3. Programming on Platform as a Service cloud
Lab Outcomes (LOs):	Students should be able to:
	1. Demonstrate the use of different types of Hypervisors.
	2. Implement IAAS service using OpenStack.
	3. Implement software as a service using Uleto OS.
	4. Implement platform as service on the GCP platform.
	5. Demonstrate Virtual Private cloud & its components.
	6. Demonstrate S3, EC2, DAAB etc. of AWS.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Creating and running virtual machines on Hosted Hypervisors like KVM Type 1 ,Vmware Workstation, Oracle Virtualbox	LO1	02
2.	Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV		02
3.	Installation and Configuration of Ulteo to demonstrate on demand Application delivery over web browser to explore SaaS Environment.	LO3	02
4.	To demonstrate installation and Configuration of Open stack Private cloud.		02
5.	To demonstrate IAAS using AWS.	LO2	02
6.	To demonstrate virtual private computing & Networking.	LO5	02
7.	Explore database as a service using AWS.		02
8.	To demonstrate Simple storage service (S3) storage.	LO6	02
9.	To study and demonstrate load balancer in AWS.		02
10.	To demonstrate Platform as a Service using Google app Engine/IBM BlueMix/tSuru	LO4	02

Implementation of practicals can be in any language.
1.Hardware Configuration for server: Intel or AMD Multi Core processors (like i3/i5/i7/Quad core/Octa core) with Intel, VT-X or AMD-V support, GB RAM, 500 GB Harddisk, Gigabit Ethernet (GbE) network interface card (NIC)
2.Hardware Configuration for Cloud Client: PC/Laptop/Smart phone/Thin Client or Any device which has built-in Wifi, Ethernet or data connection facility.
3.Software Requirements for Server: Server OS for Physical Sever like CentOS /Fedora/Ubuntu/ Redhat Server, Pre-configured OpenSSH, Xen Server DVD 4.Ulteo DVD

4.Software Requirements for Clients: JDK 1.8 or higher & .NET Framework 4, Netbeans or Eclipse IDEs, OpenSSH client or putty 4.Vmware Workstation, 5.Oracle Virtualbox, 6. Built-in web browser, Internet Connection for each PC with at least 2 MBPS bandwidth and LAN bandwidth of 1 GBPS.

5.Internet Connection for each PC with at least 2 MBPS bandwidth and LAN bandwidth of 1 GBPS.

Useful Links:

1. www.cloudshare.com

2. http://vlabs.iitb.ac.in ›vlab ›labscse

3. https://aws.amazon.com/aws_training

Web Resources:
  1. http://fosshelp.blogspot.in
  2. https://aws.amazon.com/
  3. https://docs.openstack.org/
  4. https://owncloud.org/
  5. https://appengine.google.com

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Cloud Computing Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).

Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7043	**Robotics**	**(3+0+0)**

Prerequisite:	1.Applied Mathematics III, 2. Applied Mathematics IV, 3. Linear Control Systems
Course Objectives:	1. To study basics of robotics 2.To familiarize students with kinematics & dynamics of robots 3.To familiarize students with Trajectory & task planning of robots. 4. To familiarize students with robot vision
Couse Outcomes:	At the end of completing the course of Robotics, a student will be able to: 1. Describe the basic concepts of robotics. 2. Perform the kinematic and the dynamic analysis of robots. 3. Perform trajectory and task planning of robots. 4. Describe importance of visionary system in robotic manipulation. 5. Simulate Planer motion and Task planner.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Fundamentals of Robotics	Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	CO1	04	04
2. Kinematics of Robots	2.1 Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	CO2	04	08
	2.2 Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot		04	
3. Velocity Kinematics & Dynamics	3.1 Differential motions and velocities: Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities.	CO3	05	09
	3.2 Dynamic Analysis of Forces: Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot		04	
4. Trajectory planning	Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	CO4	06	06
5. Robot Vision	5.1 Image representation, Template matching, Polyhedral objects	CO5	03	06
	5.2 Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration		03	
6.Task Planning	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-	CO6	06	06

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	motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.			
II.Course Conclusion	Prerequisite Concepts and Course Introduction	---	01	01
			Total hours	**42**

Books:

Text Books	1.Robert Shilling, "Fundamentals of Robotics - Analysis and control, Prentice Hall of India, 2009
	2.Saeed Benjamin Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011
Reference Books	1.John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009
	2.Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd., 2006
	3.Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008

Useful Links:
1. https://nptel.ac.in/courses/112/101/112101098/
2.https://nptel.ac.in/courses/112/105/112105249/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7043	**Robotics Lab**	**(1+0)**

Lab Prerequisite:	1.Applied Mathematics III, 2.Applied Mathematics IV, 3.Linear Control Systems
Lab Objectives:	1. To study basics of robotics 2. To familiarize students with kinematics & dynamics of robots 3. To familiarize students with Trajectory & task planning of robots. 4. To familiarize students with robot vision
Lab Outcomes (LOs):	At the end of completing the course, a student will be able to: 1. Perform the kinematic and the dynamic analysis of robots. 2. Perform trajectory and task planning of robots. 3. Perform template matching, iterative processing and segmentation. 4. Simulate Planer motion. 5. Simulate Task planner.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Experiment on Forward kinematics		02
2.	Experiment on Inverse kinematic	LO1	02
3.	Experiment on Dynamic analysis		02
4.	Experiment on Joint-space trajectory		02
5.	Experiment on Cartesian-space trajectory	LO2	02
6.	Experiment on Template matching		02
7.	Experiment on Iterative processing	LO3	02
8.	Experiment on Segmentation		02
9.	Experiment on motion planner	LO4	02
10.	Simulation on task planner	LO5	02

Virtual Lab Links:
http://vlabs.iitkgp.ernet.in/mr/#
Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Robotics Lab". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)
Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC7044	**Data Science and Applications**	**(3+0+0)**
Prerequisite:	Database Management System	
Course Objectives:	1. To provide strong foundation for data science and application area related to it and understand the underlying core concepts and emerging technologies in data science.	
Couse Outcomes:	On completion of the course, learner will be able to - 1. Apply data science processes to an e-commerce data and demonstrate the use of estimation methods for analyzing this data. 2. Apply appropriate machine learning algorithms for classification. 3. Compare and choose one data visualization method for effective visualization of data. 4. Design a model of recommendation system based on the content of the data. 5. Apply standard clustering methods to analyze social network graph**.**	

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Data Science	What is Data Science, Data Science Process, Data Science Toolkit, Types of data, Example and Applications	CO1	04	10
2. Data collection and management	Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management using multiple data sources		06	
3. Exploratory Data Analysis	Introduction to exploratory data analysis, Typical data formats. Types of EDA, Graphical/Non graphical Methods. Univariate /multivariate methods Correlation and covariance. Degree of freedom Statistical Methods for Evaluation including ANOVA.	CO2	08	08
4. Data Visualization	What is Data Visualization, Importance of Data Visualization Design Principles of Data Visualization, Types of Data visualization: Basic charts, plots, Histogram Multivariate Data Visualization, Visualization of groups, trees, graphs, clusters, networks, Hierarchies, Reports, Metaphorical visualization	CO3	09	09
5. Recommendation Systems	Introduction to RS, Types of RS: content based RS, collaborative RS, hybrid RS, Issues and challenges of RS, Examples of real world RS, e.g., Amazon, mobile RS	CO4	05	05
6. Social Network Analysis	Social Networks as Graphs, Varieties of Social Networks, Graphs with Several Node Types, Clustering of Social-Network Graphs. Distance	CO5	07	07

	Measures for Social-Network Graphs, Applying Standard Clustering Methods, Betweenness, The Girvan-Newman Algorithm, Using Betweenness to Find Communities			
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from the Frontline" O' Reilly Media 2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. "Mining of Massive Datasets" v2.1, Cambridge University Press
Reference Books	1. Laura Igual and Santi Segui, "Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications", Springer, 1st Edition, 2017

Useful Links:

1. https://nptel.ac.in/courses/106/106/106106179/

2. https://nptel.ac.in/courses/106/106/106106179/

3. https://www.coursera.org/browse/data-science

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

SOMAIYA

V I D Y A V I H A R

K J Somaiya Institute of Engineering and Information Technology
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Lab Code	Lab Name	Credits (P+TUT)
ETDLL7044	**Data Science & Applications Lab**	**(1+0)**

Lab Prerequisite:	1.Basic Python programming
Lab Objectives:	1. The objective of this course is to provide comprehensive knowledge of python programming paradigms required for Data Science.
Lab Outcomes (LOs):	1. Demonstrate the usage of built-in objects in Python 2. Analyze the significance of python program development environment by working on real world examples 3. Implement numerical programming, data handling and visualization through NumPy, Pandas and MatplotLib modules. 4. Students will be able to write clear documentation for and interpret the results of the performed experiments 5. Students will be able to stick to a timeline and follow rules of the laboratory. 6.Student will able to communicate clearly and effectively

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Interactive commands in Python, data operations, simple programs for writing into files and reading from files. Data file manipulations programs.	LO1, LO2, LO4. LO5, LO6	02
2.	Familiarization with IDE in Python.		02
3.	Writing programs for standard algorithms of sorting and searching in Python.		02
4.	Plotting the data using X-Y graph, Bar- chart, and using other plotting techniques.	LO1, LO2, LO3, LO4. LO5, LO6	02
5.	Write programs to perform exploratory data analysis: variance, standard derivation, summarization, distribution, and statistical inference.	LO1, LO2, LO4. LO5, LO6	02
6.	Plotting the various distributions for given data sets.		02
7.	Classifying and presentation of data using support vector machine.		02
8.	Write programs for k-means clustering and presentation for given data sets.		02
9.	Write programs on graphs of social networks for community detection		02
10.	Write programs for analysis of graphs to find centrality and page-rank.		02

The case study may be chosen on any relevant topic which involves big data. Suggested case studies are as follows:
1.Sentiment Analysis for COVID-19.
2.Counting number of likes on Instagram.
3.Weather Forecasting.
4.Predicting the trend of the market.

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Virtual Lab Links:
https://towardsdatascience.com/virtual-environments-for-data-science-running-python-and-jupyter-with-pipenv-c6cb6c44a405

Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Science and Applications Lab". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).
Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7051	**Product Life Cycle Management**	**(3+0+0)**

Course Objectives:	1. To familiarize the students with the need, benefits and components of PLM 2. To acquaint students with Product Data Management & PLM strategies 3. To give insights into new product development program and guidelines for designing and developing a product 4. To familiarize the students with Virtual Product Development 5. To familiarize the students with the need, benefits and components of PLM 6. To acquaint students with Product Data Management & PLM strategies 7. To give insights into new product development program and guidelines for designing and developing a product 8. To familiarize the students with Virtual Product Development
Couse Outcomes:	1. Apply the different phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.(PO3) 2. Analysis various approaches and techniques for designing and developing products.(PO5) 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.(PO8) 4. Applying virtual product development tools for components, machining and manufacturing plant.(PO7) 5. Create an Integration of Environmental Aspects in Product Design(PO7) 6.Analysis the Life Cycle Assessment and Life Cycle Cost Analysis(PO11,12)

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Product Lifecycle Management (PLM)	1.1 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
	1.2 PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.		04	
2. Product Design	2.1 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	CO2	05	09

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	Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering.			
	2.2 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		04	
3. Product Data Management (PDM)	3.1 Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	CO3	05	05
4. Virtual Product Development Tools	4.1 For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques.	CO4	03	05
	4.2 Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies		02	
5. 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, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	CO5	05	05
6. Life Cycle Assessment and Life Cycle Cost Analysis	6.1 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
	6.2 Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**
Books:				

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Text Books	1. Product Lifecycle Management Authors: Saaksvuori, Antti, Immonen, Anselmi ISBN 978-3-540-26906-9
	2**.** Product Lifecycle Management: 21st Century Paradigm for Product Realisation Decision engineering, ISSN 1619-5736,2005
Reference Books	1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
	2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment- A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
	3. SaaksvuoriAntti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
	4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking",TataMcGrawHill,2006,ISBN:0070636265

Useful Links:
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:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

![Somaiya Vidyavihar logo]

SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
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Course Code	Course Name	Credits (TH+P+TUT)
ILC7052	**Reliability Engineering**	**(3+0+0)**

Prerequisites:	--
Course Objectives:	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 the various aspects of Maintainability, Availability and FMEA procedure.
Couse Outcomes:	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. & Name	Sub Topics	CO mapped	Hrs./ Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Probability theory	1.1 Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem	CO1	02	08
	1.2 Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.		03	
	1.3 Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.		03	
2. Reliability Concepts, Failure Data Analysis, Reliability Hazard Models	2.1 Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.	CO2	02	08
	2.2 Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.		03	
	2.3 Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.		03	

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3. System Reliability	System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	CO 3	05	05
4. Reliability Improvement	4.1 Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	CO4	04	08
	4.2 System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.		**04**	
5.Maintainability and Availability	5.1 System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics.	CO 5	03	05
	5.2 Parts standardization and Interchange ability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.		02	
6. Failure Mode, Effects and Criticality Analysis	6.1 Failure mode effects analysis, severity/criticality analysis, FMECA examples.	CO 6	03	05
	6.2 Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text books	1. Introduction To Reliability Engineering 2Nd Edition by Lewis, Wiley India 2. Reliability Engineering Theory And Practice 8Ed (Hb 2017) by BIROLINI A., SPRINGER 3. The Certified Reliability Engineer Handbook by Donald W. Benbow, Hugh W. Broome, New Age International (P) Ltd., Publishers
Reference Books	1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985. 2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill. 3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980. 4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985. 5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons. 6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

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/downloads/Module_5_Lecture_3_final.pdf
4. https://documents.in/document/curso-nptel-reliability-engineering.html

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5. https://www.coursera.org/learn/site-reliability-engineering-slos

Continuous Assessment:
- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).   - Average marks of T-1 and T-2 will be considered.   - Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7053	**Management Information System**	**(3+0+0)**

Prerequisites:	--
Course Objectives:	1. The course is blend of Management and Technical field. 2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built. 3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage. 4. Identify the basic steps in systems development.
Couse Outcomes:	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. Apply to improve business performance and decision making. 6. Identify the types of systems used for enterprise wide knowledge management.

Module No. & Name	Sub Topics	CO mapped	Hrs./Subtopic	Total Hrs./Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Information System	1.1 Computer Based Information Systems, Impact of IT on organizations.	CO1	02	04
	1.2 Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.		02	
2. Data and Knowledge Management	2.1 Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.	CO2, CO3	04	07
	2.2 Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results.		03	
3. Ethical Issues and Privacy	3.1 Ethical issues and Privacy: Information Security.	CO3	03	07
	3.2 Threat to IS and Security Controls.		04	
4. Social Computing (SC)	4.1 Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing.	CO4	03	07
	4.2 Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.		04	
5. Computer Networks	5.1 Computer Networks Wired and Wireless technology.	CO5	03	06
	5.2 Pervasive computing, Cloud computing model.		03	

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6. **Project leadership and Ethics and Closing the projects**	6.1 Information System within Organization: Transaction Processing Systems, Functional Area Information System.		04	08
	6.2 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, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. K. Rainer, Brad Prince, Management Information Systems, Wiley. 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm10th Ed., Prentice Hall.
Reference Books	1. S. Jawadekar's Management Information Systems: published by McGraw-Hill Education. 2. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall.

Useful Links:

1.https://www.nptel.ac.in/

2.https://www.coursera.org/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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VIDYAVIHAR

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7054	**Design of Experiments**	**(3+0+0)**

Prerequisites:	--
Course Objectives:	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 experimental designs for robustness and optimization
Couse Outcomes:	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 the different two level factorial designs. 4. Distinguish 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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction	1.1 Strategy of Experimentation, Typical Applications of Experimental Design.	CO1	01	02
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.		01	
2. Fitting Regression Models	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	CO2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.		04	
3. Two-Level Factorial Designs and Analysis	3.1 The 2^2 Design, The 2^3 Design, The General $2k$ Design.	CO3	04	08
	3.2 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.		04	
4. Two-Level Fractional Factorial Designs and Analysis	4.1 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
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.		04	
5. Conducting Tests	5.1 Introduction to Response Surface Methodology, The Method of Steepest Ascent.	CO5	04	08

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	5.2 Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.		04	
6. Taguchi Approach	6.2 Crossed Array Designs and Signal-to-Noise Ratios.	CO6	03	05
	6.3 Analysis Methods, Robust design examples.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	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. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.

Useful Links:
1. https://nptel.ac.in/courses/110/105/110105087/
2.https://www.udemy.com/course/design-of-experiments-i/

Continuous Assessment:
• Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).   • Average marks of T-1 and T-2 will be considered.   • Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7055	**Operation Research**	**3+0+0**

Course Objectives:	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:	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. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
I.Prerequisite and Course outline	Prerequisite concepts, Introduction, Structure of the Mathematical Model, Limitations of operational research.	-	01	01
1.Linear Programming	1.1 Linear Programming: Problem formulation, Graphical Method and simplex method.	1	04	10
	1.2 Artificial Variable Simplex Techniques: Big-M Method and Two-Phase Method.	1	03	
	1.3 Advanced Topics in Linear Programming: Duality in Linear Programming and the Dual Simplex Method.	1	03	
2.Transportation models and Assignment models	2.1 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.	2	03	06
	2.2 Assignment Model: The Hungarian method for solution of Assignment problems, Unbalanced assignment problem and maximization problem.	2	03	
3.Queuing Model and Game Theory	3.1 Queuing Models: Introduction, Single-channel, Finite population model with Poisson Arrivals and Exponential Service Times (Limited Source Model).	3	03	06

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	3.2 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.	3	03	
4. Network analysis in project planning and Sequencing models	4.1 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)	4	04	07
	4.2 Sequencing Models: Processing n jobs through one machine, two machines and three machines, Processing n jobs through m machines.	4	03	
5. Inventory Control and Simulation	5.1 Inventory Models: Introduction, Inventory models with Deterministic demand (with and without shortages) and Inventory models with price breaks.	5	04	07
	5.2 Simulation: Definition, Types of Simulation Models, Monte Carlo Technique, Practical Problems, Applications in Queuing and Inventory problems.	5	03	
6. Decision Theory	Steps in Decision theory approach, Decision – Making Environments, Decision making under conditions of certainty and uncertainty, Decision making under conditions of Risk and Decision Trees.	6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total hours	**42**
Reference Books:	1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002. 2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009 3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002. 4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut 5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan 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):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding

contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with 02 hours and 30 minutes duration.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7056	**Cyber Security and Laws**	**(3+0+0)**

Prerequisites:	--
Course Objectives:	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
Couse Outcomes:	Learner 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 cyber-crimes. 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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite 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 and the Indian ITA 2000, A global Perspective on cybercrimes.	CO1	04	04
2. Cyber offenses & Cybercrime	How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, 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, 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	09	09
3. Tools and Methods Used in Cyberline	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	CO3	06	06
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	CO4	08	08

	in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law			
5 Indian IT Act.	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	CO5	06	06
6. Information Security Standard compliances	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				**42**

Books:	
Text Books	1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi 2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi. 4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books	1.Nina Godbole, Information Systems Security, Wiley India, New Delhi 2.Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing. 3.William Stallings, Cryptography and Network Security, Pearson Publication 4.Websites for more information is available on: The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in 5.Website for more information, A Compliance Primer for IT professional

Useful Links:
1. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2. Website for more information , A Compliance Primer for IT professional https://www.sans.org/reading-room/ whitepapers/ compliance/ compliance-primer-professionals- 33538

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7057	**Disaster Management and Litigation Measures**	**(3+0+0)**

Prerequisite:	--
Course Objectives:	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 or 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.
Couse Outcomes:	Upon completion of the course, the learners will be able to: 1. Get to Know Natural as Well as Manmade Disaster and their Extent and Possible Effects on the Economy. 2. Plan of National Importance Structures Based Upon the Previous History. 3. Get acquainted with government Policies, acts and Various Organizational Structure Associated with an Emergency. 4. Get to Know the Simple Dos and Don'ts in Such Extreme Events and act accordingly. 5. Examine Financing Relief Measures. 6. Study Preventive and Mitigation Measures.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction	1.1 Definition of Disaster, Hazard, Global and Indian Scenario, General Perspective, Importance of Study in Human Life.	CO1	02	04
	1.2 Direct and Indirect Effects of Disasters, Long Term Effects of Disasters.		02	
2.Natural Disaster and Manmade disasters	2.1 Natural Disaster: Meaning and Nature of Natural Disaster, Flood, Flash Flood, Drought, Cloud Burst.	CO2	01	07
	2.2 Earthquake, Landslides, Avalanches, Volcanic Eruptions, Mudflow, Cyclone, Storm, Storm Surge.		01	
	2.3 Climate Change, Global Warming, Sea Level Rise, Ozone Depletion.		02	
	2.4 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of Growing Population and Subsequent Industrialization.		02	
	2.5 Urbanization and Changing Lifestyle of Human Beings in Frequent Occurrences of Manmade Disasters.		01	
3.Disaster Management,	3.1 Disaster Management: Meaning, Concept, Importance.	CO3	02	06

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Policy and Administration	3.2 Objective of Disaster Management Policy, Disaster Risks in India, Paradigm Shift in Disaster Management.		02	
	3.3 Policy and Administration Importance and Principles of Disaster Management Policies, Command and Co-Ordination of in Disaster Management.		01	
	3.4 Rescue Operations: How to Start With And How to Proceed in Due Course of Time, Study of Flowchart Showing the Entire Process.		01	
4.Institutional Framework for Disaster Management in India	4.1 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
	4.2 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	
	4.3 Use of Internet and Software for Effective Disaster Management. Applications of GIS, Remote Sensing and GPS.	CO3,4	02	
5.Financing Relief Measures	5.1 Ways to Raise Finance for Relief Expenditure, Role of Government Agencies and NGO's in this Process.	CO5	02	08
	5.2 Legal Aspects Related to Finance Raising as well as Overall Management of Disasters.		02	
	5.3 Various NGO's and the Works they have Carried Out in the Past on the Occurrence of Various Disasters, Ways to Approach these Teams.		02	
	5.4 International Relief Aid Agencies and Their Role in Extreme Events.		02	
6. Preventive and Mitigation Measures	6.1 Pre-Disaster, During Disaster and Post-Disaster Measures in Some Events in General.	CO6	02	08
	6.2 Structural Mapping: Risk Mapping, Assessment and Analysis, Sea Walls and Embankments, Bio Shield, Shelters, Early Warning and Communication.		02	
	6.3 Non-Structural Mitigation: Community Based Disaster Preparedness, Risk Transfer and Risk Financing, Capacity Development and Training, Awareness And Education, Contingency Plans.		02	
	6.4 Do's And Don'ts in Case of Disasters and Effective Implementation of Relief Aids.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**
Books:				

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Text Books	1. H Gupta Disaster Management, Universities Press Publications.
	2. O Dagur, Disaster Management: An Appraisal of Institutional Mechanisms in India, Centre for Land Warfare Studies.
	3. C Damon and Butterworth, Introduction to International Disaster Management, Elseveir Publications.
Reference Books	1. K. Yonng, Concepts and Techniques of GIS –C.P.Lo, Prentice Hall (India) Publications.
	2. R Singh, Natural Hazards and Disaster Management, Vulnerability and Mitigation, Rawat Publications.

Useful Links:

1. www.msme.gov.in/

2. www.dcmesme.gov.in/

3. www.msmetraining.gov.in/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7058	**Energy Audit and Management**	**(3+0+0)**

Prerequisites	--
Course Objectives:	1.To understand the importance energy security for sustainable development and the fundamentals of energy conservation. 2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management. 3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.
Couse Outcomes:	After the successful completion of this course, the learner will be able to: 1. Illustrate present state of energy security and its importance. 2. Describe the basic principles and methodologies adopted in energy audit of an utility. 3. Apply the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. Evaluate the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. Analyze the data collected during performance evaluation and recommend energy saving measures. 6. Reviewing the concepts of Energy Conservation in buildings

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite 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, Energy Conservation Act- 2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	CO1	04	04
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, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information- analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	CO2	08	08
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. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent	CO3	10	10

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	controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.			
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. 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 and Air Conditioning system performance and savings opportunities.	CO4	10	10
5. Energy Performance Assessment	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	CO5	04	04
6. Energy conservation in Buildings	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science 2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System 3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons 4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI). 5. Energy Management Principles, C.B.Smith, Pergamon Press
Reference Books	1. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press 2. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Useful Links:

1.www.energymanagertraining.com

2.www.bee-india.nic.in

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC7059	**Development Engineering**	**(3+0+0)**

Prerequisites	----
Course Objectives:	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.
Couse Outcomes:	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. Explain methods to plan, analyze, and interpret the results of experiments.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction	1.1 Strategy of Experimentation, Typical Applications of Experimental Design.	CO1	01	03
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.		02	
2. Fitting Regression Models	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regressions.	CO2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new Response Observation, Regression Model Diagnostics, Testing for Lack of Fit.		04	
3.Two Levels Factorial Designs	3.1 The 2^2 Design, The 2^3 Design, The General 2^k Design	CO3	03	08
	3.2 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.		05	
4.Two Levels Fractional Factorial Methods	4.1 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
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.		04	

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5.1 Response Surface Methods and Designs	5.1 Introduction to Response Surface Methodology, The Method of Steepest Ascent.	CO5	04	08
	5.2 Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.		04	
6. Taguchi Approach	6.1 Crossed Array Designs and Signal-to-Noise Ratios.	CO6	02	04
	6.2 Analysis Methods, Robust Design examples.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	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, Prentice Hall.

Useful Links:

*guide.berkeley.edu/graduate/degree-programs/***development-engineering**

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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**.**

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Project Based Learning Code	Project Based Learning Name	Credits (P+TUT)
ETPR75	**Major Project Lab-A**	**(3+0)**

PBL Prerequisite:	1.PBL Mini Project Lab-1 2.PBL Mini Project Lab-2 3.PBL Minor Project Lab-1 4.PBL Minor Project Lab-2

PBL Objectives:	The Project work enables the students,
	  1. To develop the required skills and knowledge about research.
	  2. To analyze a specific problem or issue by using the latest technologies with a multidisciplinary approach.
	  3. To demonstrate proficiency in the design of a research project, application with appropriate research methods.
	  4. To present and adopt various research ideas with appropriate solution

PBL Outcomes:	Learner will be able to, 1. Identify formulate, review research literature, and analyse complex engineering problems 2. Design solutions, components, or processes for complex engineering problems 3. Select appropriate modern engineering tools and analyse data to meet the problem statement. 4. Use standard norms of engineering practices and engage in lifelong learning. 5. Excel in writing reports with effective presentation. 6. Interact efficiently as an individual with the team members for timely and professional management of project.

Guidelines:

1. Project Topic:

To proceed with the project work it is very important to select the right topic. Projects can be undertaken on any domain of electronics and recent technology programmes.

- Research and development projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum four and must be original.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Students must consult an internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff in the department will take decisions regarding selection of projects.
- Online log-book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Students have to submit a weekly progress report to the internal guide whereas the internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding the term work marks. In case of industry projects, visit by an internal guide will be preferred.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Project Report Format:

At the end of semester a project report should preferably contain at least following details,

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1. Abstract
2. CO-PO mapping
3. Introduction
4. Literature Survey
   a) Comparative Survey of Existing system
   b) Limitation of the Existing system or research gap
5. Proposed System
   a) Problem Statement and Objective
   b) Methodology (your approach to solve the problem)
   c) Analysis/Framework/ Algorithm
   d) Details of Hardware & Software
   e) Design details
   f) Budget details
   g) Implementation Plan for next semester
6. Conclusion and future scope
7. References
8. Term Work:
   Distribution of marks for term work shall be as follows:
   a) Weekly Attendance on Project Day
   b) Contribution in the Project work
   c) Project Report (Spiral Bound)
   d) Term End Presentation (Internal)
9. The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

P&O: P&O examination will be based on presentations and demonstrations of Major Project-A.

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Course Code	Course Name	Hours/Duration
INT76	Internship-6	2-4 Weeks

Prerequisite:	**In depth knowledge about societal/research/innovation/entrepreneurial problems and appropriate applicable solutions available through use of technology.**
Course Objectives:	1. To gain the experience in preparing and writing Technical documentation/ reports for product/projects. 2. To Identify and analyse the societal/research/entrepreneurial problem in detail to define its scope with problem specific data. 3. To develop clarity of presentation based on communication, teamwork and leadership skills.
Couse Outcomes:	**Upon completion of the course, students will be able to:** 1. Apply the engineering and technical knowledge for problem identification, analysis, design and developing solutions. 2. Present and demonstrate the real time problem solution across national/international project competitions and conference.

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. Mandatory participation at institute annual International Conference on Advances in Science and Technology-ICAST.

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. 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.

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Program Structure for Last Year UG Technology (ETRX)
Semester- VIII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) (TH –P–TUT)	Total (Hrs.)	Credit Assigned (TH–P–TUT)	Total Credits	Course Category
ETC801	Industrial Automation	3–0–0	03	3–0–0	03	PC
ETDLC802X	Department Level Elective-5	3–0–0	03	3–0–0	03	DLE
ETDLC803X	Department Level Elective-6	3–0–0	03	3–0–0	03	DLE
ILC804X	Institute Level Elective-2	3–0–0	03	3–0–0	03	ILE
ETL801	Industrial Automation Lab	0–2–0	02	0–1–0	01	PC
ETDLL802X	Department Level Elective-5 Lab	0–2–0	02	0–1–0	01	DLE
ETDLL803X	Department Level Elective-6 Lab	0–2–0	02	0–1–0	01	DLE
ETPR86	Project Based Learning-Major Project Lab-B	0-12**-0	12*	0–6–0	06	PBL
INT87	Internship-7	--	--	--	--	INT
Total		**12-18-0**	**30**	**12- 9- 0**	**21**	

** PBL Major -PR-B Conference /Journal Publication, Filling Patent, Creation of Product & Licensing, Startup, SIH, Participation etc) along with contents as per curriculum and for the grant of TW.
*Load of learner, not the faculty

Semester- VIII-Examination Scheme

Course Code	Course Name	CA T1	CA T2	CA Average (T-1 & T-2)	IA	ESE	TW	O	P	P&O	Total
ETC801	Industrial Automation	30	30	30	10	60	--	--	--	--	100
ETDLC802X	Department Level Elective-5	30	30	30	10	60	--	--	--	--	100
ETDLC803X	Department Level Elective-6	30	30	30	10	60	--	--	--	--	100
ILC804X	Institute Level Elective-2	30	30	30	10	60	--	--	--	--	100
ETL801	Industrial Automation Lab	--	--		--	--	25	25	--	--	50
ETDLL802X	Department Level Elective-5 Lab	--	--	--	--	--	25	25	--	--	50
ETDLL803X	Department Level Elective-6 Lab	--	--	--	--	--	25	25	--	--	50
ETPR86	Project Based Learning-Major Project Lab-B	--	--	--	--	--	50	--	--	100	150
INT87	Internship-7	--	--	--	--	--	--	--	--	--	--
Total		**--**	**--**	**120**	**40**	**240**	**125**	**75**	**--**	**100**	**700**

Major Project A and B: Students can form groups with minimum 2 and not more than 4
Faculty Load: In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

Department Level Elective-5			
Group A: Data Storage and Technology	Group B: Electronics Core	Group C: Artificial Intelligence and Data Science	Group D: Computer Domain
ETDLC8021	**ETDLC8024**	**ETDLC8023**	**ETDLC8022**
Microelectromechanical Systems (MEMS)	Virtual Instrumentation	Advanced Power Electronics	Web Design
Department Level Elective-6			
Group A: Data Storage and Technology	Group B: Electronics Core	Group C: Artificial Intelligence and Data Science	Group D: Computer Domain
ETDLC8034	**ETDLC8033**	**ETDLC8032**	**ETDLC8031**
Integrated Circuit Technology	System On Chip	Industrial Internet of Things	Next Generation Networks
Institute Level Elective-2			
ILC8041	**ILC8042**	**ILC8043**	**ILC8044**
Project Management	Finance Management	Entrepreneurship Development and Management	Human Resource Management
ILC8045	**ILC8046**	**ILC8047**	**ILC8048**
Professional Ethics and CSR	Research Methodology	IPR and Patenting	Digital Business Management
ILC8049			
Environmental Management			

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Course Code	Course Name	Credits (TH+P+TUT)
ETC801	**Industrial Automation**	**(3+0+0)**

Prerequisite:	1.Basics of Electrical Engineering 2.Electronics Devices and Circuits-I 3.Linear Control System
Course Objectives:	1. To teach automation architecture of Industrial Automation System. 2. To be familiar with various automation components. 3. To learn about Computer Aided Measurements and Control Systems 4. To disseminate knowledge about use of Robot in Industrial Automation.
Couse Outcomes:	After learning the course, the students will be able to: 1. Explain architecture of Industrial Automation System. 2. Describe various automation components and systems. 3. Learn Computer Aided Measurements and Control System. 4. Apply programmable logic controllers for industrial automation. 5. Explain Distributed Control System. 6. Use of robot for Industrial Automation.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Industrial Automation	1.1 Introduction to Automation overview, Requirement of automation systems, Architecture of Industrial Automation system.	CO1	03	06
	1.2 Introduction of PLC and supervisory control and data acquisition (SCADA). block diagram, Industrial bus systems: modbus & profibus.		03	
2.Automation components	2.1 Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement.	CO2	03	06
	2.2 Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.		03	
3. Computer aided measurement and control systems	3.1 Role of computers in measurement and control.	CO3	02	08
	3.2 Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking.		03	
	3.3 Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.		03	
4. Programmable Logic	4.1Programmable controllers, programmable logic controllers, Analog digital input and output	CO4	02	08

Controllers	modules			
	4.2 PLC programming, Ladder diagram, Sequential flow chart.		02	
	4.3 PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation.		02	
	4.4 Application of PLC to process control industries.		02	
5.Distributed Control System	5.1 Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks,	CO5	04	08
	5.2 DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.		04	
6. Overview of Industrial automation using robots	Basic construction and configuration of robot Pick and place robot, Welding robot.	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. Industrial Instrumentation and Control by S.K. Singh Mc-Graw Hill Publications, Third Edition, 2017 2. Process Control Instrumentation Technology by C.D. Johnson PHI Publications, Seventh Edition, 2019
Reference Books	1. Industrial Control Handbook by E. A. Parr, Newnem, Publication, 1998. 2. Introduction to Programmable Logic Controllers by Dunning, Thomson Publication, Third Edition 2005 3. SCADA- Supervisory Control and Data Acquisition by Stuart A. Boyer, ISA Publications 4. Industrial Robotics-Technology, Programming and Applications by Michell P. Grover, Tata McGraw-Hill Edition

Useful Links:

1. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L01(SM)(IA&C)%20((EE)NPTEL).pdf

2. https://www.youtube.com/watch?v=oxMdDsud5vg&list=PLE8F9BF5CB1201D23

3. https://www.youtube.com/watch?v=EgtQs6Pclxs

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

SOMAIYA

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Lab Code	Lab Name	Credits (P+TUT)
ETL801	**Industrial Automation Lab**	**(1+0)**

Lab Prerequisite:	1. Electronics Devices and Circuits-I 2. Electronics Devices and Circuits-II
Lab Objectives:	1. To teach various online tools available by IIT 2. To learn working of sensors and actuators 3. To learn Industrial Automation and Control System
Lab Outcomes (LOs):	After successful completion of the course student will be able to 1. Learn and use various online simulation tools. 2. Perform simulation for sensors and actuators. 3. Perform experiment on Industrial Automation and Control System 4. Design ladder diagram for Industrial Applications

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Use industrial grade sensors and transducer introduction and characteristics like proximity detector, linear encoder, rotary encoder, touch sensor, force sensor, accelerometer, RTDs, load cells and LVDT for measurement.	LO1, LO2	02
2.	Use Various actuators such as relay, solenoid valve, process control valve and motors for control applications.		02
3.	Simulate analog and digital function blocks.	LO1, LO3	02
4.	Relay logic diagram and ladder logic diagram.	LO1, LO4	02
5.	Understand and perform experiments on timers and counters.	LO1, LO3	02
6.	Logic implementation for traffic Control Application.		02
7.	Logic implementation for Bottle Filling Application.		02
8.	Tune PID controller for heat exchanger using DCS.		02
9.	Study Hardware and Software platform for DCS.		02

Useful Links:
1. http://ial-coep.vlabs.ac.in/
2. www.plctutor.com
Term work:

1. Term work should consist of a Minimum of 8 experiments.
  2. Journal must include at least 2 assignments on content of theory and practical of the course "Industrial Automation Lab".
  3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
  4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral: Oral examination will be based on experiment list and performance of experiment.

SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8021	**Micro Electromechanical System**	**(3+0+0)**

Prerequisite:	1.Basic VLSI Design
	2.Mixed Signal VLSI Design
	3.Electronic Instrumentation and Measurement
Course Objectives:	1. To provide knowledge of MEMS processing steps and processing modules
	2. To provide knowledge of MEMS Materials with respect to applications.
	3. To demonstrate the use of semiconductor-based processing modules used in the fabrication of variety of sensors and actuators (e.g., pressure sensors, accelerometers, etc.) at the micro-scale.
	4. To provide an understanding of basic design and operation of MEMS sensors, actuators and structures.
Couse Outcomes:	1. Identify types of real-world MEMS sensors/actuators and its use in various MEMs applications.
	2. Describe various MEMS materials and selection of materials based on applications.
	3. Describe working principle, construction of MEMS Sensors, Actuators and Structures.
	4. Explain MEMs fabrication processes and selection of fabrication processes based on applications.
	5. Explain working principle, constructions and fabrication steps of MEMs devices,
	6. Describe MEMS device characterization and importance of measurements of various parameters in device behavior & MEMs reliability.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction to MEMS	1.1 Introduction to MEMS, Comparison with Micro Electronics Technology	CO1	01	03
	1.2 Real world examples (Air-Bag, DMD, Pressure Sensors), MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications		02	
2. MEMS Materials and Their Properties	2.1 Materials (eg. Si, SiO2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt)	CO2	05	08
	2.2 Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.		03	
3.MEMS Sensors, Actuators and Structures	3.1 MEMS Sensing (Capacitive, Piezo electric Piezo resistive)	CO3	03	06
	3.2 Micro Actuation Techniques, Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps.		03	

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Module	Content	CO	Hrs	Total
4. MEMS Fab Processes	4.1 MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio Micro	CO4	04	10
	4.2 Machining (LIGA, Laser), X-Ray Lithography, Photolithography, PVD techniques, Wet, Dry, Plasma		03	
	4.3 Etching, DRIE, Etch Stop Techniques. Die, Wire & Wafer Bonding, Dicing, Packaging.		03	
5.MEMS Devices	Architecture, working and basic behaviour of Cantilevers, Micro heaters, Accelerometers, Pressure Sensor types, Micromirrors in DMD, Inkjet printer- head. Steps involved in Fabricating above devices.	CO5	08	08
6. MEMS Device Characterization	6.1 Piezo-resistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behaviour	CO6	03	04
	6.2 MEMS Failure Mechanisms and Reliability.		01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:

Text Books	1.MEMS and MICROSYSTEMS Design and Manufacture by Tai Ran Hsu, McGraw Hill Education
Reference Books	1. An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
	2. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill
	3. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
	4. Micro-system Design - by S. Senturia; Publisher: Springer
	5. .Analysis and Design Principles of MEMS Devices – Minhang Bao; Publisher: Elsevier Science
	6. .Fundamentals of Micro-fabrication – by M. Madou; Publisher: CRC Press; 2 editions .
	7. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Useful Links:

1.https://nptel.ac.in/courses/117/105/117105082/

2.https://www.mems-exchange.org/MEMS/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8021	**Micro Electro Mechanical System Lab**	**(1+0)**

Lab Prerequisite:	1.Basic VLSI Design 2.Mixed Signal VLSI Design 3.Electronic Instrumentation and Measurement
Lab Objectives:	1. To provide knowledge of MEMS processing steps, used of materials with respect to specific applications. 2. To provide an understanding of basic design and operation of MEMS devices. 3. To provide an understanding of performance characteristics of MEMS devices.
Lab Outcomes (LOs):	After successful completion of the course students will be able to: 1. Perform practical's using online simulation tool with active participation 2. Demonstrate clear understanding of operation of MEMS devices 3. Write clear documentation for and interpret the results of the performed experiments 4. Communicate clearly and effectively. 5. The student will be able to write accurate documentation for experiments performed. 6. The student will be able apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Design electro-statically actuated cantilever.	LO1, LO3, LO4, LO5, LO6	02
2.	Design bimorph cantilever which acts as pressure sensor.		02
3.	Dynamic analysis of Beam.		02
4.	Find the tip deflection of the cantilever with different types of loads	LO2, LO3, LO4, LO5, LO6	02
5.	Find the tip deflection of the cantilever in sweep analysis		02
6.	Model and simulate Electro-mechanical actuator. Do dc and transient analysis		02
7.	Design the geometry of MEMS and find performance characteristics such as resonant frequency, deflection per voltage or temperature		02
8.	Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam		02
9.	Model and simulate of accelerometer		02
10.	Case study of MEMS based device	LO3, LO4, LO5, LO6	02
Term work:			
1. Term work should consist of a Minimum of 8 experiments.			

2. Journal must include at least 2 assignments on content of theory and practical of the course "Micro Electro Mechanical System Lab".

3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.

4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral: Oral examination will be based on experiment list and performance of experiment.

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VIDYAVIHAR

K J Somaiya Institute of Engineering and Information Technology
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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8022	**Web Designing**	**(3+0+0)**

Prerequisite:	1. Data Structures
	2. Basics of Programming Languages
Course Objectives:	1. To design and create web pages using HTML5 and CSS3.
	2. To Create web pages and provide client side validation.
	3. To create dynamic web pages using server side scripting.
	4. To use MVC framework for web application development.
Couse Outcomes:	1. Understand the core concepts and features of Web Technology
	2. Design static web pages using HTML5 and CSS3
	3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery.
	4. Evaluate client and server side technologies and create Interactive web pages using PHP, AJAX with database connectivity using MySQL.
	5. Understand the basics of XML, DTD and XSL and develop web pages using XML / XSLT.
	6. Analyze end user requirements and Create web application using appropriate web technologies and web development framework

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to WWW	1.1 Internet Standards – Introduction to WWW – WWW Architecture – SMTP – POP3 – File Transfer Protocol	CO1	02	02
2. Client Side Programming	1.2 Overview of HTTP, HTTP request – response — Generation of dynamic web pages- W3C Validator, How web works - Setting up the environment (LAMP/XAMP/WAMP server)	CO2	02	08
	2.1 Markup Language (HTML): Introduction to HTML and HTML5 - Formatting and Fonts – Commenting Code – Anchors – Backgrounds – Images – Hyperlinks		02	
	2.2 Lists – Tables – Frames - HTML Forms and controls.		02	
	2.3 Cascading Style Sheet (CSS): The need for CSS, Introduction to CSS 3 – Basic syntax and structure, CSS Properties-Inline Styles – Embedding Style Sheets			
	2.4 Linking External Style Sheets – Backgrounds –Box Model (Introduction, Border Properties, Padding Properties, Margin Properties), Manipulating text - Margins and Padding - Positioning using CSS., Creating page Layout and Site Designs		02	

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3. Introduction to JAVA Script	3.1 Introduction - Core features - Data types and Variables - Operators, 6 Expressions, and Statements, Functions - Objects - Array, Date and Math related Objects	CO3	02	08
			02	
			02	
	3.2 Document Object Model - Event Handling Controlling Windows & Frames and Documents Form handling and validations.		02	
4. Server Side Programming	4.1 Introduction - Programming basics - Print/echo - Variables and constants – Strings and Arrays	CO4	02	09
	4.2 Operators, Control structures and looping structures – Functions – Reading Data in Web Pages		02	
	4.3 Embedding PHP within HTML - Establishing connectivity with MySQL database, cookies, sessions and Authentication		03	
	4.4 AJAX with PHP - AJAX with Databases		02	
5. XML	5.1 Dynamic page generation (adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script), XML – DTD(Document Type Definition) - XML Schema	CO5	03	06
	5.2 XML –DTD(Document Type Definition) - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX,XSL-eXtensible Style sheet Language		03	
6. Web Development Framework	6.1 Introduction to Composer - MVC Architecture	CO6	02	04
	6.2 Web Application Development using web development framework :-Introduction to Laravel, Development of Web pages using Laravel, Example web applications – Interactive websites, web based information systems , blogs, social networking sites etc.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. Ralph Moseley , M.T. Savliya , Developing Web Applications‖, Willy India, Second Edition, ISBN: 978-81-265-3867-6 2. Web Technology Black Book, Dremtech Press, First Edition, 978-7722-997 3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition 4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
Reference Books	1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, Internet and World Wide Web - How To Program, Fifth Edition, Pearson Education, 2011. 2. Achyut S Godbole and Atul Kahate, Web Technologies‖, Second Edition, Tata McGraw Hill, 2012. 3. Thomas A Powell, Fritz Schneider, JavaScript: The Complete Reference‖, Third Edition, Tata McGraw Hill, 2013. 4. David Flanagan, JavaScript: The Definitive Guide, Sixth Edition‖, O'Reilly Media, 2011 5. Steven Holzner, The Complete Reference - PHP‖, Tata McGraw Hill, 2008

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6. Mike Mcgrath, PHP & MySQL in easy Steps‖, Tata McGraw Hill, 2012.

Useful Links:

1. www.nptelvideos.in

2. www.w3schools.com

3. http://spoken-tutorial.org

| |

Continuous Assessment

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8022	**Web Designing Lab**	**(1+0)**

Lab Prerequisite:	1. Data Structures
	2. Basics of Programming Languages
Lab Objectives:	1. To design and create web pages using HTML5 and CSS3.
	2. To Create web pages and provide client side validation.
	3. To create dynamic web pages using server side scripting.
	4. To use MVC framework for web application development.
Lab Outcomes (LOs):	1. Explain the core concepts and features of Web Technology
	2. Design static web pages using HTML5 and CSS3
	3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery.
	4. Evaluate client and server side technologies and create Interactive web pages using PHP, AJAX with database connectivity using MySQL.
	5. Explain the basics of XML, DTD and XSL and develop web pages using XML / XSLT.
	6. Analyze end user requirements and Create web application using appropriate web technologies and web development framework.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Installation and Setting of LAMP / WAMP / XAMP	LO1	02
2.	Create Simple web page using HTML5	LO2	02
3.	Design and Implement web page using CSS3 and HTML5		02
4.	Form Design and Client Side Validation using: a. Javascript and HTML5 b. Javascript and JQuery	LO3	02
5.	Develop simple web page using PHP	LO4	02
6.	Develop interactive web pages using PHP with database connectivity MYSQL		02
7.	Develop XML web page using DTD, XSL	LO5	02
8.	To implement MVC architecture	LO6	02
9.	Implement a webpage using Ajax and PHP	LO4	02
10.	Hosting the website with Domain Registration Process.	LO6	02
11.	Design a Web application using Laravel Framework		02

Useful Links:	
1. www.nptelvideos.in	
2. www.w3schools.com	
3. http://spoken-tutorial.org	
Term work:	

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1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Web Designing Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).

Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8023	**Advanced Power Electronics**	**(3+0+0)**

Prerequisite:	1.Subjects taught in previous semesters, Power Electronics, Linear Control System, BEE
Course Objectives:	1. To enhance and expand the ideas of students for more complex power electronic Systems. 2. To teach the analytical methods in power electronic systems. 3. To expose the students to various applications of power electronics in various Electronics equipment and drives.
Couse Outcomes:	After successful completion of the course students will be able to: 1. Simulate three phase controlled rectifier circuits. 2. Simulate three phase inverter circuits. 3. Design mathematical model for DC-DC converter. 4. Demonstrate various speed control methods of DC drives. 5. Demonstrate speed control of AC drives in an energy efficient manner using power electronics. 6. Demonstrate various applications of power electronics

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Three-phase Rectifiers	Three-phase half-wave and full-wave controlled rectifiers with R and RL load	CO1	03	03
2. Three-phase inverters and control	2.1 Three phase bridge inverters (120^0 and 180^0 conduction mode) with R and RL load	CO2	04	06
	2.2 PWM for 3-phase voltage source inverters		02	
3. DC-DC Converters	3.1 Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters	CO3	06	08
	3.2 Feedback control of these converters (PI and PID).		02	
4.Power Electronic Applications in DC Drives	4.1 Introduction to DC motors, speed control of DC motor, drives with semi converters, full converters and dual converters	CO4	02	08
	4.2 Chopper-based drive		03	
	4.3 Electric braking of DC motors		03	
5. Power Electronic Applications in AC Drives	5.1 Introduction to three-phase induction motor	CO5	02	10
	5.2 Speed control methods for three-phase induction motor : i) Stator voltage ii) Variable frequency iii) Rotor resistance		08	

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	iv) V/f control v) Slip power recovery schemes			
6. Power Electronic Applications	6.1 Induction heating, dielectric heating, solid state relays	CO6	02	04
	6.2 Energy conversion interface in renewable energy system		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. M. H. Rashid, "Power Electronics", Prentice-Hall of India 2. L. Umanand, "Power Electronics Essentials and Applications", Wiley india Pvt. Ltd 3. Ned Mohan, "Power Electronics", Undeland, Robbins, John Wiley Publication 4. P. S. Bhimbra, "Power Electronics", Khanna Publishers, 2012
Reference Books	1.M.D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill 2.J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson 3.Education, 2002.P. C. Sen, "Modern Power Electronics", Wheeler Publication

Useful Links:

1.https://nptel.ac.in/courses/108/108/108108077/

2.https://onlinecourses.nptel.ac.in/noc19_ee65/preview

Continuous Assessment:
- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8023	**Advanced Power Electronics Lab**	**(1+0)**

Lab Prerequisite:	Power Electronics, Linear Control System
Lab Objectives:	1.To enhance and expand the ideas of students for more complex power Electronic Systems. 2. To teach the analytical methods in power electronic systems. 3. To expose the students to various applications of power electronics in various Electronics equipment and drives.
Lab Outcomes (LOs):	After successful completion of the course students will be able to: 1. Simulate single and three phase rectifiers circuits. 2. Simulate single and three phase inverter circuits. 3. Design different DC-DC converter for SMPS, chopper circuits. 4. Perform speed control of DC motor. 5. Demonstrate speed control of AC drives in an energy efficient manner using power electronics. 6. Demonstrate various applications of power electronics

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Single Phase Full Controlled Bridge Rectifier.	LO1	02
2.	Speed control of Separately excited DC motor using Armature Voltage Control	LO4	02
3.	Speed control of 3-phase Induction Motor using V/F control.	LO5	02
4.	Simulation of 3-phase fully controlled Bridge rectifier with R and RL load.	LO1	02
5.	Simulation of 1-phase fully controlled Bridge rectifier and study of various parameters.		02
6.	Simulation of 1-phase Inverter and study of various Performance parameters.	LO2	02
7.	Simulation of Closed loop dc-dc converter	LO4	02
8.	Study High Frequency Induction heating & Dielectric heating	LO6	02
9.	Study of operation and control of solid state relays.		02

Useful Links:

1. http://iitb.vlab.co.in/?sub=8&brch=117

2.http://vlabs.iitkgp.ernet.in/rcs/index.html

Term work:
1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Advanced Power Electronics Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks) .

Oral: Oral examination will be based on experiment list and performance of experiment.

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V I D Y A V I H A R

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An Autonomous Institute affiliated to University of Mumbai

Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8024	Virtual Instrumentation	(3+0+0)

Prerequisite:	1.Instrumentation System Design, 2. Biomedical Instrumentation
Course Objectives:	1. To understand virtual instrumentation (VI) & to realize its architecture 2. To familiarize with VI software & learn programming in VI 3. To study various instruments interfacing & data acquisition methods 4. To understand various analysis tools & develop programs for different measurement applications.
Couse Outcomes:	At The end of the course, students should gain the ability to, 1.Describe the concepts of virtual instrumentation 2.Select the proper data acquisition hardware 3.Configure the data acquisition hardware using LabVIEW 4 . Use LabVIEW to interface related hardware like transducers 5 . Design virtual instruments for practical applications

Module No. & Name	Sub Topics	CO mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction to Virtual Instrumentation (VI)	1.1.Historical perspective Need for VI Advantages of VI Definition of VI Block diagram & architecture of VI	CO1	02	04
	1.2 Data flow techniques Graphical programming in data flow Comparison with conventional programming		02	
2.Programming Techniques	2.1 VI & sub-VI Loops & charts Arrays Clusters Graphs Case & sequence structures	CO2	03	06
	2.2 Formula nodes Local & global variables String & files inputs		03	
3. Application Development Software (LabVIEW)	3.1 Creating virtual instrument in LabVIEW Implementing dataflow programming in LabVIEW VI	CO3	03	09
	3.2 Sub-VI & modular code creation in LabVIEW Arrays & file I/O in LabVIEW Textual math integration in LabVIEW		03	
	3.3 Interfacing external instruments to PC using LabVIEW		02	
4. Data Acquisition Basics	4.1 Digital I/O Counters & timers PC hardware structure Timing Interrupts DMA Software & hardware installation	CO4	03	08
	4.2 IEEE GPIB 488 concepts Embedded system buses PCI EISA CPCI		03	
	5.1 Current loop RS 232C / RS 485 Interface basics USB PCMCIA VXI SCXI PXI	CO5	03	06

5. Common Instrument Interfaces	5.2 Networking basics for office & industrial application VISA & IVI Image acquisition & process Motion control Digital multimeter (DMM) Waveform generator		03	
6. Using Analysis Tools & Application of VI	6.1 Fourier transform Power spectrum Correlation method Windowing & filtering Pressure control system	CO5	03	06
	6.2 Flow control system Level control system Temperature control system Motion control employing stepper motor PID controller toolbox		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				**42**

Books:	
Text Books	1. Gupta ,'' Virtual Instrumentation Using Lab view'' 2nd Edition, Tata McGraw-Hill Education, 2010
Reference Books	1. Dr. Sumathi S. & Surekha P, LabVIEW Based Advanced Instrumentation System, PHI, 2nd edition (2007)
	2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, 2nd edition (2006)
	3. Lisa K. Wells & Jeffrey Travis, LabVIEW for Everyone, PHI, 3rd edition (2009)
	4. Robert H. Bishop, Learning with LabVIEW 7 Express, Pearson Education, 1st edition (2005) 2nd edition (2010)
	5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2nd edition (2010)
	7. Sokoloff; "Basic concepts of Labview 4", Prentice Hall Inc., New Jersey 1998.
	8. Gupta.S., Gupta.J.P., "PC interfacing for Data Acquisition & Process Control", Second Edition, Instrument Society of America, 1994.

Useful Links:
https://nptel.ac.in/courses/108/105/108105064/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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V I D Y A V I H A R

K J Somaiya Institute of Engineering and Information Technology
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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8024	**Virtual Instrumentation Lab**	**(1+0)**

Lab Prerequisites:	---
Lab Objectives:	1. To provide knowledge on design of process control by using virtual instrumentation techniques 2. To provide knowledge in process analysis by VI tools. 3. To give basic knowledge in describing function analysis. 4. Get adequate knowledge VI tool sets
Lab Outcomes:	After the successful completion of the course the students will be able to: 1. Execute mathematical operations by using LabVIEW 2. Analyze and design different type of programs based on data acquisition. 3. Design virtual instruments for practical applications 4. Write accurate documentation for experiments performed 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Verification of arithmetic operations	LO1, LO4, LO5	02
2.	Verification of Boolean Expressions / half-adder & full-adder		02
3.	Implementation of array functions		02
4.	Program to convert Celsius into Fahrenheit & vice-versa	LO2, LO4, LO5	02
5.	Program for implementing seven segment display		02
6.	Program for calculating body mass index (BMI) using cluster		02
7.	Program to control temperature using thermistor / RTD & DAQ		02
8.	Program to control liquid flow using DAQ		02
9.	Program to control liquid level using DAQ		02
10.	Program to control pressure using DAQ		02
11.	Program for DC motor speed control using PID toolbox	LO3, LO4, LO5	02

Useful Links:

1. http://iitb.vlab.co.in/?sub=8&brch=117
2. http://vlabs.iitkgp.ernet.in/rcs/index.html

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Virtual Instrumentation Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)   .

Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8031	**Next Generation Networks**	**(3+0+0)**

Prerequisite:	1. Computer Communication Networks 2. Advanced Networking Technologies
Course Objectives:	1. To provide exposure to the new technologies and services. 2. To Explore SDN networks. 3. To demonstrate MPLS VPNs for NGN
Couse Outcomes:	Course Outcomes: After the course completion student will be able to
	1. Explain the building blocks of **N**GN architecture 2. Describe the software Defined Networks. 3. Comprehend IP network Technologies for local, mobile and global networks. 4. Describe the MPLS VPNs for remote access 5. Compare different technologies for wireline and wireless networks. 6. Explore applications of NGN and Future Evolution.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Communicating in the New Era	1.1　New Era of Networking Technological Winners: IP everywhere, Optical Anywhere, Wireless through the air	CO1	02	06
	1.2 Building Blocks for Next Generation Networks: IP Networks, Multiservice Networks, VPNs, Optical Networks, wireline Networks, Wireless networks		02	
	1.3　Next Generation Network Services: Network Infrastructure Convergence, Services Convergence, From Technology Push to Service Pull		02	
2.Software Defined Network	Evolving network requirements-The SDN Approach: Requirements, SDN Architecture, Characteristics of Software-Defined Networking, Network Function Virtualisation , SDN and NFV- Related Standards: Standards-Developing Organizations, Industry Consortia, Open Development Initiatives. Networking, Network Function Virtualisation, SDN and NFV- Related Standards: Standards-Developing Organizations, Industry Consortia, Open Development Initiatives.	CO2	06	06
3. MPLS Networks	3.1 Multiprotocol Label Switching Networks: Frame-Based MPLS: Frame-Based MPLS Components and Terminology, Frame-Based MPLS Functionality	CO3	03	06

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	3.2 MPLS Services: MPLS Benefits for Service Providers MPLS Example Benefits for Large Enterprises MPLS Layer 3 VPNs, MPLS Layer 2 VPNs, Layer 2 Any Transport over MPLS		03	
4. IP Networks	4.1 IP: Past, Present and Future, IP network convergence, Wide area technologies and topologies: VPNs, Carrier Ethernet and types, SD-WAN, Secure Access Service Edge (SASE)	CO4	04	12
	4.2 Mobile IP networks: Wi-Fi 6 (802.11ax), SD-access		02	
	4.3 Mobility Networks: SIP, IP RAN Transport (Segment Routing for 5G)/ O-RAN (RF Side), IP and MPLS at the Core of Mobility Networks, Integrating Complementary WLAN 802.11 Technology (VoWiFi), Packet-Based VoIP and IMS (VoLTE), Global IP Networks: Public and Private clouds, Data Center, Future Internet(With IoT)		06	
5. Wireline and Wireless networks	5.1 Wireline Networks: Broadband-FTTX (Optical Fiber Communication), GPON	CO5	03	06
	5.2 Wireless networks: LAN: WiFi 6, Li-Fi, MAN: 5G Architecture		03	
6. NGN Vision, Scenarios and Advances.	NGN Networks: Perspectives and Potentials, Some Possible Scenarios, Virtual Space Flight, Virtual International Congress, Virtual Global Exhibition, Virtual Classroom, e-Education and Experimental Laboratory, NGN Advances etc.	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. Next-Generation Network Services: By Robert Wood, Published Nov 1, 2005 by Cisco Press. Part of the Networking Technology series 2. Next Generation Telecommunications Network, Parliament office of Science and Technology (Postnote). Dec 2007, No. 296 Ref. www.parliament.uk.
Reference Books	1.Next Generation Network Services: Technologies & Strategies by Neill Wilkinson, Jhon Wiley & Sons Publication, Edition: 1. 2.Next Generation Networks: Perspectives and Potentials by Jingming Li Salina, Pascal Salina, Publisher:John Wiley & Sons, 2008 3.Best Practices for Implementing Next Generation Networks (NGN) in the Asia and Pacific Region, International Telecommunication Union, Telecommunication Development Bureau, June 2012.

Useful Links:
1. https://opennetworking.org/reference-designs/ng-sdn/
2. https://opennetworking.org/software-defined-standards/specifications/
4. https://opennetworking.org/wp-content/uploads/2014/10/openflow-switch-v1.5.1.pdf
5. https://opennetworking.org/stratum/

6. https://opennetworking.org/sd-ran/

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8031	**Next Generation Networks Lab**	**(1+0)**

Lab Prerequisite:	1. Computer Communication Networks
	2. Next Generation Networks
Lab Objectives:	1. Learn how to build a network topology.
	2. Explore Mininet emulator to perform networking tasks.
	3. Learn about the GNS-3 environment for MPLS.
Lab Outcomes (LOs):	On successful completion of the course the students will be able to:
	1. Analyze the working of Mininet.
	2. Design different custom network topology using Mininet.
	3. Create a SDN environment on Mininet.
	4. Evaluate the Performance of MPLS layer 2 and 3 VPN in a GNS-3
	5. Explain NUYSIM open-source 5G channel simulator.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Set up Mininet network emulation environment using Virtual Box and Mininet. Demonstrate the basic commands in Mininet.	LO1	02
2.	Implement different custom network topology (Simple, Linear, and Tree). Analyze flow tables.	LO2	02
3.	Create a SDN environment on Mininet and configure a switch to provide a firewall functionality	LO3	02
4.	Study various Layer 2 and Layer 3 MPLS Standard documents which are used by different vendors while developing their devices and network operating systems	LO4	02
5.	To Implement Layer 2 MPLS VPN technologies in a GNS-3 simulation environment.		02
6.	To evaluate the Performance of MPLS layer 3 VPN in a GNS-3	LO5	02
7.	Study of NUYSIM open-source 5G channel simulator		02
8.	Emulate a Data Center and manage it via a Cloud Network Controller: create a multi-rooted tree-like (Clos) topology in Mininet to emulate a data center.	LO3	02

Useful Lab Tools/Software:
1. MPLS Lab Tools/Software:
  a) GNS3
  b) Cisco IOS 7200 Enterprise
  c) Wireshark
  d) Putty (Built-in GNS3)

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2. SDN Lab Tools/Software

  a) Open Source Controller- Open Day Light (ODL) Controller

  b) Open Source Controller- ONOS (Open Network Operating System) Controller

  c) Mininet Tool (To Simulate SDN Open vSwitch)

  d) Wireshark

3. SD-WAN Lab Tools/Software

  a) Cisco Viptela Controller- vManage, vSmart,vBond Virtual Machine

  b) Cisco viptela vEdge Router Virtual Machines

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Next Generation Networks Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).

Oral: Oral examination will be based on experiment list and performance of experiment.

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K J Somaiya Institute of Engineering and Information Technology
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Course Code	Course Name	Credits (TH+P+TU)
ETDLC8032	**Industrial Internet of Things**	**(3+0+0)**

Prerequisite:	1. Internet of Things 2. Basic knowledge of computer and internet 3. Computer Communication Networks
Course Objectives:	The objectives of this course are to: 1. Understand the concepts of Industry 4.0 and basics of Industrial IoT. 2. Apply Sensing, actuation, Communication and Networking in Industrial IoT. 3. Understand the need of security, analytics for Industrial IoT. 4. Apply the Industrial IoT-for various Application Domains.
Couse Outcomes:	On successful completion of the course the students will be able to: 1. Explain the concepts of Industry 4.0. 2. Discuss the basics of Industrial IoT. 3. Analyze the use of Sensing, actuation, Communication and Networking in Industrial IoT. 4. Implementation of analytics in Industrial IoT. 5. Describe need of Security in IoT 6. Demonstrate various Industrial IoT-Application Domains

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Industry 4.0	1.1 Introduction to Industry 4.0: Globalization, The Fourth Revolution, Sustainability Assessment of Manufacturing Industry	CO1	03	06
	1.2 Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Cyber Security in Industry 4.0		03	
2.Industrial IoT	Introduction to IIoT, IIoT Business Model, IIoT Reference Architecture	CO2	06	06
3.Sensing & actuation, Communication and Networking	3.1 IIoT- Sensing & actuation	CO3	03	08
	3.2 IIoT- Processing		02	
	3.3 IIoT- Communication and Networking		03	
4.Analytics	Role of Analytics in IoT, Data visualization Techniques, Big Data Analytics, Software Defined Networks	CO4	08	08
5. Security	Introduction to web security, Conventional web technology and relationship with IIoT, Vulnerabilities of IoT, IoT security, Security model for IoT.	CO5	05	05
6. Application Domains	Inventory Management & Quality Control, Plant Safety and Security, Facility Management	CO6	06	06

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II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:

Text Books	1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", ISBN 9780367897581,Published December 15, 2020 by CRC Press
Reference Books	1.Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", (Apress) 2.Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat "Industrial Internet of Things: Cyber manufacturing Systems", (Springer)

Useful Links:

https://onlinecourses.nptel.ac.in/noc20_cs69

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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K J Somaiya Institute of Engineering and Information Technology
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Lab Code	Lab Name	Credits (P+TU)
ETDLL8032	**Industrial Internet of Things Lab**	**(1+0)**

Lab Prerequisite:	1. Internet of Things 2. Basic knowledge of computer and internet 3. Computer Communication Networks
Lab Objectives:	The objectives of this course are to: 1.Identification of the basic requirements for Industrial IoT. 2.Apply Sensing, actuation, Communication and Networking in Industrial IoT. 3.Understand the need of analytics for Industrial IoT 4.Apply the Industrial IoT-for various Application Domains
Lab Outcomes (LOs):	On successful completion of the course the students will be able to: 1. Identify the use of Sensing & actuation, Communication and Networking in Industrial IoT Application. 2. Apply Sensing & actuation, Communication and Networking in Industrial IoT Application. 3. Implementation of analytics in Industrial IoT Application. 4. Demonstrate various Industrial IoT case studies. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Identify the use of Sensing & actuation in Industrial IoT Application	LO1, LO5, LO6	02
2.	Identify the use of Communication and Networking in Industrial IoT Application		02
3.	Apply Sensing & actuation in Industrial IoT Application	LO2, LO5, LO6	02
4.	Apply Communication and Networking in Industrial IoT Application		02
5.	Implementation of analytics in Industrial IoT Application-I	LO3, LO5, LO6	02
6.	Implementation of analytics in Industrial IoT Application-II		02
7.	Case Study - Industrial IoT Application Domain-I	LO4, LO5, LO6	04
8.	Case Study - Industrial IoT Application Domain-II		04

Useful Links:

https://onlinecourses.nptel.ac.in/noc20_cs69

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Industrial Internet of Things Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8033	**System On Chip**	**(3+0+0)**

Prerequisite:	1. Mixed Signal VLSI Design 2. Basic VLSI Design Lab
Course Objectives:	1. To introduce modern system design using SoC 2. To understand the concept of hardware-software co-design
Couse Outcomes:	At the End of the course students will be able to 1. Explain basics of SoC 2. Design and verify the SoC systems 3. Explain the physical design flow 4. Analyze routing issues in SoC 5. Interpret complex SoC systems 6. Explain non-technical issues related to the SoC

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to SoC Design	1.1 The fundamental trends of SoC design, SoC design flow, The Semiconductor Economics, Challenges in SoC design	CO6	03	08
	1.2 Hardware system structure, Software structure, Accelerating Processors for traditional software task, System Design with multiple processor design	CO1	05	
2. System Level Design	2.1 Complex SoC system architecture, Processor centric SoC organization, Communication Design Hardware and Software interconnects	CO2	03	05
	2.2 Balancing computation and Communication, SoC Design flow, Non-processor building block in SoC design	CO5	02	
3. RTL Synthesis	Review of Verilog - RTL Coding and RTL Synthesis RTL coding guidelines, Synthesizable coding style, FSM Coding style, Memory Modeling.	CO2	08	08
4. SoC Verification	Verification technology options, Verification methodology. System level verification, block-level verification. Timing verification.	CO1	08	08
5. Physical Design	Partitioning, Floor Planning, Placement, Routing, Goals of routing - Global routing –Maze routing, Detailed routing, Over the Cell Routing, Physical verification and design sign-off.	CO3	07	07
6. Routing	Clock routing, Power and Ground routing, Clock tree synthesis.	CO4	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01

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	Total hours	**42**

Books:	
Text Books	1. Rowen, Chris. Engineering the complex SOC: fast, flexible design with configurable processors. Pearson Education, 2008. 2. Rashinkar, Prakash, Peter Paterson, and Leena Singh. System-on-a-chip Verification: Methodology and Techniques. Springer Science & Business Media, 2007. 3. Vahid, Frank. Digital design with RTL design, VHDL, and Verilog. John Wiley & Sons, 2010.
Reference Books	1. Rajsuman, Rochit. System-on-a-chip: Design and Test. Artech House, Inc., 2000. 2. Sait, Sadiq M., and Habib Youssef. VLSI physical design automation: theory and practice. Vol. 6. World Scientific, 1999. 3. Chang, Henry, et al. Surviving the SoC revolution. Dordrecht: Kluwer academic publishers, 1999.

Useful Links:
https://nptel.ac.in/courses/117/101/117101058/
https://nptel.ac.in/courses/108/107/108107129/
http://cmosedu.com/

Continuous Assessment:
• Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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). • Average marks of T-1 and T-2 will be considered. • Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8033	**System On Chip Lab**	**(1+0)**

Lab Prerequisite:	1. Mixed Signal VLSI Design 2. Basic VLSI Design Lab
Lab Objectives:	1. To design digital systems using SoC 2. To analyze the performance of digital systems implemented using different design methodologies
Lab Outcomes (LOs):	After the successful completion of the course student will be able to 1. Design and implement systems with RTL design using Verilog. 2. Design and implement systems software logic on the FPGA 3. Design digital systems with software- hardware co-design. 4. Trouble shoot using debug ports 5. Interface boards using serial protocol.

Star (*) marked experiments are compulsory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Write an application to blink an LED.	LO2	02
2.	Write an application to display different values on LEDs and verify it to be working		02
3.	Write a software application to add 2 numbers and display their sum		02
4.	Develop an accelerator which accepts start address, number of words as inputs and reads corresponding amount of data from BRAM, adds them and displays on LED	LO3	02
5.	Design a 4-bit wrap-around counter that increments every one second. The counter value is shown on the LEDS.	LO1	02
6.	Design a debouncer circuit switch.		02
7.	Design a counter with a button parser.		02
8.	Design an accumulator with memory block		02
9.	Design a calculator that can perform some basic functionality such as load, store, and sum of two operands.		02
10.	Design an UART transmitter	LO1, LO5	02
11.	Design an UART receiver	LO1	02
12.	Design a module that interfaces with Digi-lent video IP to draw a triangle to a monitor.		02
13.	Interfacing between PS and PL	LO3	02
14.	Flash LED using timer		02
15.	Design a system that will light an LED in response to a user input, but at the same time flash another LED at a frequency		02

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	of 1Hz.		
16.	Implement an interrupt-based design to send and receive data from the external board via SPI.	LO3, LO5	02

Term work:
1. Term work should consist of a Minimum of 8 experiments.   2. Journal must include at least 2 assignments on content of theory and practical of the course "System On Chip Lab".   3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.   4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks).
Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ETDLC8034	Integrated Circuit Technology	(3+0+0)

Prerequisite:	1. Electronics Devices and Circuits-1 2. Digital Circuit Design 3.VLSI Design
Course Objectives:	1. To teach fundamental principles of fabrication of VLSI devices and circuits. 2. To learn about measurement, packaging and testing of ICs 3. To be familiar with fabrication of ICs in SOI, GaAs and Bipolar Technologies 4. To disseminate knowledge about novel VLSI devices
Couse Outcomes:	1.Students will be able to demonstrate a clear understanding of CMOS fabrication flow and technology scaling. 2. Students will be able to describe various MOS fabrication processes 3.Students will be able to explain semiconductor measurements, packaging, testing. 4. Students will be able to know about advanced semiconductor technologies 5. Students will be able to discuss physical mechanism in Novel devices. 6.Students will be able verify processes and device characteristics via simulations

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Crystal Growth, wafer preparation and wafer fabrication	1.1 Semiconductor Manufacturing: Semiconductor technology trend, Clean rooms, Wafer cleaning and Guttering.	CO1	03	07
	1.2 Semiconductor Substrate: Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications.		04	
2.Fabrication Process- I	2.1 Epitaxy: Classification, Molecular Beam Epitaxy	CO2, CO6	01	10
	2.2 Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silocon Dioxide, Oxide quality		01	
	2.3 Device Isolation: LOCOS, Shallow Trench Isolation (STI).		02	
	2.4 Deposition: Physical Vapor Deposition-Evaporation and Sputtering, Chemical Vapor Deposition: APCVD, LPCVD, PECVD		02	
	2.5 Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, diffusion system, problems in diffusion		02	

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Module	Topic	CO	Hrs	Total
	2.6 Ion Implantation: Penetration range- Nuclear& Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.		02	
3.Fabrication Process- II	3.1 Etching: Basic concepts and Classification	CO2, CO6	02	10
	3.2 Lithography: Introduction to Lithography process, Types of Photoresist, Types- electron beam, ion beam and X-ray lithography		02	
	3.3 Metallization and Contacts: Introduction to Metallization, Schottky contacts and Ohmic contacts.		02	
	3.4 CMOS Process Flow: N well, P-well and Twin tub, CMOS Latch Up		02	
	3.5 Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting contact		02	
4.Measuring and Testing	4.1 Semiconductor Measurements: Conductivity type, Resistivity, Hall Effect measurements, Drift Mobility	CO3	02	04
	4.2 Testing: Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality		02	
5.VLSI Technologies	5.1 SOI Technology: SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD SOI and FD SOI Device structure and their features	CO4	02	04
	5.2 Advanced Technologies: low κ and high κ, BiCMOS, HκMG Stack, Strained Silicon.		02	
	5.3 GaAs Technologies: MESFET Technology, MMIC technologies, MODFET			
6.Novel Devices and Materials	6.1 Multigate Devices: Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire)	CO5, CO6	04	04
	6.2 Nanowire: Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires.			
II.Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "Silicon VLSI Technology", Pearson Indian Edition 2. Sorab K. Gandhi, "VLSI Fabrication Principles", Wiley, Student Edition 3. Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 2nd Edition.

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Reference Books	1. G. S. May and S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley, First Edition. 2. Kerry Bernstein and N. J. Rohrer, "SOI Circuit Design Concepts", Kluwer Academic Publishers, 1st Edition. 3. James E. Morris and KrzysztolIniewski, "Nanoelectronic Device Applications Handbook", CRC Press 4. Michael L. Bushnell and Vishwani D. Agrawal, "Essentials of Electronic Testing for digital, memory and mixed-signal VLSI circuits", Springer

Useful Links:

1. https://nptel.ac.in/courses/117/103/117103066/

2. https://www.youtube.com/watch?v=lpXNCwsnxjM

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Lab Code	Lab Name	Credits (P+TUT)
ETDLL8034	**Integrated Circuit Technology Lab**	**(1+0)**

Lab Prerequisite:	VLSI Design
Lab Objectives:	1. To teach various online simulation tools available in nanohub.org 2. To learn various fabrication processes by performing simulation. 3. To draw layout for various CMOS devices using simulation tool.
Lab Outcomes (LOs):	After successful completion of the course student will be able to 1. Use various online simulation tools available in nanohub.org. 2. Perform simulation for various fabrication processes. 3. Generate Layout for various CMOS devices using simulation tool. 4. Write accurate documentation for experiments performed. 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	To simulate oxidation process using online tool-a TCAD Lab on nanohub.org.	LO2, LO4, LO5	02
2.	To simulate diffusion process using online tool-a TCAD Lab on nanohub.org.		02
3.	To simulate Si and Ge PN junction using online tool- a TCAD Lab on nanohub.org.	LO1, LO4, LO5	02
4.	To simulate n/p type MOSFETs using online tool- a TCAD Lab on nanohub.org.		02
5.	To simulate carbon nanotube MOSFET using online tool-FETToy on nanohub.org.	LO2, LO4, LO5	02
6.	To simulate silicon nanowire MOSFET using online tool-FETToy on nanohub.org.		02
7.	To simulate SOI & double gate MOSFET using online tool-NanoMOS on nanohub.org.		02
8.	To draw and simulate layout for CMOS NAND and CMOS NOR. Tool- Microwind	LO3, LO4, LO5	02
9.	To draw and simulate layout for given equation. Tool-Microwind		02
10.	To draw and simulate layout for 6T SRAM Cell. Tool-Microwind		02

Useful Links:

https://nanohub.org/

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Integrated Circuit Technology Lab".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

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Oral: Oral examination will be based on experiment list and performance of experiment.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8041	Project Management	(3+0+0)

Course Objectives:	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.	
Couse Outcomes:	1. Apply selection criteria and select an appropriate project from different options. 2. Write 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. Capture lessons learned during project phases and document them for future reference 6. Inculcate leadership qualities and ethics.	

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Project Management Foundation	1.1 Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process.	CO1	02	05
	1.2 Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).		03	
2.Initiating Projects	2.1 How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models)	CO2	03	06
	2.2 Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.		03	
3. Project Planning and Scheduling	3.1 Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering,	CO3	03	08
	3.2 Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart.		03	
	3.3 Introduction to Project Management Information System (PMIS).		02	

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4.Planning Projects	4.1 Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.	CO4	02	06
	4.2 Risk Management in projects: Risk management planning, Risk identification and risk register.		02	
	4.3 Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks		02	
5. Executing Projects	5.1 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
	5.2 Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.		03	
	5.3 Project procurement management, contracting and outsourcing.		02	
6.Project Leadership and Ethics	6.1 Introduction to project leadership, ethics in projects. Multicultural and virtual projects.	CO6	03	06
	6.2 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 lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Edition.
	2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA,USA
	3. Gido Clements, Project Management, Cengage Learning.
Reference Books	1.Gopalan, Project Management,, Wiley India 2.Dennis Lock, Project Management, Gower Publishing England, 9th Edition

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
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- Average marks of T-1 and T-2 will be considered.

- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8042	**Finance Management**	**(3+0+0)**
Course Objectives:	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	
Couse Outcomes:	After successful completion of course student will be able to: 1. Students will be able to describe Indian financial system 2. Students will be able to apply basic concepts of returns and risks. 3. Students will be able to use basic concepts of Time value of money. 4. Students will be able to understand sources of finance, capital structure, dividend policy 5 Students will be able to discuss basic concepts of corporate finance 6 Students will be apply to use basic concepts of working capital management	

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Overview of Indian Financial System:	1.1 Characteristics, Components and Functions of Financial System	CO1	02	06
	1.2 Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments-Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.		02	
	1.3 Financial Markets: Meaning, characteristics and Classification of Financial Markets Capital Market, Money Market and Foreign Currency Market		02	
	1.4 Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges			
2. Concepts of Returns and Risks:	2.1 Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	CO2	04	08
	2.2 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.		04	

3. Overview of Corporate Finance	Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	CO3	08	08
4. 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, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	CO4	04	04
5. 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. 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, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure.	CO5	03 / 02	05
6. Dividend Policy	Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	CO6	08	08
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		42
Books:				

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Text Books	1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi. 2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
Reference Books	1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi. 2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi. 3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi. 4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Continuous Assessment:

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- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8043	**Entrepreneurship Development and Management**	**(3+0+0)**

Course Objectives:	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.
Couse Outcomes:	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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Overview Of Entrepreneurship:	1.1 Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development.	CO1	01	04
	1.2 Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur.		01	
	1.3 Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.		02	
2. Business Plans And Importance Of Capital To Entrepreneurship:	2.1 Introduction: Preliminary and Marketing Plans, Management and Personnel.	CO2	02	09
	2.2 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.		03	
	2.3 Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business.		02	
	2.4 New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.		02	

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3. Women's Entrepreneurship Development	Women's Entrepreneurship Development, Social Entrepreneurship-Role and Need, EDP Cell, Role of Sustainability and Sustainable Development for SMEs, Case Studies, Exercises.	CO3	05	05
4. Indian Environment for Entrepreneurship	4.1 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
	4.2 Role of State Governments in Terms of Infrastructure Developments and Support etc.		04	
	4.3 Public Private Partnerships, National Skill Development Mission, Credit Guarantee Fund, PMEGP, Discussions, Group Exercises etc.		02	
5. Effective Management of Business	5.1 Issues and Problems Faced by Micro and Small Enterprises and Effective Management of M and S Enterprises.	CO5	04	08
	5.2 Risk Management, Credit Availability, Technology Innovation, Supply Chain Management, Linkage with Large Industries, Exercises, E-Marketing.		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	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. P Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson 2. R Hisrich and M Peters, Entrepreneurship, The McGraw Hill Company. 3. D Kuratko, Entrepreneurship- Principles and Practices, Thomson Publication
Reference Books	1. Dr T Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi. 2. Law and Practice Relating to Micro, Small and Medium Enterprises, Taxmann Publication Ltd. 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

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Continuous Assessment:

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End Semester Examination (ESE):

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- Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8044	**Human Resource Management**	**(3+0+0)**

Course Objectives:	1. To introduce the students with basic concepts, techniques and practices of the human resource management.
	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.
	3. To familiarize the students about the latest developments, trends & different aspects of HRM.
	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.
Couse Outcomes:	**Upon completion of the course, the learners will be able to:**
	1. Describe the concepts, aspects, techniques and practices of human resource management.
	2. Describe the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
	3. Apply the knowledge about the latest developments and trends in HRM.
	4. Analyze the knowledge of Cross-cultural Leadership and Decision Making.
	5. Apply the knowledge of behavioral skills learnt and integrate it with in interpersonal and intergroup environment emerging as future stable engineers and managers.
	6. Apply the Labor Laws & Industrial Relations and various Act.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to HR	1.1 Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.	CO1	02	05
	1.2 Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.		03	
2. Organizational Behavior (OB)	2.1 Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues.	CO2	01	07
	2.2 Personality: Meaning and Determinants of Personality, Personality development, Personality		02	

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	Types, Assessment of Personality Traits for Increasing Self Awareness.		
	2.3 Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour.	02	
	2.4 Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor).	01	
	2.5 Group Behavior 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.	01	
	2.6 Case study	01	
3. Organizational Structure &Design	3.1 Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	CO3	02
	3.2 Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	02	06
	3.3 Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	02	
4. Human resource Planning	4.1 Recruitment and Selection process, Job-enrichment, Empowerment-Job-Satisfaction, employee morale.	CO4	02
	4.2 Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning.	01	05
	4.3 Training & Development: Identification of Training Needs, Training Methods	02	
5. Emerging Trends in HR	5.1 Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment.	CO5	03
	5.2 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.	03	06
6. HR & MIS	6.1 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	03	10

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	6.2 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.		03	
	6.3 Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act.		04	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1.S. Robbins, Organizational Behavior, Pearson Education Limited. 2.V.S.P. Rao, Human Resource Management, Excel publishing. 3.K. Aswathapa, Human resource management: Text & cases.
Reference Books	1.C. B. Mamoria and S. V. Gankar, Dynamics of Industrial Relations in India, Himalaya Publishing. 2.P. Subba Rao, Essentials of Human Resource management and Industrial relations, Himalaya Publishing. 3.L. Mullins, Management & Organizational Behavior, Pearson Publications.

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8045	**Professional Ethics and Corporate Social Responsibility**	**(3+0+0)**

Course Objectives:	1.To understand professional ethics in business 2.To recognized corporate social responsibility
Couse Outcomes:	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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite 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; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	CO1	04	04
2. Professional Ethics in the Marketplace	Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy. Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	CO2	04	08
3. Professional Ethics of Consumer Protection	Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	CO3	04	06
4. Introduction to Corporate Social Responsibility	Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	CO4	05	05
5. Corporate Social Responsibility	Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and ublic-Private Partnership (PPP) in India	CO5	08	08
6. Corporate Social	Corporate Social Responsibility voluntary Guidelines, 2009 issued by the Ministry of	CO6	08	08

Responsibility in Globalizing India	Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility Companies Act, 2013.			
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	**Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher Springer.**
Reference Books	1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer. 2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge. 3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi. 4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8046	**Research Methodology**	**(3+0+0)**

Prerequisite:	-----

Course Objectives:	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
Couse Outcomes:	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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction and Basic Research Concepts	1.1 Research Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology	CO1	02	09
	1.2 Need of Research in Business and Social Sciences		02	
	1.3 Objectives of Research		01	
	1.4 Issues and Problems in Research		02	
	1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical		02	
2. Types of Research	2.1. Basic Research	CO1, CO2	01	07
	2.2. Applied Research		01	
	2.3. Descriptive Research		01	
	2.4. Analytical Research		01	
	2.5. Empirical Research		01	
	2.6. Qualitative and Quantitative Approaches		02	
3. Research Design and Sample Design	3.1 Research Design: Meaning, Types and Significance	CO1	04	07
	3.2 Sample Design Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors		03	
4. Research Methodology	4.1 Meaning of Research Methodology	CO6	01	08
	4.2. Stages in Scientific Research Process:		07	

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	a. Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis Hypothesis testing and Interpretation of Data Preparation of Research Report			
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	6.1 Preparation of the report on conclusion reached	CO3	02	04
	6.2 Validity Testing & Ethical Issues		01	
	6.3 Suggestions and Recommendation		01	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
		Total hours		**42**

Books:	
Text Books	1. C. Kothari, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited, 1985.
Reference Books	1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors. 2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited. 3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step guide for Beginners, (2nded), Singapore, Pearson Education

Useful Links:
https://libguides.newcastle.edu.au/researchmethods

Continuous Assessment:
- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): 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).   - Average marks of T-1 and T-2 will be considered.   - Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8047	**IPR and Patenting**	**(3+0+0)**

Prerequisite:	---

Course Objectives:	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

Couse Outcomes:	**After successful completion of the course student will be able to** 1. Explain Intellectual Property assets 2. Explain the enforcements in IPR 3. Investigate the issues in IPR. 4. Illustrate basics of patent. 5. Explain the patent rules 6. Apply the procedure of filing patent nationally and internationally

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Intellectual Property Rights (IPR)	1.1 Meaning of IPR, Different category of IPR instruments Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.	CO1	03	05
	1.2 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		02	
2. Enforcement of Intellectual Property Rights	2.1 Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement.	CO2	03	07
	2.2 Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.		04	

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3. Emerging Issues in IPR	Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	CO3	05	05
4. Basics of Patents	Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	CO4	07	07
5. Patent Rules	Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	CO5	08	08
6. Procedure for Filing a Patent (National and International)	Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement. Patent databases: Important websites, Searching international databases	CO6	07	07
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India 2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws 3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press 4. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell 5. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
Reference Books	1. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, 2. TMHR Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books 3. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books 4. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications 5. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers,

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	1st Edition, BS Publications
	6. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
	7. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
	8. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
	9. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
	10. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Continuous Assessment:
- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
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- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8048	**Digital Business Management**	**(3+0+0)**

Course Objectives:	1.To familiarize with digital business concept 2.To acquaint with E-commerce 3.To give insights into E-business and its strategies
Couse Outcomes:	**After the successful completion of this course, learner 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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Digital Business	1.1 Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy.	CO1	06	09
	1.2 Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines /services) Opportunities and Challenges in Digital Business.		03	
2. Overview of E-Commerce	E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behaviour, market research and advertisement 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 Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	CO2	06	06

3. Digital Business Support services	ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business applications and infrastructure	CO3	06	06
4. Managing E-Business	Managing Knowledge, Management skills for e-business, Managing Risks in e-business 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, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	CO4	06	06
5. E-Business Strategy	E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	CO5	04	04
6. Materializing e-business	From Idea to Realization-Business plan preparation. Case Studies and presentations	CO6	08	08
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1.A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011. 2.E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002 3.Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014 4.Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
Reference Books	1. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson 2. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer 3. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan 4. E-Governance-Challenges and Opportunities in: Proceedings in 2nd International Conference theory and practice of Electronic Governance 5. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5 6. Measuring Digital Economy-Anewperspective-DOI:10.1787/9789264221796 enECD Publishing

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
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- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

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Course Code	Course Name	Credits (TH+P+TUT)
ILC8049	**Environmental Management**	**(3+0+0)**

Prerequisites	General Awareness of environment and factors affecting the environment.
Course Objectives:	1. Understand and identify environmental issues relevant to India and global concerns 2. Learn concepts of ecology 3. Familiarise environment related legislations 4. Understand to protect and sustain our natural resources of land, water, air, and vegetation.
Couse Outcomes:	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. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction and Definition of Environment	1.1 Significance of Environment Management for contemporary managers	CO1	02	10
	1.2. Career opportunities		01	
	1.3. Environmental issues relevant to India		02	
	1.4. Sustainable Development		03	
	1.5. The Energy scenario		02	
2. Global Environmental concerns	2.1 Global Warming	CO3	01	06
	2.2 Acid Rain		01	
	2.3 Ozone Depletion		01	
	2.4 Hazardous Wastes	CO3, CO5	0.5	
	2.5 Endangered life-species		0.5	
	2.6 Loss of Biodiversity		01	
	2.7 Industrial/Man-made disasters/Atomic/Biomedical hazards, etc		01	
3. Concepts of Ecology	3.1 Ecosystems and interdependence between living organisms	CO2	01	05
	3.2 Habitats		0.5	
	3.3 limiting factors		0.5	
	3.4 Carrying capacity		01	
	3.5 Food chain		01	
	3.6 Ecology		01	
	4.1 Scope of Environment Management		03	10

4. Scope of Environment Management	4.2 Role & functions of Government as a planning and regulating agency.	CO1, CO4	03	
	4.3 Environment Quality Management and Corporate Environmental Responsibility		04	
5. Quality Environmental Management	5.1 Total Quality Environmental Management	CO6	02	05
	5.2 ISO-14000		02	
	5.3 EMS certification		01	
6. General overview of major legislations	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	CO3, CO4	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999 2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing 3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
Reference Books	1. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005 2. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC 3. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015 4. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000

Useful Links:

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:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
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- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

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.

Project Based Learning Code	Project Based Learning Name	Credits (P+TUT)
ETPR86	**Major Project Lab-B**	**(6+0)**

PBL Pre-requisites:	Major Project Lab-A

PBL Objectives:	The Project work enables the students:
	1. To develop the required skills and knowledge about research.
	2. To analyze a specific problem or issue by using the latest technologies with a multidisciplinary approach.
	3. To demonstrate proficiency in the design of a research project, application with appropriate research methods.
	4. To implement and present research idea with appropriate solution
PBL Outcomes:	Learner will be able to:
	1. Review literature, Design solutions, components or processes for complex engineering problems on the basis of research knowledge.
	2. Implement projects using modern tools which are useful to society.
	3. Apply contextual knowledge to assess the public health/safety/societal/environmental issues for sustainable development.
	4. Document the work in project report and log book by referring reputed material.
	5. Apply ethical principles and commit to professional ethics, responsibilities norms of the engineering practice and engage in independent and life-long learning.
	6. Present their work in clear and effective manner with professional values like team work, time management and make financial arrangements.

Guidelines:

- To proceed with the project implementation work for the selected research idea.
- Projects can be designed in any domain of electronics by using recent technologies with multi-disciplinary approach.
- For developing project/problem, theoretical concepts should be implemented as a practical implementation.
- Project work must be carried out by the group of students with proper plan of work.
- Students should involve themselves in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Students must consult an internal guide along with external guide (if any) in implementation of the topic.
- Online log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Students have to submit a weekly progress report to the internal guide whereas the internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding the term work marks. In case of industry projects, visit by an internal guide will be preferred.

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- Students shall be motivated to publish/present a paper based on their research work done.
- The publication should be in any national/international conferences or project presentations in any national/international project competitions/symposium.
- Students should prepare thesis as per the guidelines by the institute.

Project Report Format:

At the end of semester a project report should preferably contain at least following details:-
1. Abstract
2. CO-PO mapping
3. Introduction
4. Literature Survey
   - a) Comparative Survey of Existing system
   - b) Limitation of the Existing system or research gap
5. Proposed System
   - a) Problem Statement and Objective
   - b) Methodology (your approach to solve the problem)
   - c) Analysis/Framework/ Algorithm
   - d) Details of Hardware & Software
   - e) Design details
   - f) Budget details
   - g) Implementation Plan for next semester
6. Conclusion and future scope
7. References
8. **Published papers and certificates**

Term Work:

Distribution of marks for term work shall be as follows:
   - a) Weekly Attendance on Project Day
   - b) Contribution in the Project work
   - c) Project Report
   - d) Term End Presentation (Internal)
The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Distribution of Term work marks for both semesters shall be as below:		Marks
1.	Marks awarded by guide based on log book	10
2.	Marks awarded by review committee for presentation	10
3.	Quality of Project report	10
4.	Implementation of project	10
5.	• Effort taken by students • Paper publications • Idea/project/poster competition	10

Practical & Oral:

Practical & Oral examination of Major Project Lab-B should be conducted by Internal and External examiners. Students have to give a presentation and demonstration on Major Project Lab-B.

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Course Code	Course Name	Hours/Duration
INT87	Internship-VII	2-4 Weeks

Prerequisite:	**In depth knowledge about filling IPR/ copywriting a product/solution.**
Course Objectives:	1. To gain the knowledge of filling patent and Copy write. 2. Presenting technology solutions across worldwide problems through competitions and publications.
Couse Outcomes:	**Upon completion of the course, students will be able to:** 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 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.