Item No: 4.A.4
A.C. Date: 07/07/2023

SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
(Formerly known as K J Somaiya Institute of Engineering and Information Technology)
An Autonomous Institute permanently affiliated to University of Mumbai

Autonomy Syllabus Scheme-II

for

Bachelor of Technology (B.Tech.)

in

Artificial Intelligence and Data Science (AI-DS)

(Last Year)
(Semester VII and VIII)

Including

Honours Degree Program

With effect from A.Y. 2023-24

Somaiya Ayurvihar Complex, Eastern Express Highway, Sion (East), Mumbai. 400 022, India
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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 Technology (KJSIT), 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 KJSIT 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, KJSIT Syllabus Scheme –II introduces 03 newer dimensions to Scheme – I: Internship, SBL of Foreign and Indian Languages, and Honours Degree that shall be implemented w.e.f. from A.Y. 2022-23 across all the branches and all 04 years of engineering.

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

   Further, the students of KJSIT already have an exposure to the work culture and trends in industries

through live / collaborative projects / product developments, etc. and they often contribute significantly to the society through various projects. Under autonomy too, through the component of Project-Based Learning included in the syllabus, the students develop Mini, Minor, and Major projects in Second, Third, and Last Year respectively concerning healthcare, agriculture, societal / industrial need-based problems, etc. Through duality of Major Project development and newly introduced activities / components as a part of Internship, the students shall learn about research methodology, IP and IPR — resulting into generation of quality research articles, copyrights, and patents.

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

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

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

Preamble by Member Secretary, Academic Council:

K J Somaiya Institute of Technology (KJSIT) 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 KJSITs 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. KJSITs 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 specialization 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, Scheme-II from Academic Year 2022-23 and Scheme-II B from Academic Year 2023-24, 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 KJSIT 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, KJSIT, Sion

Preface by Board of Studies in Artificial Intelligence and Data Science:

We, the members of Board of Studies of B. Tech in Artificial Intelligence and Data Science (AI-DS) are very happy to present Autonomy Syllabus Scheme-II of Last Year of B. Tech in Artificial Intelligence with effect from the Academic Year 2023-24. We are assured that you will discover this syllabus interesting and challenging.

AI-DS is one of the newest programme amongst engineering students. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas like human intelligence and its applications in industry, defense healthcare, agriculture and many other areas. It is envisioned to deliver a modern, industry-oriented education in AI-DS. It aims at creating skilled engineers who can successfully acquaint with the demands of the industry worldwide. We have included internships under Autonomy Syllabus Scheme-II from SEM-II to SEM-VIII of B.Tech AI-DS. Also honor degree courses introduced in this Syllabus Scheme-II of AI-DS. They obtain skills and experience in up-to-date knowledge to analysis, design, employ, technologies, software and systems.

In this course, the students may have career opportunities in healthcare, business, e-Commerce, social networking companies, biotechnology, genetics and other areas. For holistic development of students Foreign and Regional Indian language and other skill-based courses introduced first time in this new scheme. 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.

Board of Studies in Artificial Intelligence and Data Science are,

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. Milind U. Nemade	Head of the Department concerned (Chairman)	11	Prof. Vidya Sagvekar	Member
2	Dr. Michel Mistry	Experts from outside parent university nominated by Academic council	12	Prof. Sejal Shah	Member
3	Dr. Sanjay Shitole		13	Prof. G. R. Phadke	Member
4	Dr. Madhav Chandane	One expert to be nominated by the Vice-Chancellor	14	Prof. Sarika Mane	Member
5	Mr. Akhil Hada	One Representative from Industry /Corporate Sector/ Allied area relating to Placement	15	Prof. Sheetal Jagtap	Member
6	Dr. Vaishali Wadhe	Member	16	Prof. Devanand Bathe	Member
7	Prof. Pankaj Deshmukh	Member	17	Prof. Ganesh Wadmare	Member
8	Prof. Medha Asurlekar	Member	18	Dr. Hariram Chavan	Other Member
9	Dr. Sunita Patil	Other Member	19	Dr. Radhika Kotecha	Other member
10	Dr. Namrata Gharat	Other member			

SEMESTER-VII-B.TECH.(ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)

Semester- VII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credit Assigned		Course Category
		(TH–P–TUT)	Total	(TH–P–TUT)	Total	
AIC701	Deep Learning	3–0–0	03	3–0–0	03	PC
AIC702	Natural Language Processing	3–0–0	03	3–0–0	03	PC
AIDLC703X	Department Level Elective-3	3–0–0	03	3–0–0	03	DLE
AIDLC704X	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
AIL701	Deep Learning Lab	0–2–0	02	0–1–0	01	PC
AIL702	Natural Language Processing Lab	0–2–0	02	0–1–0	01	PC
AIDLL703X	Department Level Elective-3 Lab	0–2–0	02	0–1–0	01	DLE
AIPR75	Project Based Learning- Major Project Lab-A	0–6#–0	06*	0–3–0	03	PBL
INT-71	Internship-VI	--		---	---	INT
Total		**15-12-0**	**27**	**15-6-0**	**21**	

Major Project A and B:

- Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- Faculty Load: In Semester VII – ½ hour per week per project group
  In Semester VIII – 1 hour per week per project group

EXAMINATION SCHEME

Course Code	Course Name	Marks										
		CA				ESE	Duration in Hrs	TW	O	P	P&O	Total
		T-1	T-2	Avg. of T1 & T2	IA							
AIC701	Deep Learning	30	30	30	10	60	2.30	--	--	--	--	100
AIC702	Natural Language Processing	30	30	30	10	60	2.30	--	--	--	--	100
AIDLC703X	Department Level Elective-3	30	30	30	10	60	2.30	--	--	--	--	100
AIDLC704X	Department Level Elective-4	30	30	30	10	60	2.30	--	--	--	--	100
ILC705X	Institute Level Elective-1	30	30	30	10	60	2.30	--	--	--	--	100
AIL701	Deep Learning Lab	--	--	--	--	--	--	25	--	--	25	50
AIL702	Natural Language Processing Lab	--	--	--	--	--	--	25	--	--	25	50
AIDLL703X	Department Level Elective-3 Lab	--	--	--	--	--	--	25	25	--	--	50
AIPR75	Project Based Learning- Major Project Lab-A	--	--	--	--	--	--	25	--	--	50	75
INT-71	Internship-VI	--	--	--	--	--	--	--	--	--	--	--
Total		**150**	**150**	**150**	**50**	**300**	--	**100**	**25**	**--**	**100**	**725**

Major Project A and B:

- Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- Faculty Load: In Semester VII – ½ hour per week per project group
  In Semester VIII –1 hour per week per project group

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

Electives - Department Level Elective Courses & Labs (PE-DLC -3 & PE-DLC-4)

Department Level Elective-3			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC7031	AIDLC7032	AIDLC7033	AIDLC7034
Speech Processing	Internet of Everything	Cryptography and Network Security	Biostatistics

Department Level Elective-4			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC7041	AIDLC7042	AIDLC7043	AIDLC7044
Business Intelligence	AI in Healthcare	Digital Forensics	Genetic Engineering and Genomics
Open Electives-Institute Level Courses (OE-ILC-1)			
ILC7051	**ILC7052**	**ILC7053**	**ILC7054**
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			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC701	Deep Learning	03	-	-	03

Prerequisite:	Basic mathematics and Statistical concepts, Linear algebra, Machine Learning.
Course Objectives: (COBs):	1. To learn the fundamentals of Neural Network and Deep Networks. 2. To gain an in-depth understanding of training Deep Neural Networks. 3. To acquire knowledge of advanced concepts of Convolution Neural Networks, Auto encoders and Recurrent Neural Networks. 4. To know application and recent trends in Deep Learning.
Course Outcomes: (COs):	1. Gain basic knowledge of Neural Networks and Deep Networks. 2. Acquire in depth understanding of training Deep Neural Networks. 3. Design appropriate DNN model for unsupervised learning application-autoencoders. 4. Design appropriate DNN model for supervised learning application-CNN. 5. Design appropriate DNN model for supervised learning application-RNN. 6. Gain familiarity with recent trends and applications of Deep Learning.

Module No. & Name	Subtopics	COs Mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction: Deep Network fundamentals	1.1 Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes	CO1	02	04
	1.2 Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning		02	
2. Training, Optimization and Regularization of Deep Neural Network	2.1 Training Feedforward DNN Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	CO2	03	09
	2.2 Optimization Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp		03	
	2.3 Regularization Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output		03	
3.Autoencoders: Unsupervised	3.1 Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders,	CO3	03	07

Learning	Regularization in Autoencoders			
	3.2 Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders.		03	
	3.3 Application of Autoencoders: Image Compression		01	
4.Convolutional Neural Networks (CNN): Supervised Learning	4.1 Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function.	CO4	04	07
	4.2 Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture.		03	
5. Recurrent Neural Networks (RNN): Supervised Learning	5.1 Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT.	CO5	05	08
	5.2 Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit		03	
6. Recent Trends and Applications	6.1 Generative Adversarial Network: GAN Architecture.	CO6	02	04
	6.2 Applications: Image Generation, Deep Fake		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	--	01	01
			Total hours	42

Books:	
Text Books:	1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. "Deep Learning", MIT Press Ltd, 2016. 2. Li Deng and Dong Yu, "Deep Learning Methods and Applications", Now publishers Inc (30 June 2014). 3. Buduma, N. and Locascio, N., "Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.". 4. JM Zurada "Introduction to Artificial Neural Systems", Jaico Publishing House 5. M. J. Kochenderfer, Tim A. Wheeler. "Algorithms for Optimization", MIt Press.
Reference Books:	1. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill. 2. François Chollet. "Deep learning with Python "(Vol. 361). 2018 New York: Manning. 3. Douwe Osinga. "Deep Learning Cookbook", O'REILLY, SPD Publishers, Delhi. 4. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc 5. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.
Useful Links:	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
	https://nptel.ac.in/courses/106/106/106106184/
	https://www.deeplearningbook.org/
	http://introtodeeplearning.com/
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz /

	assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIC702	Natural Language Processing	03	--	--	03

Prerequisite:	1. Data structures & Algorithms 2. Project Probability Theory
Course Objectives (COBs):	1. To understand natural language processing and apply basic algorithms in this field. 2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics. 3. To design and implement various language Models and applications of NLP techniques in real life applications
Course Outcomes (COs):	1. Explain about the basics of natural language processing. 2. Explore capabilities and limitations of current natural language technologies 3. Build model linguistic phenomena with formal grammars. 4. Apply algorithms for NLP based pragmatics problems 5. Analyze mathematical and linguistic foundations underlying approaches to the various areas in NLP. 6. Apply NLP techniques to design real world NLP 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 Natural Language Processing	1.1 Introduction to data and its significance in NLP. History of NLP, levels of NLP. Natural language vs. programming language	CO1	01	03
	1.2 Knowledge in language processing, 03 Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP		02	
2. Word Level Analysis	2.1 Morphology analysis survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, finite automata	CO2	04	08
	2.2 Finite state transducers (FST), Morphological parsing with FST, Lexicon free FST Porter stemmer. N Grams Ngram language model, N-gram for spelling correction		04	
3. Syntax analysis	3.1 Part-Of-Speech tagging (POS) Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues Multiple tags & words, Unknown words. Introduction to CFG, Types of Passing	CO3	05	08
	3.2 Sequence labelling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).		03	
4. Semantic Analysis	4.1 Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their sense	CO4	06	08
	4.2 Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD), Dictionary based approach, Information extracting and		02	

	Extracting relationships/relations, Latent semantic analysis			
5. Pragmatics	Discourse reference resolution, reference phenomenon , syntactic & semantic constraints on co reference	CO5	06	06
6. Applications of NLP	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition, Language skill: formally a dialog system or dialog engine, Topic Modeling	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	--	01	01
			Total hours	42

Books:	
Text Books	1. Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008. 2. 2. Christopher D. Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999 3. Steven Bird, Ewan Klein, "Natural Language Processing with Python", O'Reilly, ISBN-13 978-0596516499, 2009
Reference Books	1. Siddiqui and Tiwary U.S., "Natural Language Processing and Information Retrieval", Oxford University Press (2008). 2. Daniel M Bikel and Inned Zitouni, "Multilingual Natural Language Processing Applications", Pearson, 2013. 3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin Editor) The Handbook of Computational Linguistics and Natural Language Processing. 4. Nie1 J le Roux, Sugnet Lubbe, A step by step Tutorial: An introduction into R application and programming.
Useful Links:	1. https://wordnetweb.princeton.edu/perl/webwn
	2. https://onlinecourses.nptel.ac.in/noc21_cs102/preview
	3. Kaggle Databases
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7031	Speech Processing	03	--	--	03

Prerequisite:	1. Applications of Mathematics in Engineering-I,II
Course Objectives (COBs):	1. To teach Fundamentals of Digital Speech Processing. 2. To introduce Digital Models for The Speech Signal. 3. To teach Speech Analysis in time and frequency domain. 4. To introduce Homomorphic Speech processing, Pattern Recognition 5. To explore Methods and Application of audio Signal Processing.
Course Outcomes (COs):	1. Demonstrate Fundamentals of Digital Speech Processing. 2. Describe Digital Models for the Speech Signal. 3. Describe Speech Analysis in time and frequency domain. 4. Explain Homomorphic Speech Processing. 5. Demonstrate Pattern Recognition Methods. 6. Demonstrate Application of Audio Recognition.

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 Digital Speech Processing	1.1 Discrete Time Signal and Systems,	CO1	04	06
	1.2 Transform Representation of Signals and Systems- The z-Transform, Discrete time Fourier Transform and The Discrete Fourier Transform, Fast Fourier Transform			
	1.3 Fundamentals of Digital Filters FIR Systems, IIR System		02	
	1.4 Sampling– The sampling Theorem, Decimation and Interpolation of Sampled Waveforms			
2. Digital Models for the Speech Signal	2.1 The Process of Speech Production– The Mechanism of Speech Production, Acoustic Phonetics	CO2	04	08
	2.2 The Acoustic Theory of Speech Production– Sound Propagation, Example: Uniform Lossless Tube, Effect of Losses in the Vocal Tract, Effects of Radiation at the Lips		02	
	2.3 Digital Models for Speech Signals Vocal Tract, Radiation, Excitation, The Complete Model		02	
3. Time Domain and Frequency Domain Analysis of Speech	3.1 Time energy, average magnitude, and zero-crossing rate, speech vs silence discriminations	CO3	05	10
	3.2 Short-time autocorrelation, pitch period estimation using short-time autocorrelation, median smoothing			
	3.3 Time dependent Fourier representation for voiced and unvoiced speech signals, linear filtering interpretation, spectrographic displays		03	
	3.4 Pitch period estimation based on FFT and harmonic peak detection method, estimation of formants using		02	

	log spectrum			
4.Homomorphic Speech Processing	4.1 Cepstral analysis of speech, Mel frequency cepstral coefficients (MFCC), perceptual linear prediction (PLP)	CO4	03	05
	4.2 Pitch period estimation in cepstral domain, evaluation of formants using cepstrum		02	
5. Automatic Speech Recognition	5.1 Introduction to Statistical Speech Recognition, HMMs for Acoustic Modelling, HMMs and WFSTs, WFSTs for ASR	CO5	04	08
	5.2 Neural Network based acoustic modelling (Hybrid/Tandem/TDNN models),Intro to RNN-based models and Language modelling, RNN-based language models		02	
	5.3 Speech Synthesis, Convolutional Neural Networks in Speech		02	
6. Audio Processing Applications	6.1 Applications: Music Applications, Text to Speech, Speech/Music Discrimination	CO6	02	02
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	----	01	01
			Total hours	42

Books:	
Text Books	1. Rabiner and Schafer, "Digital Processing of Speech Signals", Pearson Education, Delhi, 2004. 2. Shaila D. Apte, "Speech and Audio Processing", Wiley India, New Delhi, 2012. 3. Ben Gold and Nelson Morgan, ―Speech and Audio Signal Processing‖, Wiley India (P) Ltd, New Delhi, 2006. 4. Thomas F. Quatieri,"Discrete-Time Speech Signal Processing: Principles and Practice‖, Prentice Hall, 2001
Reference Books	1. Douglas O'Shaughnessy, "Speech Communications: Human & Machine", Universities Press, Hyderabad, Second Edition, 2001. 2. Eduardo R. Caianiello, "Speech Processing, Recognition and Artificial Neural Networks", Proceedings of 3rd International School on Neural Nets. 3. Jouni Pohjalainen, Espoo, "Methods of Audio Content Classification, Thesis submitted November 2007. 4. J. L. Flanagan, "Speech Analysis Synthesis and Perception", Second edition, Springer Verlag (1972). 5. M. Muller, D. P. W. Ellis, A. Klapuri and G. Richard, "Signal Processing for Music Analysis," IEEE Journal of Selected Topics in Signal Processing, vol. 5, no. 6, pp. 1088-1110, Oct. 2011, doi: 10.1109/JSTSP.2011.2112333. 6. Anssi Klapuri, Manuel Davy, "Signal Processing Methods for Music Transcription", 2006, ISBN: 978-0-387-30667-4.
Useful Links:	1. https://onlinecourses.nptel.ac.in/noc22_ee117/preview
	2. https://www.youtube.com/watch?v=M4GRBJJMecY
	3. https://www.cse.iitb.ac.in/~pjyothi/cs753/index.html
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2 : 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes.

	• Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7032	Internet of Everything	03	--	--	03

Prerequisite:	1. Internet of Things 2. Computer Networks
Course Objectives (COBs):	**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. Demonstrate the Industrial IoT-for various application domains.
Course Outcomes (COs):	**On successful completion of the course the students will be able to:** 1. Understand the concepts of Industry 4.0 and Industrial IoT. 2. Implement sensing, actuation, communication and networking for Industrial IoT. 3. Implement analytics for Industrial IoT. 4. Understand the need of security for Industrial IoT. 5. Demonstrate Industrial IoT for manufacturing and oil & gas industry. 6. Demonstrate Industrial IoT for transportation and smart & connected cities.

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. In Industry 4.0 and Industrial IoT	1.1 Industry 4.0: Basics – Globalization, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Impacts of Industry 4.0	CO1	04	08
	1.2 Industrial IoT: Basics- IIoT and Industry 4.0, IIC, Industrial Internet systems, Industrial Processes		04	
2. Sensing & actuation, Communication and Networking	2.1 IIoT- Industrial Sensing, Snsors and actuators Next generation sensors	CO3	03	08
	2.2 IIoT- Processing		02	
	2.3 IIoT- Communication and Networking.		03	
3. Analytics	3.1 Introduction to data analytics for IoT, 3.2 Edge streaming analytics, Network Analytics, Data Visualization Techniques	CO4	06	06
4. Security	4.1 Need of IIoT Security, Basic Security Goals, IT and OT Security Requirement, IIoT Security Risk Management, IIoT Attack Surface, Security Framework for IIoT, Standards Related to IIoT Security.	CO5	05	05
5. Application Domains-I	5.1 Manufacturing: Connected Manufacturing, Architecture for Connected Factory, Industrial Automation Control Protocols, Connected Factory Security, Edge Computing in connected factory	CO5	06	06
	5.2 Oil and Gas: Introduction, Key Challenges, IoT architecture for Oil and Gas, Improving operational efficiency.			

6.Application Domains-II	6.1 Smart and Connected Cities: An IoT strategy for smart cities, Smart City IoT architecture, Smart City Security Architecture, Smart City- Use cases. 6.2 Transportation: Introduction, Transportation Challenges, An IoT architecture for transportation, IoT use cases for transportation.	CO5	06	06
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 2. David Hanes, et.al., "IoT Fundamentals- Networking Tehnologies, Protocols, and Use cases for the Internet of Things"
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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7033	Cryptography and Network Security	03	--	--	03

Prerequisite:	Computer Networks
Course Objectives (COBs):	**Students will try to learn:** 1. To introduce classical encryption techniques and concepts of modular arithmetic and number theory. 2. To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms. 3. To explore the design issues and working principles of various authentication protocols, PKI standards. 4. To explore various secure communication standards including Kerberos, IPsec, and SSL/TLS and email. 5. To use existing cryptographic utilities to build programs for secure communication. 6. To use the concepts of cryptographic utilities and authentication mechanisms to design secure applications.
Course Outcomes(COs):	**Students will be able to:** 1. Define system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory. 2. Explain, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication. 3. Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes. 4. Apply different digital signature algorithms to achieve authentication and create secure applications. 5. Apply network security basics, analyse different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP. 6. Apply the knowledge of cryptographic utilities and authentication mechanisms to design secure 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 Number Theory and Basic Cryptography	1.1 Security Goals, Attacks, Services and Mechanisms, Techniques. Modular Arithmetic: Euclidean Algorithm, Fermat's and Euler's theorem	CO1	03	07
	1.2 Classical Encryption techniques, Symmetric cipher model, mono alphabetic and polyalphabetic substitution techniques: Vigenere cipher, play fair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers		04	
2. Block Ciphers &	2.1 Data Encryption Standard-Block cipher	CO2	04	08

Public Key Cryptography	principles-block cipher modes of operation, Advanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm			
	Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm		03	
	2.3 Key management Diffie Hellman Key exchange		01	
3. Cryptographic Hashes, Message Digests and Digital Certificate	3.1 Authentication requirement, Authentication function , Types of Authentication	CO3	02	08
	3.2 MAC: Hash function, Security of hash function and MAC-MD5-SHA-HMAC-CMAC		04	
	3.3 Digital Certificate: X.509, PKI		02	
4. Digital signature schemes and Authentication Protocol	4.1 Digital signature and authentication protocols : Needham Schroeder Authentication protocol	CO4	02	05
	4.2 Digital Signature Schemes – RSA, EI Gamal and Schnorr, DSS.		03	
5. Network Security	5.1Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP SYN flood, DNS Spoofing	CO5	02	07
	5.2 Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood		02	
	5.3 Distributed Denial of Service, Defenses against Denial of Service Attacks		01	
	5.4 Firewalls, Intrusion Detection Systems: Host Based and Network Based IDS, Honey pots.		02	
6. Network Security Applications	6.1 Authentication Applications, Kerberos, Internet Security Protocols: SSL, TLS	CO6	02	04
	6.2 IPSEC: AH, ESP, Secure Email: PGP and S/MIME, Key Management.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Mark Stamp's Information Security Principles and Practice, Deven Shah,Wiley. 2. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013. 3. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill. 4. Bernard Menezes, "Cryptography & Network Security", Cengage Learning.
Reference Books	1. Bruce Schneier, Applied Cryptography, Protocols Algorithms and Source Code in C, Wiley. 2. Atul Kahate, Cryptography and Network Security, Tata Mc Graw Hill. 3. Dr. V. K. Pachghare, Cryptography and Information Security.
Useful Links:	1. Cryptography And Network Security - Course (nptel.ac.in)
	2. Cryptography I | Coursera
	3. Free Cryptography Tutorial - Introduction to Information Security | Udemy
Continuous Assessment	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2 : 30 Marks (where each Test shall be of 30 Marks),

(CA):	• Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7034	Biostatistics	03	--	--	03

Prerequisite:	1. Applications of Mathematics in Engineering-I and II
Course Objectives (COBs):	1. To cover basic concepts and theory related to statistics and its applications in healthcare. 2. To focus on various statistical abilities for healthcare such as analysis of variance, hypothesis testing, estimation, etc.
Course Outcomes (COs):	1. Explain concepts of Biostatistics, Descriptive statistics and basic probability concepts. 2. Apply Probability Distributions, Sampling Distribution and measure of location to solve healthcare problems. 3. Estimate t distribution, chi-square distribution, and F distribution. 4. Describe a null and alternative hypothesis and carry out a structured hypothesis test. 5. Analyse variance using regression and correlation. 6. Apply mathematical properties of chi-square distribution and use the chi-square distribution for goodness-of-fit tests.

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 Biostatistics	1.1 Sources and types of Data, collection of medical data, Presentation and Illustration of quantitative and qualitative data	CO1	02	04
	1.1 Basic concepts, Measurement and measurement scales, Sampling and Statistical Inference		01	
	1.2 Descriptive statistics: Measures of central tendency, Measures of dispersion		01	
2. Probability Distributions, Sampling Distribution and Measure of location	2.1 Introduction to Probability Distributions and its medical applications, Binomial distributions, Poisson distributions, Normal distributions	CO2	02	07
	2.2 Sampling distributions – sample mean, difference between two sample means, sample proportions, difference between two sample proportions		02	
	2.3 Measure of location-Percentiles, Types of variability, Measures of variability		03	
3. Estimation	3.1 Confidence intervals for a population mean, The 't' distribution, Confidence intervals for difference between two population means, population proportion, difference between two population proportions	CO3	04	07
	3.2 Variance of normally distributed population, ratio of variances of two normally distributed populations, Determination of sample size for estimating means and proportions		03	

4. Hypothesis Testing	4.1 Hypothesis testing for – A single population means, proportion and variance, difference between two population means, proportion and variance, Parametric and Nonparametric testing	CO4	03	06
	4.2 Type – I and II error and power of test		03	
5. Analysis of variance	5.1 Completely randomized design, Randomized complete block design, Repeated measures design, Factorial experiment	CO5	03	08
	5.2 Simple Linear Regression and Correlation: The regression model, Sample regression equation, correlation model, correlation coefficient		02	
	5.3 Multiple Regression and Correlation Multiple Linear regression model, Obtaining and Evaluating multiple Regression Equation, Multiple correlation model		03	
6. Chi square Distribution, analysis of frequency and introduction to AI vital statistics	6.1 Mathematical properties of the chi-square distribution and its application in healthcare , Test of Goodness of fit, independence and Homogeneity	CO6	03	07
	6.2 Definition of vital statistics, scope and objective, methods, case study of Civil Registration System in India		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Wayne W. Daniel, "Biostatistics-A foundation for analysis in health sciences", Seventh edition, Wiley India 2. Bratati Banerjee, "Mahajan's Methods in Biostatistics for Medical Students and Research Workers", The Health Sciences Publisher New Delhi, 9th Edition. 3. Sunder Rao and J. Richard, "An Introduction to Biostatistics", Third Edition, Prentice Hall of India. 4. Usman Zafar Paracha, "Basic Biostatistics with Basic Steps in Python" Kindle Edition, Amazon Asia-Pacific Holdings Private Limited. 5. J. Ravichandran, "Probability and statistics for engineers", Wiley /India.
Reference Books	1. Biostatistics – How it works by Steve selvin, Pearson education 2. B.L.Agarwal, "Basic statistics", New Age International Publisher 3. Probability and Statistics by Schaum's series. 4. S. C. Gupta and V. K. Kapoor, "Fundamentals of mathematical statistics", Second edition, Sultan Chand Publisher
Useful Links:	1. https://nptel.ac.in/courses/102106051
	2. https://www.udemy.com/course/statistics-for-ai-ml-developers/
	3. https://www.coursera.org/specializations/data-science-statistics-machine-learning
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2 : 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz /

	assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7041	Business Intelligence	03	--	--	03

Prerequisite:	1. Basic knowledge of database concepts and SQL. 2. Understanding of data warehousing. 3. Familiarity with programming. 4. Basic knowledge of statistics. 5. Familiarity with Excel. 6. Knowledge of business operations.
Course Objectives (COBs):	1. Understanding of database design, data modeling, and Structured Query Language (SQL) is essential to grasp the concepts of Business Intelligence. 2. Knowledge of data warehousing concepts such as data extraction, transformation, and loading (ETL) is required to understand how data is processed in Business Intelligence systems. 3. Knowledge of at least one programming language is essential to understand the logic behind building Business Intelligence applications and creating reports. 4. Understanding of basic statistics concepts such as mean, median, mode, standard deviation, correlation, and regression is helpful in analyzing and interpreting data in Business Intelligence. 5. A basic understanding of Microsoft Excel and its features, such as pivot tables, charts, and formulas, is helpful in creating and analyzing data in Business Intelligence. 6. An understanding of business operations and processes is necessary to understand the requirements and goals of Business Intelligence solutions and how they can improve business performance.
Course Outcomes (COs):	After successful completion of course student will be able to: 1. Explain the scope of BI solutions and their architecture. 2. Develop BI solutions including reports, ad hoc queries, dashboards, and scorecards. 3. Plan and manage BI projects, collect user requirements, and validate BI requirements. 4. Create different types of reports and perform data grouping, filtering, and sorting. 5. Deploy, administer, and secure BI solutions, including system sizing, authentication, and authorization. 6. Explain the importance of data quality and be able to perform data cleansing and profiling.

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 Business Intelligence	1.1 Understanding the scope of today's BI solutions and how they fit into existing infrastructure Assessing new options such as SaaS and cloud-based technology.	CO1	02	08
	1.2 Describing BI, its components and architecture, and previewing the future of BI.		02	

	1.3 Crafting a better experience for all business users, End User Assumptions Setting up Data for BI		02	
	1.4 The Functional Area of BI Tools		02	
2. Elements of Business Intelligence Solutions	2.1 Reports and ad hoc queries Analyzing OLAP data	CO2	03	07
	2.2 Developing Dashboards and Scorecards Metadata Models		02	
	2.3 Automating tasks and events Real-time monitoring capabilities		02	
3: Planning and Building the BI Project	3.1 Planning the BI project Identifying Project Resources Defining Project Tasks	CO3	02	06
	3.2 Risk Management and Mitigation Cost-justifying BI solutions and measuring success Collecting User Requirements Prioritizing and Validating BI Requirements.		02	
	3.3 Best Practices for BI Design Post-Implementation Evaluations.		02	
4. Reporting Authoring	Types of Reports: List, Crosstabs, Statistics, Chart, Map, Financial, etc.	CO4	02	06
	Adding Calculations to Reports Adding Summary Lines to Reports Drill up, Drill down, Drill-through capabilities Running or scheduling reports		02	
	Exporting Reports to different output forms such as PDF, Excel, CSV, and XML.		02	
5. BI Deployment, Administration, and Security	Centralized Versus Decentralized Architecture BI Architecture Alternatives.	CO5	02	06
	Expanding BI Authentication Authorization Access Permissions, Groups, and Roles Single-sign-on Server Administration.		02	
	Manage Status and Monitoring Audit, Mail Server, and Portal Integration.		02	
6. Advanced Topics in Business Intelligence	Real-time Analytics Social Media Analytics.	CO6	02	06
	Artificial Intelligence and Business Intelligence Integration.		02	
	Ethics and Governance in Business Intelligence.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	42

Books:

Text Books	1. Rick Sherman, "Business Intelligence Guidebook: From Data Integration to Analytics" 2. Ramesh Sharda, Dursun Delen, "Business Intelligence: A Managerial Perspective on Analytics" 3. Wilfried Grossmann, Stefanie Rinderle-Ma, "Fundamentals of Business Intelligence"

Reference Books	1.Swain Scheps and Alan R. Simon, "Business Intelligence for Dummies" 2. Paulraj Ponniah, "Data Warehousing Fundamentals for IT Professionals"
Useful Links:	https://en.wikipedia.org/wiki/Business_intelligence.
	https://www.webopedia.com/TERM/B/Business_Intelligence.html.
	https://www.cio.com/article/40296/Business_Intelligence_Definition_and_Solutions.
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7042	AI in Healthcare	03	--	--	03

Prerequisite:	1. Artificial Intelligence. 2. Internet of Things
Course Objectives (COBs):	1. To understand the need and significance of AI for Healthcare. 2. To study advanced AI algorithms for Healthcare. 3. To learn Computational Intelligence techniques. 4. To understand evaluation metrics and ethics in intelligence for Healthcare systems.
Course Outcomes (COs):	**After the successful completion of this course, learner will be able to:** 1. Explain the role of AI for handling Healthcare data. 2. Apply AI algorithms for Healthcare Problems. 3. Apply various Computational Intelligence techniques for Healthcare Application. 4. Evaluate metrics of healthcare systems. 5. Explain various NLP Techniques in healthcare 6. Design real time Healthcare 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	1.1 Overview of AI and ML,A Multifaceted Discipline, Applications of AI in Healthcare - Prediction, Diagnosis, personalized treatment and behaviour modification, drug discovery, follow-up care etc,	CO1	03	06
	1.2 Realizing potential of AI and ML in healthcare, Healthcare Data - Use Cases.		03	
2. AI, ML, Deep Learning and Data Mining Methods for Healthcare	2.1 Knowledge discovery and Data Mining, ML, Multi classifier Decision Fusion, Ensemble Learning, Meta-Learning and other Abstract Methods.	CO2	02	07
	2.2 Computational Intelligence Techniques, Unsupervised learning, dimensionality reduction algorithms		02	
	2.3 Deep Learning CNN,DBN		03	
3. Evaluating learning for Intelligence	3.1 Model development and workflow, evaluation metrics, Parameters and Hyper parameters,	CO3	03	07
	3.2 Hyper parameter tuning algorithms, multivariate testing, Ethics of Intelligence.		04	
4. Natural Language Processing in Healthcare	4.1 NLP tasks in Medicine, Low-level NLP components, High level NLP components, NLP Methods.	CO4	03	06
	4.2 Clinical NLP resources and Tools, NLP Applications in Healthcare. Model Interpretability using Explainable AI for NLP applications.	CO4	03	
5. Intelligent personal Health Record	5.1 Introduction, Guided Search for Disease Information, Recommending SCA's.	CO5	03	06
	5.2 Recommending HHP's, Continuous User Monitoring.		03	

6. Future of Healthcare using AI	6.1 Evidence based medicine, Personalized Medicine, Connected Medicine, Digital Health and Therapeutics, Conversational AI, Virtual and Augmented Reality,	CO6	04	07
	6.2 Block chain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, and Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Bose, T.K and S.K. Mitra. (1990). Fruits, Tropical and Subtropical. Naya Prakash, 206 Bidthan saran, Calcutta. 2. Nature and Properties of Soils, The Hardcover – Import, 1 March 2016 Publishing House Pvt Ltd, New Delhi. 3. Das, P.C. (2012). Vegetable Crops of India. Kalayani Publishers, New Delhi. 4.Bosoi, E.S. (2018). Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2). Oxonion Press Pvt. Ltd., New Delhi. 5. Donnel Hunt. Farm Machinery and management. Iowa State University Press, Ames, USA.
Reference Books	1. De, G.C. (1989). Fundamentals of Agronomy. Oxford & IBH Publishing Co Pvt Ltd, New Delhi. 2. Russel. Soil Condition and Plant Growth. ELBS, Longmans, U.K. 3.Review of agricultural IoT technology Jinyuan Xu a , Baoxing Gu a , Guangzhao Tian a,b,
Useful Links:	1. https://www.sciencedirect.com/journal/artificial-intelligence-in-agriculture
	2. https://onlinecourses.nptel.ac.in/noc22_bt57/preview:-Biotechnology
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7043	Digital Forensics	03	--	--	03

Prerequisite:	Computer Network, Cryptography and System Security
Course Objectives (COBs):	1.To discuss the need and process of digital forensics and Incident Response Methodology. 2. To explore the procedures for identification, preservation, and acquisition of digital evidence. 3.To explore techniques and tools used in digital forensics for Operating system and malware investigation. 4.To explore techniques and tools used for Mobile forensics and browser, email forensics.
Course Outcomes (COs):	1. Describe the phases of Digital Forensics and methodology to handle the computer security incident. 2. Describe the process of collection, analysis and recovery of the digital evidence. 3. Explore various tools to analyze malwares and acquired images of RAM/hard drive. 4. Acquire adequate perspectives of digital forensic investigation in mobile devices 5. Analyze the source and content authentication of emails and browsers. 6. Write unambiguous investigation reports which offer valid conclusions.

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 Forensics	1.1 Digital Forensics Defination, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics	CO1	03	06
	1.2 Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident		03	
2. Digital Evidence, Forensics Duplication and Digital Evidence Acquisition	2.1 Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody	CO2	03	09
	2.2 Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques,.		03	
	2.3 Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory (Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition		03	
3. Forensics Investigation	3.1 Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers	CO3	02	04
	3.2 Malware Analysis - Malware, Viruses, Worms,		02	

	Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and Techniques			
4.Windows and Unix Forensics Investigation	4.1 Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics	CO4	04	08
	4.2 Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships		04	
5.Mobile Forensics	**5.1** Android Forensics, Mobile Device Forensic Investigation - Storage location, Acquisition methods, Data Analysis	CO5	02	08
	5.2 GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and Track Points, Display the Tracks on a Map.		02	
	5.3 SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.		02	
6.Browser, Email Forensic & Forensic Investigation Reporting	**6.1** Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC)	CO6	02	04
	6.2 Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1 Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill, 2006. 2 Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019. 3 Xiaodong Lin, "Introductory Computer Forensics: A Hands-on Practical Approach", Springer Nature, 2018.
Reference Books	1. M S Khan et al, Applied Molecular Biotechnology- next generation to Genetic Engineering, CRC Press, 2016. 2. Jane K Setlow, Genetic Engineering-Principles and methods, Volume 27, 2006, Springer. 3. Green M.R and Sambrook J. "Molecular Cloning", a Laboratory Manual, Cold Spring Harbor Laboratory Press, New York, USA. Fourth Edition (2012).
Suggested MOOC Course Links	Course on "Ethical Hacking" https://nptel.ac.in/courses/106/105/106105217/
	Course on "Digital Forensics" https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
	Course on Cyber Incident Response https://www.coursera.org/learn/incident-response
	Course on "Penetration Testing, Incident Responses and Forensics" https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC7044	Genetic Engineering and Genomics	03	--	--	03

Prerequisite:	1. Molecular biology 2. Cellular biology
Course Objectives (COBs):	1. To gain an understanding of genetic engineering. 2. To gain an understanding of basic molecular biology concepts and techniques. 3. To know of gene expression and the process of development in eukaryotes. 4. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
Course Outcomes (COs):	After successful completion of course, students will be able to - 1. Explain the concepts of molecular biology. 2. Explain sequencing principles of DNA, RNA in human being, plants. 3. Describe DNA modification techniques. 4. Acquire knowledge on host cells and vectors. 5. Find proficiency in conducting experiments involving genetic manipulation. 6. Explain genome sequencing and genome mapping for gene prediction.

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. Introducing molecular biology	1.1: Introduction-Genetic Engineering, flow of genetic information, The structure of DNA, RNA	CO1	02	07
	1.2: Gene organization, anatomy of gene, structure of gene in prokaryotes and eukaryotes		02	
	1.3: Gene expression from gene to proteins, regulation, transcription and translation, genes and genomes, size, complexity, organization.		03	
2. Working with nucleic acid	2.1: Handling and quantification of nucleic acid, isolation of DNA, RNA	CO2	02	07
	2.2: labeling nucleic acid, nucleic acid hybridization, gel electrophoresis		02	
	2.3: DNA sequencing principles, preparation of DNA fragments, sequencing types		03	
3. DNA modification	3.1: Restriction enzymes-cutting DNA, Type II restriction, restriction mapping	CO3	03	05
	3.2: DNA modifying enzymes, DNA ligase, joining DNA molecules.		02	
4. Host Cells and Vectors	4.1: host cell types, basic cloning plasmid,	CO4	02	06
	4.2: Bacteriophage vectors, hybrid/plasmid phase vectors		02	
	4.3: Artificial chromosomes, transformation and transfection of DNA into Cells, packaging phage DNA		02	
5. Cloning strategies	5.1: Cloning from mRNA, Cloning from genomic DNA	CO5	03	06
	5.2: Advanced cloning strategies, synthesis and cloning of cDNA		03	
6. Genomics	6.1: Introduction, Genome mapping, genome	CO6	03	08

	sequencing, Gene prediction and counting			
	6.2: Genome similarity, SNPs and comparative genomics,		03	
	6.3: Pharmacogenomics, functional genomics and microarrays, molecular phylogeny		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Desmond S T Nicholl, An Introduction to Genetic Engineering, Third Edition, Cambridge University Press, 2008 2. A. J. Nair PhD, Introduction to Biotechnology and Genetic Engineering, Infinity Science Press, 2007.
Reference Books	1. M S Khan et al, Applied Molecular Biotechnology- next generation to Genetic Engineering, CRC Press, 2016 2. Jane K Setlow, Genetic Engineering-Principles and methods, Volume 27, 2006, Springer 3. Green M.R and Sambrook J. "Molecular Cloning", a Laboratory Manual, Cold Spring Harbor Laboratory Press, New York, USA. Fourth Edition (2012).
Useful Links:	1. https://oyc.yale.edu/biomedical-engineering/beng-100/lecture-3
	2. https://www.youtube.com/watch?v=Yh9w_fyvpUk
	3. https://www.ebi.ac.uk/training/online/courses/functional-genomics-i-introduction-and-design/what-is-genomics/
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7051	Product Life Cycle Management	03	--	--	03

Course Objectives (COBs):	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.
Course Outcomes (COs):	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 Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering.	CO2	05	09
	2.2 Characteristic Features of Concurrent Engineering,		04	

	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			
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	5.1 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:	
Text Books	1. Saaksvuori, Antti, Immonen, Anselmi, "Product Lifecycle Management" 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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2 : 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7052	Reliability Engineering	03	--	--	03

Course Objectives (COBs):	1. To familiarize the students with various aspects of probability theory 2. To acquaint the students with reliability and its concepts 3. To introduce the students to methods of estimating the system reliability of simple and complex systems 4. To understand the various aspects of Maintainability, Availability and FMEA procedure.
Course Outcomes (COs):	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	
3. System Reliability	3.1 System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	CO3	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	5.1 System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault	CO5	03	05

Availability	Isolation and self-diagnostics.			
	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.	CO6	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. Lewis, "Introduction to Reliability Engineering", 2nd Edition Wiley India 2. Birolini A, "Reliability Engineering Theory and Practice" 8ed (Hb 2017), Springer. 3. Donald W. Benbow, Hugh W. Broome, "The Certified Reliability Engineer Handbook" 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
	5. https://www.coursera.org/learn/site-reliability-engineering-slos
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7053	Management Information System	03	--	--	03

Course Objectives (COBs):	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.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1.Describe how information system transforms business. 2.Identify the impact information systems have on an organization. 3.Describe IT infrastructures and its components and its current trends. 4.Explain the principal tools and technologies for accessing information from databases. 5.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	
6.Project leadership and Ethics and Closing the projects	6.1 Information System within Organization: Transaction Processing Systems, Functional Area Information System.	CO6	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.		04	
II. Course	Recap of Modules, Outcomes, Applications, and	---	01	01

Conclusion	Summarization.			
			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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.			
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7054	Design of Experiments	03	--	--	03

Course Objectives (COBs):	1. To understand the issues and principles of Design of Experiments (DOE) 2. To list the guidelines for designing experiments 3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply 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 General2k 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
	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	03	05
	6.2 Analysis Methods, Robust design examples.		02	
II. Course	Recap of Modules, Outcomes, Applications, and	---	01	01

Conclusion	Summarization.			
			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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.			
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7055	Operation Research	03	--	--	03

Course Objectives (COBs):	1.To understand Research and Research Process 2.To acquaint students with identifying problems for research and develop research strategies 3.To familiarize students with the techniques of data collection, analysis of data and interpretation
Course Outcomes (COs):	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./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	-	01	01
1.Linear Programming	1.1 Linear Programming: Problem formulation, Graphical Method and simplex method.	CO1	04	10
	1.2 Artificial Variable Simplex Techniques: Big-M Method and Two-Phase Method.		03	
	1.3 Advanced Topics in Linear Programming: Duality in Linear Programming and the Dual Simplex Method.		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.	CO2	03	06
	2.2 Assignment Model: The Hungarian method for solution of Assignment problems, Unbalanced assignment problem and maximization problem.		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).	CO3	03	06
	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.		03	
4.Network analysis in	4.1 Project Management: Phases of project management, Network construction, Critical Path	CO4	04	07

project planning and Sequencing models	Method (CPM) and Process Evaluation & Review Techniques (PERT). (Exclude Cost analysis, crashing, resource scheduling and updating)			
	4.2 Sequencing Models: Processing n jobs through one machine, two machines and three machines, Processing n jobs through m machines.		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.	CO5	04	07
	5.2 Simulation: Definition, Types of Simulation Models, Monte Carlo Technique, Practical Problems, Applications in Queuing and Inventory problems.		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.	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	–	01	01
			Total hours	42

Books:	
Reference Books	1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002. 2. avindran, 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. S. D. Sharma, Kedar Nath, Ram Nath “Operations Research” 5. Kanti Swarup, P. K. Gupta and Man Mohan, “Operations Research” 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):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7056	Cyber Security and Laws	03	--	--	03

Course Objectives (COBs):	1. To understand and identify different types cybercrime and cyber law. 2. To recognized Indian IT Act 2008 and its latest amendments. 3. To learn various types of security standards compliances.
Course Outcomes (COs):	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 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	CO4	08	08

	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. Suresh T. Vishwanathan; The Indian Cyber Law, Bharat Law House New Delhi 3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi. 4. Advocate Prashant Mali, "Cyber Law & Cyber Crimes", 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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7057	Disaster Management and Litigation Measures	03	--	--	03

Course Objectives (COBs):	1. To understand physics and various types of disaster occurring around the world 2. To identify extent and damaging capacity of a disaster. 3. To study and understand the means of losses and methods to overcome 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.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain 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. Explain the Simple Dos and Don'ts in Such Extreme Events and act accordingly. 5. Examine Financing Relief Measures. 6. Explain 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, Policy and Administration	3.1 Disaster Management: Meaning, Concept, Importance.	CO3	02	06
	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	

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:	
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	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks),

(CA):	• Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7058	Energy Audit and Management	03	--	--	03

Course Objectives (COBs):	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.
Course Outcomes (COs):	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 controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting,	CO3	10	10

	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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC7059	Development Engineering	03	--	--	03

Course Objectives (COBs):	1. To understand the issues and principles of Design of Experiments (DOE). 2. To list the guidelines for designing experiments. 3. To become familiar with methodologies that can be used in conjunction with designs for robustness and optimization.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Plan data collection to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply different two-level factorial designs. 4. Differentiate the different fractional factorial methods. 5. Apply the methods taught to real life situations. 6. 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 2^2Design, 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	
5. Response Surface Methods and Designs	5.1Introduction to Response Surface Methodology, The Method of Steepest Ascent.	CO5	04	08
	5.2Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.		04	
6.Taguchi Approach	6.1Crossed Array Designs and Signal-to-Noise Ratios.	CO6	02	04
	6.2Analysis 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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIL701	Deep Learning Lab	-	01	-	01

Lab Prerequisite:	1. Python Programming, 2. Engineering Mathematics
Lab Objectives(LOBs):	1. To implement basic neural network models for simulating logic gates. 2. To implement various training algorithms for feedforward neural networks. 3.To design deep learning models for supervised, unsupervised and sequence learning.
Lab Outcomes (LOs):	1. Implement basic neural network models to learn logic functions using virtual lab. 2. Design and train feedforward neural networks using various learning algorithms. 3. Build and train deep learning models such as Auto encoders. 4. Build and train deep learning models such as CNNs. 5. Build and train deep learning models such as RNN. 6. Build and train deep learning models such as LSTM.

Lab No.	Experiment Title	LO mapped	Hrs./ Lab
0	**Lab Prerequisite**	--	02
1	**Based on Module 1 (Any two) using Virtual Lab** 1. Implement Mc-Culloch Pitts model for binary logic functions. 2. Implement Perceptron algorithm to simulate any logic gate. 3. Implement Multilayer Perceptron algorithm to simulate XOR gate. 4.To explore python libraries for deep learning e.g. Theano, TensorFlow etc.	LO1	02
2	**Module 2 (Any Two)** 1.Apply any of the following learning algorithms to learn the parameters of the supervised single layer feedforward neural network. a.Stochastic Gradient Descent b.Mini Batch Gradient Descent c.Momentum GD d.Nestorev GD e.Adagrad GD f.Adam Learning GD 2. Implement a back propagation algorithm to train a DNN with at least 2 hidden layers. 3. Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function.	LO2	02
3	**Module 3 (Any One)** 1. Design the architecture and implement the auto encoder model for Image Compression. 2. Design the architecture and implement the auto encoder model for Image denoising.	LO3	02
4	**Module 4 (Any One)**	LO4	02

	1. Design and implement a CNN model for digit recognition application. 2. Design and implement a CNN model for image classification.		
5	**Module 5 (Any Two)** 1. Design and implement LSTM for Sentiment Analysis. 2. Design and implement GRU for classification on text data. 3. Design and implement RNN for classification of temporal data.	LO5 LO6	02
Virtual Lab Links:	1. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php		
	2. http://noiselab.ucsd.edu/ECE228_2018/Reports/Report16.pdf		
Term work (TW):	• Term work should consist of a minimum of 8 experiments • The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. • Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. • The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. • The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. • Total 25 Marks (Experiments: 20-marks, Assignments/Case study/demo/presentation: 05-marks) Note: Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.		
Oral/Practical/P&O:	• P&O examination will be based on experiment list and performance of experiment. • For Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).		

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIL702	Natural Language Processing Laboratory	--	01	--	01

Lab Prerequisite:	1. Python 2. R Language
Lab Objectives (LOBs):	1. To implement basic algorithms of NLP. 2. To apply N Gram to the Text. 3. To implement Semantics of the Text using NLP algorithms 4. To apply different NLP techniques to the Indian Languages
Lab Outcomes (LOs):	1. Apply the basic algorithms using Python. 2. Implement the grammar rules of NLP to the text and test the results. 3. Implement the error free Language reading by applying suitable algorithms. 4. Implement the NLP techniques to real life applications. 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
0	Lab Prerequisite	--	02
1	Pre-processing of Text (Tokenization,), filtration, Script Validation, Stop word removal, Stemming	LO1, LO5, LO6	02
2	Morphological Analysis	LO2, LO5, LO6	02
3	N-Gram Model	LO2, LO5, LO6	02
4	POS Tagging	LO2, LO5, LO6	02
5	Chunking	LO3, LO5, LO6	02
6	Named Entity Recognition	LO4, LO5, LO6	02
7	Case Studies (Proposed case studies) a) Sentiment Analysis / Opinion Mining Gauge attitude / sentiments / evaluations / emotions of a speaker or chat b) CV parsing Shortlisting Candidate Automated Interview. c) Clause classification in legal contracts Contract Making d) Automate response to RFP Tender Filing e) Concept extraction from legal / lease documents Risk Analysis f) Text summarization Evaluation, Automated Paper Correction. g) Meeting analyzer / Meeting notes summary generation MOM. h) Automatic email response, Office Efficiency.	LO4, LO5, LO6	02
Useful Lab Links:	1. https://cse24-iiith.virtual-labs.ac.in/#		
Term work:	1. Term work should consist of a minimum of 6 experiments and a Case Study		

	2. Journal must include contents on practical performance and a report on case study of the course. 3. 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/Case study/demo/presentation: 05-marks). 4. A practical/Oral exam of 25 marks will be conducted at the end of the semester.
Oral/Practical/ P&O:	• Practical examination will be based on experiment list and performance of experiment. • For Total 25 Marks (Practical: 15 Marks and Oral: 10 Marks).

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL7031	Speech Processing Laboratory	--	01	--	01

Lab Prerequisite:	1. Applications of Mathematics in Engineering-I and II 2. Python
Lab Objectives (LOBs):	1. To study types of signal and Speech signal processing. 2. To perform analysis of Speech Signal. 3. To study classification methods for pattern recognition.
Lab Outcomes (LOs):	After successful completion of lab student will be able to 1. Implement synthesis of vowels by source filter model. 2. Plot STFT for speech segment analysis and through Praat for the estimation of signal parameters. 3. Compute of Linear Predictive coefficients and plot the LPC spectrum. 4. Perform Cepstral analysis of speech segments. 5. Perform Classification using pattern recognition. 6. Write accurate documentation for experiment performed.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
0	Lab Prerequisite	--	02
1	Digital speech analysis using PRAAT.	LO1	02
2	Sampling Frequency and Bit Resolution for Speech Signal Processing	LO1	02
3	Identification of Voice/Unvoiced/Silence regions of Speech	LO1	02
4	Recognition of different language phonemes.	LO2	02
5	Speech synthesis based on source filter model	LO2	02
6	Plotting of STFT and estimation of signal parameters	LO2	02
7	Cepstral Analysis of Speech	LO4	02
8	Linear Prediction Analysis	LO3	02
9	Spoken English Digit/Character classification using Pattern Recognition Methods	LO5	02
10	Spoken English Vowel classification using Pattern Recognition Methods	LO5	02
11	Case study	LO5	02

Useful Lab Links:	1.https://vlab.amrita.edu/index.php?sub=59&brch=164 2.https://ssp-iiith.vlabs.ac.in/List%20of%20experiments.html
Term work (TW):	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 "Speech Processing 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/Practical /P&O:	Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL7032	Internet of Everything Lab	--	01	--	01

Lab Prerequisite:	1. Internet of Things 2. Basic knowledge of computer and internet 3. Computer Communication Networks
Lab Objectives (LOBs):	**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. Implement analytics for Industrial IoT applications. 4. Demonstrate 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
0	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 Communication and Networking in Industrial IoT Application	LO2, LO5, LO6	02
4	Implementation of analytics in Industrial IoT Application-I	LO3, LO5, LO6	02
5	Implementation of analytics in Industrial IoT Application-II		02
6	Implementation of Big Data Analytics Tools and Technology.		02
7	Implementation of Big Data Analytics Tools and Technology.		02
8	Implementation of Streaming Analytics.		02
9	Case Study - Industrial IoT Application Domain-I	LO4, LO5, LO6	04
10	Case Study - Industrial IoT Application Domain-II		04

Useful Lab Links:	https://onlinecourses.nptel.ac.in/noc20_cs69
Term work(TW):	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 "Internet of Everything 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/Practical/P&O:	Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL7033	Cryptography and Network Security Laboratory	--	01	--	01

Lab Prerequisite:	1. Computer Networks 2. Operating System 3. Basics of Java and Python
Lab Objectives (LOBs):	Students will try: 1. To be able to apply the knowledge of symmetric cryptography to implement simple ciphers 2. To be able to analyze and implement public key algorithms like RSA and El Gamal 3. To analyze and evaluate performance of hashing algorithms 4. To explore the different network reconnaissance tools to gather information about networks 5. To explore and use tools like sniffers, port scanners and other related tools for analyzing packets in a network. 6. To be able to set up firewalls and intrusion detection systems using open source technologies and to explore email security.
Lab Outcomes (LOs):	Students will learn to: 1. Apply the knowledge of symmetric cryptography to implement simple ciphers 2. Analyze and implement public key algorithms like RSA and El Gamal 3. Analyze and evaluate performance of hashing algorithms 4. Explore the different network reconnaissance tools to gather information about networks 5. Use tools like sniffers, port scanners and other related tools for analyzing packets in a network 6. Apply and set up firewalls and intrusion detection systems using open source technologies and to explore email security.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
0	Lab Prerequisite	--	02
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers	LO1	02
2	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal	LO2	02
3	Implementation of Diffie Hellman Key exchange algorithm	LO2	02
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs	LO3	02
5	Exploring wireless security tools like Kismet, NetStumbler etc.	LO3	02
6	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.	LO4	02
7	Study of packet sniffer tools wireshark, :- 1. Observer performance in promiscuous as well as non-promiscuous mode. 2. Show the packets can be traced based on different filters.	LO5	02
8	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan,	LO5	02

	etc.		
9	Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark.	LO4	02
10	Simulate DOS attack using Hping and other tools	LO5	02
11	Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities.	LO5	02
12	Set up IPSEC under LINUX.	LO6	02
13	Set up Snort and study the logs.	LO6	02
14	Explore the GPG tool of linux to implement email security	LO6	02
Useful Lab Links:	Virtual Labs (iitb.ac.in)		
Term work(TW):	1. Term work should consist of a minimum of 8 experiments 2. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. 3. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. 4. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. 5. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. 6. Total 25 Marks (Experiments-20 marks, Assignments:-05 marks) **Note:** Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.		
Oral/Practical /P&O:	Oral/Practical /P&O examination will be based on experiment list and performance of experiment.		

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL7034	Biostatistics Laboratory	--	01	--	01

Lab Prerequisite:	1. Applications of Mathematics in Engineering-I, II. 2. Python/R programming. 3. MS Excel.
Lab Objectives (LOBs):	1. To cover basic concepts and theory related to statistics. 2. To focus on various statistical abilities such as analysis of variance, hypothesis testing, estimation, etc.
Lab Outcomes (LOs):	1. Demonstrate the concept of Measurement and Sampling. 2. Interpret Probability Distributions and Sampling Distribution 3. Demonstrate the importance and basic principles of estimation and uses of the distribution, chi-square distribution, and F distribution. 4. Compare a null and alternative hypothesis and carry out a structured hypothesis test. 5. Compare Simple and Multiple Linear Regression and Correlation models. 6. Show mathematical properties of chi-square distribution and use the chi-square distribution for goodness-of-fit tests.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
0	Lab Prerequisite	--	02
1	Measurement and Sampling: To select a simple random sample from *.sav and enter your data into an R file.	LO1	02
2	Frequency Distributions: To explore the AGE data in your sample with a stem-and-leaf plot and frequency table.	LO1	02
3	Summary Statistics: To calculate and interpret summary statistics for the data in your sample.	LO1	02
4	Probability: To calculate and interpret binomial probabilities and Normal probabilities.	LO2	02
5	Introduction to Estimation: To learn about the sampling distribution of means and confidence intervals for μ.	LO3	02
6	Introduction to Hypothesis Testing: To learn about significance testing and to conduct one-sample tests for means.	LO4	02
7	Paired Samples: To learn how to analyze paired samples for a quantitative outcome.	LO5	02
8	Independent Samples: To compare two independent means.	LO5	02
9	Inference About a Proportion: To make inferences about a population proportion (prevalence, in this instance).	LO6	02
10	Cross-Tabulated Counts and Independent Proportions: To cross-tabulate binary data from independent groups and compare independent proportions.	LO6	02

Mini Project (if any)

Virtual Lab Links:	1. https://www.youtube.com/watch?v=fDRa82lxzaU
	2. https://www.youtube.com/watch?v=tutoTRTI7Qc
Term work(TW):	1. Term work should consist of a minimum of 6 experiments and 2 Case studies.

	2. Journal must include at least 2 assignments on content of theory and practical of the course "Biostatistics". 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 examination will be based on experiment list and performance of experiment.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIPR75	Major Project Lab-A	--	03	--	03

Prerequisites	1. PBL Mini Project Lab-1 2. PBL Mini Project Lab-2 3. PBL Minor Project Lab-1 4. PBL Minor Project Lab-2
Course Objectives (COBs):	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.
Course Outcomes (COs):	Learner will be able to, 1. Identify formulate, review research literature, and analyses 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 programmers.

- 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 should publish a review paper based on the literature survey of project title and present it in Conferences/Journals.

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. Review paper published copy with certificate of publication.
9. 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) with review paper published in conference/Journal
    d. Term End Presentation (Internal)
10. The final certification and acceptance of TW of 25 Marks ensures the satisfactory performance on the above aspects.

P&O: P&O examination of 50 marks will be based on Presentations of Major Project-A

SEMESTER VIII - B.TECH. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)

Semester- VIII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credit Assigned		Course Category
		(TH–P–TUT)	Total	(TH–P–TUT)	Total	
AIC801	Reinforcement Learning	3–0–0	03	3–0–0	03	PC
AIDLC802X	Department Level Elective-5	3–0–0	03	3–0–0	03	DLE
AIDLC803X	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
AIL801	Reinforcement Learning Lab	0–2–0	02	0–1–0	01	PC
AIDLL802X	Department Level Elective-5 Lab	0–2–0	02	0–1–0	01	DLE
AIL805	Robotic Process Automation Lab	0–2–0	02	0–1–0	01	PC
AIPR86	Project Based Learning-Major Project Lab-B	0-12#-0	12*	0–6–0	06	PBL
INT81	Internship-VII	--		--	--	INT
Total		**12-18-0**	**30**	**12-9-0**	**21**	

#PBL-PR-B (Conference /Journal Publication Filling Patent, Creation of Product & Licensing, Start up, SIH, Participation etc)

*Load of learner, not the faculty

Semester- VIII-Examination Scheme

Course Code	Course Name	Examination Scheme										
		Marks										
		CA				ESE	Duration in Hrs	TW	O	P	P&O	Total
		T-1	T-2	Avg. of T1 and T2	IA							
AIC801	Reinforcement Learning	30	30	30	10	60	2.30	--	--	--	--	100
AIDLC802X	Department Level Elective-5	30	30	30	10	60	2.30	--	--	--	--	100
AIDLC803X	Department Level Elective-6	30	30	30	10	60	2.30	--	--	--	--	100
ILC804X	Institute Level Elective-2	30	30	30	10	60	2.30	--	--	--	--	100
AIL801	Reinforcement Learning Lab	--	--	--	--	--	--	25	--	--	25	50
AIDLL802X	Department Level Elective-5 Lab	--	--	--	--	--	--	25	25	--	--	50
AIL805	Robotic Process Automation Lab	--	--	--	--	--	--	25	--	--	25	50
AIPR86	Project Based Learning-Major Project Lab-B	--	--	--	--	--	--	50	--	--	100	150
INT81	Internship-VII	--	--	--	--	--	--	--	--	--	--	--
Total		**120**	**120**	**120**	**40**	**240**	--	**125**	**25**	**--**	**150**	**700**

Major Project A and B: Students can form groups with minimum 2 and not more than 3

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

In Semester VIII – 1 hour per week per project group

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

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

Department Level Elective-5			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC8021	**AIDLC8022**	**AIDLC8023**	**AIDLC8024**
High Performance Computing	Design thinking and Innovation	Social Media Analytics	ML in Bioinformatics
Department Level Elective-6			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**

AIDLC8031	AIDLC8032	AIDLC8033	AIDLC8034
Quantum Computing	Intelligent Vehicle Technology	Threat Analysis and Modelling	Biometric System Modelling and Simulation
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			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
A1C801	Reinforcement Learning	03	--	--	03

Prerequisites	1. Machine Learning 2. Analysis of Algorithm
Course Objectives (COBs):	1. To Learn how to define RL tasks and the core principals behind the RL. 2. To understand and work with tabular methods to solve classical control problems. 3. To understand and work with approximate solutions (deep Q network-based algorithms). 4. To learn the policy gradient methods from vanilla to more complex cases. 5. To explore recent advance in RL. 6. To recognize current advanced techniques and applications in RL.
Course Outcomes (COs):	1. Describe Reinforcement Learning and its basics. 2. Explain tabular methods to solve classical control problems. 3. Explain approximate solutions like deep Q network-based algorithms. 4. Describe the policy gradient methods. 5. Describe recent advances in Reinforcement Learning. 6. Apply suitable RL techniques for real time 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 Reinforcement Learning	1.1 Introduction and basics of reinforcement learning (RL), Examples, Elements of RL, Limitations and Scope, History of Reinforcement Learning	CO1	03	03
2. Tabular Solution Methods	2.1 Multi-arm Bandits, Finite Markov Decision Processes, Dynamic Programming, and Monte Carlo Methods	CO2	03	10
	2.2 Temporal-Difference Learning, Q-Learning and n-Step algorithm		03	
	2.3 Case Study: Automatically Scaling Application Containers to Reduce Cost Extensions to Q-Learning: Standard, Double, Delay Q learning.		04	
3.Deep Q-Networks	3.1 Deep Learning Architectures-- Fundamentals, Common Neural Network Architectures, Deep Learning Frameworks, Deep Reinforcement Learning	CO3	05	09
	3.2 Deep Q Learning -- Experience Relay, Q-Network clones, NN Architecture, Implementing DQN, Case Study: Reducing Energy Usage in Buildings		04	
4. Policy Gradient Methods	4.1 Benefits of Learning a Policy Directly Calculate the Gradient of a Policy Policy Gradient Theorem Policy Functions -- Linear Policies, Arbitrary Policies	CO4	04	08
	4.2 Practical Reinforcement Learning The RL Project Life Cycle-- Definition RL Engineering and Refinement-- Process, Environment Engineering, State Engineering or State		04	

	Representation Learning, Policy Engineering			
5. Recent Advances	5.1 Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL	CO5	04	04
6. Applications and Case Studies	6.1 TD Gammon Samuel's Checkers Player The Acrobot Elevator Dispatching Dynamic Channel allocation Job-Shop Scheduling	CO6	05	05
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Dr. Phil Winder, "Reinforcement Learning: Industrial applications with intelligent Agents", O'REILLY Publication. 2. Richard S. Sutton and Andrew G. Barto , "Reinforcement Learning: An Introduction" , Second edition. 3. Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning." Adaptation, learning, and optimization 12 (2012).
Reference Books	1. Enes Bilgin, Mastering Reinforcement Learning with Python: Build next-generation, self-learning models using reinforcement learning techniques and best practices, Paperback 2. Maxim Lapan , Deep Reinforcement Learning Hands-On: Apply modern RL methods to practical problems of chatbots, robotics, discrete optimization, web automation, and more, 2nd Edition Paperback 3. G. Ciaburro, Keras Reinforcement Learning Projects, Packet Publishing 4. S. Ravichandiran, Hands-on Reinforcement Learning with Python, Packet Publishing
Useful Links:	
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8021	High Performance Computing	03	--	--	03

Prerequisites	Digital Logic and Computer Architecture
Course Objectives (COBs):	1. To learn concepts of parallel programming as it pertains to high-performance computing. 2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms.
Course Outcomes (COs):	1. Recognize parallel processing approaches. 2. Describe different Pipeline and hazard techniques. 3. Describe different parallel processing platforms involved in achieving High Performance Computing. 4. Demonstrate efficient and high-performance parallel programming. 5. Interpret Parallel Programming performance measures. 6. Learn parallel programming using message passing paradigm using open- source APIs and MPI.

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 Introduction to Parallel Computing: Introduction to Parallelism(What, Why, Applications) Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function)	CO1	02	05
	1.2 Classification Models: Architectural Schemes (Flynn‘s, Shore‘s, Feng‘s, Handler‘s)		01	
	1.3 Memory Access: Shared Memory, Distributed Memory, Hybrid Distributed Shared Memory		01	
	1.4 Parallel Architectures: Pipeline Architecture, Array Processor, Multiprocessor Architecture, Systolic Architecture, Data Flow Architecture		01	
2.Pipeline Processing	2.1 Introduction, Pipeline Performance, Arithmetic Pipelines,	CO2	02	06
	2.2 Pipeline instruction processing, Pipeline stage design,		02	
	2.3 Hazards, Dynamic instruction scheduling		02	
3.Parallel Programming Platforms	3.1 Parallel Programming Platforms: Implicit Parallelism:	CO3	01	07
	3.2 Trends in Microprocessor & Architectures, Limitations of Memory System Performance,		02	
	3.3 Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines		04	
	4.1 Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques	CO4	02	08
	4.2 Characteristics of Tasks and Interactions, Mapping		03	

4.Parallel Algorithm Design	Techniques for Load Balancing			
	4.3 Methods for Containing Interaction Overheads, Parallel Algorithm Models		03	
5.Performance Measures	5.1 Performance Measures: Speedup, execution time, efficiency, cost, scalability	CO5	01	05
	5.2 Effect of granularity on performance, Scalability of Parallel Systems		02	
	5.3 Amdahl's Law, Gustavson's Law, Performance Bottlenecks		02	
6.HPC Programming	6.1 Programming Using the Message-Passing Paradigm: Principles of Message Passing Programming	CO6	02	08
	6.2 The Building Blocks: Send and Receive Operations		02	
	6.3 MPI: The Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Introduction to OpenMP		04	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, ―Introduction to Parallel Computing‖, Pearson Education, Second Edition, 2007 2. M. R. Bhujade, ―Parallel Computing, 2nd edition, New Age International Publishers, 2009. 3. Georg Hager, Gerhard Wellein, ―Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
Reference Books	1. Michael J. Quinn, ―Parallel Programming in C with MPI and OpenMP‖, McGraw-Hill International Editions, Computer Science Series, 2008. 2. Kai Hwang, Zhiwei Xu, ―Scalable Parallel Computing: Technology, Architecture, Programming‖, McGraw Hill, 1998. 3. Laurence T. Yang, MinyiGuo, ―High- Performance Computing: Paradigm and Infrastructure‖ Wiley, 2006 4. Kai Hwang, Naresh Jotwani, ―Advanced Computer Architecture: Parallelism, Scalability, Programmability‖, McGraw Hill, Second Edition, 2010
Useful Links:	1. https://nptel.ac.in/courses/106/108/106108055/
	2. https://www.coursera.org/courses?query=high%20performance%20computing
	3. https://www.edx.org/learn/discrete-mathematics
	4. https://www.coursera.org/specializations/discrete-mathematics
	5. https://nptel.ac.in/courses/106/106/106106094/
	6. https://swayam.gov.in/nd1_noc19_cs67/preview
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz /

	assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8022	Design Thinking and Innovation	03	--	--	03

Prerequisites	Basics of TBL, PBL Basics of communication skill
Course Objectives (COBs):	1.To develop creative mind-set while designing, innovating, developing, and testing solutions for new products, services and processes. 2.To understand the role of creative idea to construct innovation in the digital era and drive disruptive innovation. 3.To create a design thinking culture to drive innovation in an organizational setup. 4.To envisage innovative solutions individually and in teams for maximizing business impact 5.To develop the ability to create and test prototypes those are customer-centric and innovative.
Course Outcomes (COs):	After successful completion of course student will be able to: 1. Explain basic rules of design thinking. 2. Define the user needs for HCD design. 3. Create a design thinking culture for idea immersion. 4. Develop a story to explain idea to product and give visual experience. 5. Envisage innovative solutions individually and in teams for maximizing business impact. 6. Develop the ability to create and test prototypes that are customer-centric and innovative.

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 design thinking and innovation	1.1 Introduction, need for design thinking , what is design key concept of design thinking, advantages disadvantages and applications, What is Creativity?, Thinking Differently, Basic Rules of Design Thinking, A Simplified Process of Design	CO1	02 02 02	06
2. Context, environment and design	2.1 Types of research, Ethnographic Research, Participatory Research, Evaluative Research, Effective Research for HCD Design in the World. User Context Visible and Invisible Users, Hybrid Model of Research, Identifying user needs, Re-defining the Problem, The User Value Proposition, Needs vs. Wants.	CO2	03 03 02	08
3. Ideation and Immersion	3.1 Creative Ideation and Pattern Recognition, Developing Creative Habits, Creative Thinking Techniques, SCAMPER Brainstorming Tools, The Importance of True Immersion, Immersive Learning, Immersive Experience in the Design Process, Mindful Design Automobile Design Process	CO3	03 03	06
4. Storytelling	4.1 Stories vs. Narrations Storyteller Across Time and	CO4	02	06

and visualization	Cultures, Experimental Storytelling, Storytelling in Research, Rural storytelling, The Importance of Visuals and Visualization, Visualizing Human Experiences Storyboarding or Image Boarding		02 02	
5. Integrating design technology and business	5.1 Introduction to Project Management Methodologies Scrum, Kanban, and Scrumban, Customer Segmentation and Innovation, Design and Systems Thinking, Design and Systems Thinking Working Harmoniously Business Design Contributions of a Business Designer	CO5	02 02 02	06
6. Innovations project life cycle	6.1 Innovations project life cycle and innovation management Tools Lean Management Principles, Logical and Creative Thinking Product Implementation Lifecycle, Types of Innovation, Roadblocks to Idea Generation and Implementation, Strategies for Whole Brain Thinking, Design Management	CO6	02 02 03	07
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Thomas Lockwood, "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value" Published by Allworth Press. 2. HarperCollins, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Kindle Edition published by e-books; 1st edition 3. David Kelley and Tom Kelley, "Creative Confidence: Unleashing the Creative Potential within Us", published by William Collins.
Reference Books	1. Christian Müller-Roterberg, "A practical guide to design thinking, Moritz Gekeler publisher Friedrich-Ebert-Stiftung (FES) Handbook of Design Thinking", Publisher: Kindle Direct Publishing ISBN: 978-1790435371 2. Idris Mootee, "Design by startigic Innovation", Published by John Wiley & Sons, Inc., Hoboken, New Jersey. 3. Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers" published by Columbia University Press. 4. Jeanne Liedtka , Karen Hold , Jessica Eldridge, "Experiencing Design: The Innovator's Journey", Published by Columbia Business School Publishing.
Useful Links:	1. https://nptel.ac.in/courses/110106124
	2. https://onlinecourses.nptel.ac.in/noc22_mg32/preview
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8023	Social Media Analytics	03	--	--	03

Prerequisites	Graph Theory, Data Mining, Python/R programming
Course Objectives (COBs):	**The course aims:** 1. Familiarize the learners with the concept of social media. 2. Familiarize the learners with the concept of social media analytics and understand its significance. 3. Enable the learners to develop skills required for analyzing the effectiveness of social media. 4. Familiarize the learners with different tools of social media analytics. 5. Familiarize the learner with different visualization techniques for Social media analytics. 6. Examine the ethical and legal implications of leveraging social media data.
Course Outcomes (COs):	After successfully completion of the course the student will be able to 1. Explain the concept of Social media 2. Explain the concept of social media Analytics and its significance. 3. Analyze the effectiveness of social media 4. Apply different Social media analytics tools effectively and efficiently. 5. Apply different effective Visualization techniques to represent social media analytics. 6. Acquire the fundamental perspectives and hands-on skills needed to work with social media data.

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. Social Media Analytics: An Overview	1.1 Core Characteristics of Social Media, Types of Social Media, and Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations.	CO1	03	06
	1.2 Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools.		03	
2. Social Network Structure, Measures & Visualization	2.1 Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust.	CO2	02	06
	2.2 Network Visualization - Graph Layout, Visualizing Network features, Scale Issues.		02	
	2.3 Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.		04	

3. Social Media Text, Action & Hyperlink Analytics	3.1 Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools	CO3	04	08
	3.2 Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools		02	
	3.3 Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools.		02	
4.Social Media Location & Search Engine Analytics	4.1 Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools.	CO4	03	06
	4.2 Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools.		03	
5. Social Information Filtering	5.1 Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems	CO5	03	06
	5.2 Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks		03	
6. Social Media Analytics Applications and Privacy	6.1 Social media in public sector - Analyzing public sector social media, analyzing individual users, case study.	CO6	02	07
	6.2 Business use of Social Media - Measuring success, Interaction and monitoring, case study.		03	
	6.3 Privacy - Privacy policies, data ownership and maintaining privacy online.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Gohar F. Khan, Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, (ISBN-10: 1507823207). 2. Jennifer Golbeck, Analyzing the Social Web 1st Edition 3. Matthew A Russell, Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, O'Reilly. 4. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011.
Reference Books	1. Matthew Ganis, Avinash Kohirkar, Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, IBM Press 2. Alex Gonçalves, Social Media Analytics Strategy_ Using Data to Optimize Business Performance, A Press Business Team 3. Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus, Social Media Data Mining and Analytics, (2019), Wiley, ISBN 978-1-118-82485-6. 4. Siddhartha Chatterjee, Michal Krystyanczuk, Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition. 5. Raghav Bali, Dipanjan Sarkar, Tushar Sharma.Learning, Social Media Analytics with

	R 6. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013. 7. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013. 8. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011.
Useful Links:	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
	https://nptel.ac.in/courses/106106146
	https://7layersanalytics.com/
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8024	ML in Bioinformatics	03	--	--	03

Prerequisites	1. Molecular Biology, 2. Machine Learning
Course Objectives (COBs):	1. To learn cellular molecular biology 2. Learn how to implement machine learning for biological problems 3. Learn algorithms used in machine learning. 4. Apply machine learning to practical projects.
Course Outcomes (COs):	**After successful completion of course, students will be able -** 1. Explain basic cell architecture and structure of DNA 2. Apply probabilistic framework in bioinformatics 3. Apply nearest neighbor clustering in bioinformatics 4. Apply suitable machine learning algorithm 5. Evaluate prediction performance using neural network 6. Explain future techniques applicable in bioinformatics

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 bioinformatics	1.1: The structure, content and scale of DNA, basic cell architecture, genes and proteins, genomes- diversity, size and structure, information content of biological sequences.	CO1	03	08
	1.2: Introduction to search and its algorithm, complexity of search, use of graph in bioinformatics		02	
2. ML foundation-I	2.1: Introduction to probability, Baye's Theorem, Bayesian network.	CO2	02	08
	2.2: Bayesian Modelling, Bayesian inference and induction, The Cox Jaynes Axioms, graphical model structure		03	
	2.3: Probabilistic modelling and inference examples, the simplest sequence models, statistical mechanics		03	
3. ML foundation-II	3.1: Introduction, Nearest neighbour method, Nearest neighbour approach for secondary structure protein folding prediction	CO3	03	08
	3.2: Clustering- Advanced clustering techniques, Application guidelines		02	
	3.3: Decision Tree- Methods, Gain criterion, Over fitting and pruning, Application guidelines, Bioinformatics applications		03	
4. ML algorithms	4.1: Introduction, dynamic programming, gradient descent algorithm	CO4	03	08
	4.2: EM/GEM algorithms		02	
	4.3: Markov Chain, Monte-Carlo Methods, Simulated Annealing, Evolutionary and Genetic Algorithms, Learning Algorithms: Miscellaneous Aspects.		03	

5.Neural Network application	5.1: Sequence Encoding and Output Interpretation, Sequence Correlations and Neural Networks, Prediction of Protein Secondary Structure	CO5	02	05
	5.2: Prediction of Signal Peptides and Their Cleavage Sites, Applications for DNA and RNA Nucleotide Sequences , Prediction Performance Evaluation, Different Performance Measures		03	
6. Future Techniques	6.1: Genetic Programming- Method, Application guidelines, Bioinformatics applications	CO6	02	05
	6.2: Cellular Automata- Method, Application guidelines, Bioinformatics applications, hybrid method		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. Edward Keedwell and Ajit Narayanan, Intelligent Bioinformatics: The Application of Artificial Intelligence Techniques to Bioinformatics Problems, Wiley (2005). 2. P Baldiand S Brunak, Bioinformatics: The Machine Learning Approach, (2001)
Reference Books	1. Olson et al., 2018. Data-driven advice for applying machine learning to bioinformatics problems, 2. Husmeier D, Dybowski R, and Roberts S (2005), Probabilistic Modeling in Bioinformatics and Medical Informatics, Springer, 3. Kim JB, Porreca GJ, Song L, Greenway SC, Gorham JM, Church GM, Seidman CE, Seidman JG. Polony multiplex analysis of gene expression (PMAGE) in mouse hypertrophic cardiomyopathy. Science. 2007 Jun 8; 316(5830):1481-4. PubMed PMID: 17556586. 4. MacBeath G, Schreiber SL. Printing proteins as microarrays for high-throughput function determination. Science. 2000 Sep 8; 289(5485):1760-3. PubMed PMID: 10976071. 5. Shankar J, Wu TD, Clemons KV, Monteiro JP, Mirels LF, et al. (2011) Influence of 17b-Estradiol on Gene Expression of Paracoccidioides during Mycelia-to- Yeast Transition. PLoS ONE 6(12): e28402. doi: 10.1371/journal.pone.0028402, 6. Published in final edited form as: Nature. 2015 Oct 15; 526(7573): 343–350. doi: 10.1038/nature1581.
Useful Links:	1. https://www.advancedsciencenews.com/machine-learning-for-bioinformatics-and-neuroimaging/
	2.https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_neural_networks.htm
	3. https://www.analyticsvidhya.com/blog/2017/09/understaing-support-vector-machine-example-code/
	4. Link to NPTEL course contents:https://nptel.ac.in/courses/106104019/
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

(ESE):	

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8031	Quantum Computing	03	--	--	03

Prerequisites	----
Course Objectives (COBs):	1. To introduce the fundamentals of quantum computing 2. The problem solving approach using finite dimensional mathematics
Course Outcomes (COs):	After the completion of course, students will be able to 1. Explain the basic principles of quantum computing. 2. Explain basic concepts of linear algebra required for quantum computing 3. Explain 1-qubit and 2-qubit gate operations and gain the ability to build simple quantum circuits 4. Analyze algorithms and compare effectiveness versus classical algorithms 5. Analyze the effectiveness of simple error correction codes

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 Background	1.1 Overview, Circuit model of computation,	CO1	02	06
	1.2 A linear Algebra Formulation of the circuit model,		01	
	1.3 Review of Quantum Physics, Quantum physics and computations		02	
2.The linear Algebra and Dirac Notation	2.1 Dirac Notation and Hilbert Spaces, Dual Vectors , operators,	CO2	03	08
	2.2 The spectral Theorem, Functions of operators,		02	
	2.3 Tensor Products, The Schmidt decomposition theorem		03	
3.Qubits and Framework of quantum mechanics	3.1 State of quantum system, Time evolution of closed system, composite systems, Measurements	CO3	03	09
	3.2 Mixed states and general quantum operations		02	
	3.3 The quantum circuit model, Quantum gates,		02	
	3.4 Universal states of quantum gates		02	
4. Introductory Quantum Algorithms	4.1 Probabilistic versus Quantum Algorithms, Phase Kick-Back	CO4	02	08
	4.2 Deutsch Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Problem		04	
	4.3 Simon's Algorithm		02	
5. Algorithms Based on Amplitude Amplification	5.1 Grover's Quantum Search Algorithm, Amplitude amplification, The Geometry of Amplitude Amplification	CO4	02	06
	5.2 Quantum Amplitude estimation and quantum counting Practical Implications of Grover's Algorithm and Amplitude Amplification		04	
6.Quantum Error Correction	6.1 Classical error correction, The classical 3 bit code	CO5	01	05

	6.2 Quantum error correction, error models for quantum computing		02	
	6.3 Three and Nine qubit quantum codes, Fault Tolerant quantum computation		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42
Books:				
Reference Books	1. Phillip Kaye Raymond Laflamme Michele Mosca, "An Introduction to Quantum Computing", by by Oxford University Press Inc., New York 2. Eleanor Rieffel and Wolfgang Polak, "Quantum Computing: A Gentle Introduction, by The MIT Press Cambridge, Massachusetts London, England. 3. David McMahon, Quantum computing explained, Wiley-interscience, John Wiley & Sons, Inc. Publication 2008.			
Useful Links:	Online math tutorial: http://patrickjmt.com/			
Continuous Assessment:	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.			
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8032	Intelligent Vehicle Technology	03	--	--	03

Prerequisites	----
Course Objectives (COBs):	1. To understand the basics of electric vehicle system, their design methodologies, architecture and fundamentals. 2. To analyze various electric motors drives suitable for electric vehicles. 3. To discuss hybrid electric vehicles and their management. 4. To discuss different propulsion systems used for electric vehicles and their management. 5. To design different configurations of electric vehicles and components, sizing of components, design optimization and energy management. 6. To discuss intelligent controls for electric vehicles.
Course Outcomes (COs):	**After successful completion of course student will be able to:** 1. Describe electrical vehicle system. 2. Identify suitable motor for electric vehicles. 3. Discuss hybrid vehicle technologies. 4. Explain electric vehicle propulsion systems. 5. Design electric vehicles. 6. Explain intelligent controls for electric vehicles.

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. Vehicle Mechanics Roadway Fundamentals	1.1 Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power,	CO1	02	06
	1.2 Force-Velocity Characteristics, Maximum Gradability.		02	
	1.3 Velocity and Acceleration, Constant FTR, Level Road, Velocity Profile,		02	
	1.4 Distance Traversed, Tractive Power, Energy Required, Nonconstant FTR, General Acceleration, Propulsion System Design.			
2. Electric Vehicles Configuration	2.1 Electric and Hybrid Electric Vehicles Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics. , Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving	CO2	04	08
	2.2 Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.		04	
3. Hybrid Electric vehicles	3.1 Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Introduction to Energy Storage.	CO3	08	08
4. Electric Propulsion	4.1 Electric Propulsion EV consideration, DC motor drives and speed control, Induction motor drives,	CO4	03	05
			02	

	Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives			
5. Design of Electric and Hybrid Electric Vehicles	5.1 Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator,	CO5	03	05
	5.2 Design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, and energy storage design.		02	
6. Intelligent Electric Vehicle	6.1 Intelligent Hybrid Battery Management System for Electric Vehicle, Rule-Based Control, Optimization-Based Control, AI-Based Control, Traffic (Look Ahead Method) Based Control.	CO6	08	08
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. M. Ehsani, Y. Gao, S. Gay and Ali Emadi Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design CRC Press 2005. 2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press 2003.
Reference Books	1.Chitra A., Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, S. Himavathi Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles, ISBN: 978-1-119-68190-8 July 2020 2. Emadi, A., Miller, J., Ehsani, M., Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003. 3. Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010. 4. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012. 5. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013. 6. Amir Khajepour, Saber Fallah, Avesta Goodarzi, Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic, Wiley 7. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics.
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8033	Threat Analysis and Modeling	03	--	--	03

Prerequisites	1.Cryptography and network security
Course Objectives (COBs):	1. To learn concepts of threat modeling 2. To explore and manage various threats
Course Outcomes (COs):	1. Explain strategies for threat modeling 2. Find different threats 3. Explore attack trees and attack libraries. 4. Classify and address threats. 5. Apply various threat modeling tools for web, cloud and mobile. 6. Interpret threats to cryptosystems.

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 Dive In and Threat Model, Learning to Threat Model.	CO1	03	06
	1.2 Strategies for Threat Modeling, Brainstorming Your Threats, Structured Approaches to Threat Modeling, Models of Software		03	
2.Finding Threats	2.1 STRIDE, Spoofing Threats, Tampering Threats, Repudiation Threats, Information Disclosure Threats	CO2	04	05
	2.2 Denials-of-Service Threats.		01	
3.Attack Trees	3.1 Attack Trees, Working with Attack Trees, Representing a Tree, Real Attack Trees.	CO3	02	04
	3.2 Attack Libraries, Properties of Attack Libraries.		02	
4 Managing and Addressing Threats	4.1, Processing and Managing Threats	CO4	02	08
	4.2 Starting the Threat Modeling Project, Digging Deeper into Mitigations, Tracking with Tables and Lists, Scenario-Specific Elements of Threat Modeling. Defensive Tactics and Technologies.		03	
	4.3 Tactics and Technologies for Mitigating Threats, Addressing Threats with Patterns, Mitigating Privacy Threats.		03	
5 Threat Modeling Tools	5.1 Generally Useful Tools, Open-Source Tools, Commercial Tools.	CO5	03	07
	5.2 Web and Cloud Threats, Web Threats, Cloud Tenant Threats, Cloud Provider Threats, Mobile Threats.		04	
6. Threats to Cryptosystems	6.1 Cryptographic Primitives, Classic Threat Actors, Attacks against Cryptosystems	CO6	03	09
	6.2 Building with Crypto, Things to Remember about		03	

	Crypto Experimental Approaches.			
	6.3Looking in the Seams, Operational Threat Models, Threats to Threat Modeling Approaches, How to Experiment.		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42
Books:				
Text Books	1 Adam Shostack, "Threat Modeling: Designing for Security Designing for Security" Wiley publication, Edition, 2008. 2.Frank Swiderski, Window Snyder "Threat Modeling (Microsoft Professional)" Microsoft Press, Edition, 2008.			
Reference Books	1 Adam Shostack, "Threat Modeling: Designing for Security Designing for Security" Wiley publication, Edition, 2008. 2.Frank Swiderski, Window Snyder "Threat Modeling (Microsoft Professional)" Microsoft Press, Edition, 2008.			
Useful Links:	Introduction to Threat Modeling - Threat Modeling | Coursera			
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.			
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIDLC8034	Biometric System Modeling and Simulation	03	--	--	03

Prerequisites	1. Machine Learning
Course Objectives (COBs):	1. To understand the technologies of fingerprint, iris, face and speech recognition 2. To understand the general principles of design of biometric systems and the underlying trade-offs. 3. To recognize personal privacy and security implications of biometrics based identification technology. 4. To identify issues in the realistic evaluation of biometrics based systems.
Course Outcomes (COs):	1. Demonstrate knowledge engineering principles underlying biometric systems. 2. Design basic biometric system applications. 3. Apply biometric system for face recognition. 4. Explain biometric system used for Iris recognition. 5. Explain biometric system used for speaker recognition. 6. Explain personal authentication system.

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. Human Body and Biometrics	Our Body: Overview, Physical Structures, Behavioural Characteristics, Ways of Behaving	CO 2, CO 3	04	04
2. Fingerprint Identification Technology	Review of Fingerprint Systems, Definitions and Notations, Fingerprint Image Processing, Minutiae Determination, Fingerprint Matching.	CO 1	08	08
3. Face Recognition	Introduction to Face Recognition System Detection and Location of Faces, Features Extraction and Face Recognition	CO 1	07	07
4. Iris Biometrics	Introduction, Iris Recognition, Coordinate System, Texture Energy Feature	CO 1	04	04
5. Speaker Recognition	Introduction, Principles of Speaker Recognition, GSMSV Method.	CO 4	07	07
6. Personal Authentication	Examples of Current Applications, Potential Application Areas, How to Select a Biometrics System, Application Programming Interface Standards	CO 4	08	08
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	02	02
			Total hours	42

Books:

Text Books	1. David D. Zhang, Automated Biometrics: Technologies and Systems, Kluwer Academic Publishers, New Delhi, 2000. 2. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, Biometric Systems, Technology Design and Performance Evaluation, Springer, 2005. 3. Arun A. Ross , Karthik Nandakumar, A.K.Jain, Handbook of Multibiometrics, Springer, New Delhi, 2006.
Reference	1. Paul Reid, Biometrics for Network Security, Pearson Education, 2004.

Books	2. Nalini K Ratha, Ruud Bolle, Automatic fingerprint Recognition System, Springer, 2003 3. L C Jain, I Hayashi, S B Lee, U Halici, Intelligent Biometric Techniques in Fingerprint and Face Recognition CRC Press, 1999. 4. John Chirillo, Scott Blaul, Implementing Biometric Security, John Wiley, 2003. 5. S.Y. Kung, S.H. Lin, M.W.Mak, Biometric Authentication: A Machine Learning Approach Prentice Hall, 2005
Useful Links:	1. https://www.udemy.com/course/biometrics/
	2. https://www.coursera.org/lecture/usable-security/biometric-authentication-RXVog
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8041	Project Management	03	--	--	03

Course Objectives (COBs):	1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. 2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.
Course Outcomes (COs):	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	
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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.

End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8042	Finance Management	03	--	--	03

Course Objectives (COs):	1. Overview of Indian financial system, instruments and market 2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management 3. Knowledge about sources of finance, capital structure, dividend policy
Course Outcomes (COs):	After successful completion of course student will be able to: 1. Describe Indian financial system 2. Apply basic concepts of returns and risks. 3. Explain basic concepts of Time value of money. 4. Explain sources of finance, capital structure, dividend policy 5. Explain basic concepts of corporate finance 6 .Apply 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.	CO3	08	08

	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.			
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:				
Text Books	1. Eugene F. Brigham and Joel F Houston; Fundamentals of Financial Management, 13th Edition (2015) Publisher: Cengage Publications, New Delhi. 2. Robert C. Higgins; Analysis for Financial Management, 10th Edition (2013) by Publishers: McGraw Hill Education, New Delhi.			

Reference Books	1.M. Y. Khan; Indian Financial System, 9th Edition (2015) Publisher: McGraw Hill Education, New Delhi. 2.I. M. Pandey; Financial Management, 11th Edition (2015) Publisher: S. Chand (G/L) & Company Limited, New Delhi.
Continuous Assessment (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8043	Entrepreneurship Development and Management	03	--	--	03

Course Objectives (COBs):	1. To acquaint with entrepreneurship and management of business. 2. Understand Indian environment for entrepreneurship. 3. Idea of EDP, MSME. 4. Discuss the government plan for startup business. 5. Analyze the business risk. 6. Discuss the successful business stories.
Course Outcomes (COs):	Upon completion of the course, the learners will be able to: 1. Explain the concept of Business Plan and the Role of Money and Capital Markets in Entrepreneurial Development. 2. Analyze Key regulations and legal aspects of entrepreneurship in India. 3. Explain Government Policies for Startup. 4. Describe Different Government initiatives for Startup. 5. Explain Issues and Problems Faced by Micro and Small Enterprises. 6. Describe Growth Strategies for small businesses.

Module No. & 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	
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: .	6.1 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
Continuous Assessment(CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester	• Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8044	Human Resource Management	03	--	--	03

Course Objectives (COBs):	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 behavioural skills in an organizational setting required for future stable engineers, leaders and managers.
Course Outcomes (COs):	**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 Types, Assessment of Personality Traits for		02	

	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	06
	3.2 Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.		02	
	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	05
	4.2 Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning.		01	
	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	06
	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	
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
	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 –		03	

	Corporate Mission, Vision, Objectives and Goals.			
	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(CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8045	Professional Ethics and Corporate Social Responsibility	03	--	--	03

Course Objectives (COBs):	1.To understand professional ethics in business 2.To recognized corporate social responsibility
Course Outcomes(COs):	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 Responsibility in Globalizing India	Corporate Social Responsibility voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility	CO6	08	08

	Companies Act, 2013.			
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	Ananda Das Gupta; Business Ethics: Texts and Cases from the Indian Perspective (2013) Publisher Springer.
Reference Books	2. Andrew Crane, Dirk Matten, Laura Spence; Corporate Social Responsibility: Readings and Cases in a Global Context (2007) Publisher: Routledge. 3. Manuel G. Velasquez; Business Ethics: Concepts and Cases, 7th Edition (2011) Publisher: Pearson, New Delhi. 4. Bidyut Chakrabarty, Routledge, Corporate Social Responsibility in India (2015) New Delhi.
Continuous Assessment(CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8046	Research Methodology	03	--	--	03

Prerequisite:	-----
Course Objectives(COBs):	1. To understand Research and Research Process 2. To acquaint students with identifying problems for research and develop research strategies 3. To familiarize students with the techniques of data collection, analysis of data and interpretation
Course Outcomes(COs):	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: **a.** Identification and Selection of Research Problem		07	

	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(CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.			
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.			

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8047	IPR and Patenting	03	--	--	03

Prerequisite:	---
Course Objectives (COBs):	1.To understand intellectual property rights protection system 2.To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures 3.To get acquaintance with Patent search and patent filing procedure and applications.
Course Outcomes (COs):	**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	
3. Emerging Issues in IPR	Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional	CO3	05	05

	knowledge etc.			
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, 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 (CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8048	Digital Business Management	03	--	--	03

Course Objectives(COBs):	1.To familiarize with digital business concept 2.To acquaint with E-commerce 3.To give insights into E-business and its strategies
Course Outcomes(COs):	**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:	CO3	06	06

	Building Digital business applications and infrastructure			
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(CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.

End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Course Code	Course Name	Credits			
		TH	P	TUT	Total
ILC8049	Environmental Management	03	--	-	03

Prerequisites	General Awareness of environment and factors affecting the environment.
Course Objectives (COBs):	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.
Course Outcomes (COs):	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. Explain 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	1.1Significance 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. Scope of Environment Management	4.1 Scope of Environment Management	CO1, CO4	03	10
	4.2 Role & functions of Government as a planning and regulating agency.		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. C J Barrow, Routledge; Environmental Management: Principles and Practice, Publishers London, 1999 2. Jon C. Lovett and David G. Ockwell; A Handbook of Environmental Management Edited by, Edward Elgar Publishing 3. V Ramachandra and Vijay Kulkarni, Environmental Management TERI Press
Reference Books	1. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005 2. Mary K Theodore and Louise Theodore, Introduction to Environmental Management, CRC 3. Majid Hussain, Environment and Ecology, 3rd Ed. Access Publishing.2015 4. S N Chary and Vinod Vyasulu; Environmental Management: An Indian Perspective, 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(CA):	• Continuous Assessment shall be conducted for Total 40 Marks, and includes • Average of Test 1 and Test 2: 30 Marks (where each Test shall be of 30 Marks), • Internal Assessment: 10 Marks. • Duration of each Test shall be 1 Hour and 30 Minutes. • Internal Assessment shall be based on presentation / during-the-lecture quiz / assignments / field studies / course-specific activity.
End Semester Examination (ESE):	• End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours and 30 Minutes.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIL801	Reinforcement Learning Lab	--	01	--	01

Lab Prerequisite:	Machine Learning. Analysis of Algorithm. Python.
Lab Objectives (LOBs):	1. To cover basic concepts and theory related to Reinforcement Learning. 2. To learn different RL algorithms.
Lab Outcomes (LOs):	1. Demonstrate the used of tabular methods to solve classical control problems. 2. Implement approximate solutions like deep Q network-based algorithms. 3. Apply the policy gradient methods. 4. Apply dynamic programming in Reinforcement Learning. 5. Demonstrate how to implement Q learning method. 6. Apply suitable RL techniques for real time applications.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
0	Lab Prerequisite	--	02
1	Implementation of following algorithms:	LO1	02
2	Bandit Problems: Epsilon Greedy Agent	LO1	02
3	Markov Decision Processes: Episode Returns	LO1	02
4	Markov Decision Processes: Returns and Discount Factors	LO2	02
5	The Bellman Equation	LO3	02
6	Iterative Policy Evaluation and Improvement	LO3	02
7	Policy Evaluation and Iteration	LO4	02
8	Dynamic Programming	LO5	02
9	Q-Learning and Sampling Based Methods	LO1	02
10	Monte Carlo Rollouts	LO6	02
11	Case studies	LO1	02

Useful Lab Links:	1. Fundamentals of Deep Reinforcement Learning | edX
	2. http://www.incompleteideas.net/book/RLbook2020.pdf
Term work(TW):	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 "Reinforcement Learning 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/Practical/P&O:	Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL8021	High Performance Computing Lab	--	01	--	01

Lab Prerequisite:	Operating Systems
Lab Objectives (LOBs):	1. To learn concepts of parallel programming as it pertains to high-performance computing. 2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms.
Lab Outcomes (LOs):	**At the end of the lab, students will be able to:** 1. Interpret parallel processing approaches & different design issues in parallel programming 2. Identify different parallel processing platforms involved in achieving High Performance Computing. 3. Demonstrate efficient and high-performance parallel programming. 4. Execute parallel programming using message passing paradigm using open- source APIs. 5. Implement programs with Multicore processor and GPU systems (OpenMP and CUDA). 6. Apply ethical principles like timeliness and adhere to rules of laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
0.	Lab Prerequisite	--	02
1	Execution of Simple Hello world program on MPI platform	LO2, LO5, LO6	01
2	a. Program to send data and receive data to/from processors using MPI b. Program illustrating Broadcast of data using MPI	LO5, LO6	02
3	Implement a parallel program to demonstrate the cube of N number within a set range.	LO1, LO6	02
4	Write a parallel program for area of a circle/triangle	LO1, LO6	02
5	Implement a program to demonstrate balancing of workload on MPI platform	LO3, LO5, LO6	02
6	Using directives of MPI / OpenMP and API implement parallel programming for calculator application (add, sub, multiplication, and division)	LO1, LO4, LO5, LO6	02
7	**Mini Project** Evaluate performance enhancement of HPC for any of the following: One-Dimensional Matrix-Vector Multiplication/ Single-Source Shortest-Path/ Sample Sort/Two-Dimensional Matrix-Vector Multiplication	LO1, LO2, LO3, LO4, LO5, LO6	02

Term work (TW):	1. Term work should consist of a minimum of 6 experiments 2. Journal must include at least 2 assignments on content of theory "High Performance Computing" and practical of the course "High Performance 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 and Assignments: 05-marks)

Oral/Practical/P &O:	Practical Examination will be based on above experiment list and performance of experiments for 25 Marks

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL8022	Design Thinking and Innovation Lab	--	01	--	01

Lab Prerequisite:	1. Application of TBL, PBL. 2. Basics of communication skill
Lab Objectives (LOBs):	1. To study how to convert idea to product. 2. To implement prototype. 3. To study customer needs and with consideration to that design innovative product.
Lab Outcomes (LOs):	After successful completion of lab student will be able to 1. Implement creative idea to become proto type. 2. Define problem according to customer needs. 3. Perform role playing to understand need and pain point. 4. Design prototype and test. 5. Perform using mind mapping and scamper for innovation and given challenges for improved design. 6. Design and Analyse some small. Innovative project

Lab No.	Experiment Title	LO mapped	Hrs./Lab
0.	Lab Prerequisite	--	02
1.	Random Word Ideation-	LO1	02
2.	Crazy 8s	LO1	02
3.	Customer Journey Mapping	LO2	02
4.	Role-playing	LO3	02
5.	Rapid Prototyping	LO4	02
6.	Reverse Brainstorming	LO5	02
7.	Mind Mapping	LO5	02
8.	SCAMPER	LO5	02
9.	Case Study 1	LO6	02
10.	Case Study 2	LO6	02

Useful Lab Links:	1. https://www.designsociety.org/download-publication
Term work:	1. Term work should consist of a minimum of 6 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Design Thinking 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/Practical/ P&O:	Practical Examination will be based on above experiment list and performance of experiments for 25 Marks.

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL8023	Social Media Analytics Lab	--	01	--	01

Lab Prerequisite:	Types of Graphs, Data Mining, Data Analytics
Lab Objectives (LOBs):	1. To understand the fundamental concepts of social media networks. 2. To learn various social media analytics tools and evaluation matrices. 3. To collect and store social media data. 4. To analyze and visualize social media data 5. To design and develop social media analytics models. 6. To design and build a social media analytics application.
Lab Outcomes (LOs):	**The students will be able to** 1. Explain characteristics and types of social media networks. 2. Explain social media analytics tools for business 3. Collect, monitor, store and track social media data 4. Analyze and visualize social media data from multiple platforms 5. Design and develop content and structure based social media analytics models. 6. Design and implement social media analytics applications for business.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
0	Lab Prerequisite	--	02
1	Study various - i) Social Media platforms (Facebook, twitter, YouTubeetc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc) iii) Social Media Analytics techniques and engagement metrics (page level, post level,member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/	LO1 LO2 LO4 LO6	02
2	Data Collection-Select the social media platforms of your choice (Twitter, Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing).	LO3	02
3	Data Cleaning and Storage- Pre-process, filter and store social media data for business (Using Python, MongoDB, R etc).	LO3	02
4	Exploratory Data Analysis and visualization of Social Media Data for business.	LO4	02
5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics)	LO5	02
6	Develop Structure based social media analytics model for any business. (e.g. Structure Based Models -community detection, influence analysis)	LO5	02
7	Develop a dashboard and reporting tool based on real time social media data.	LO6	02
8	Design the creative content for promotion of your business on	LO6	02

	social media platform.		
9	Analyze competitor activities using social media data.	LO3	02
10	Develop social media text analytics models for improving existing product/ service by analyzing customer's reviews/comments.	LO5	02
Term work (TW):	1. Term work should consist of 8 experiments. 2. Journal must include at least 2 assignments. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 20-marks, and Assignments: 05-marks)		
Oral/Practical/ P&O:	Practical Examination will be based on above experiment list and performance of experiments for 25 Marks		

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIDLL8024	ML in Bioinformatics Lab	--	01	--	01

Lab Prerequisite:	1. PYTHON / PEARL
Lab Objectives (LBOs):	1. Develop an understanding of important concepts in machine learning in the context of biological problems. 2. Implementation ML model in the context to solve biological problems.
Lab Outcomes (LOs):	After successful completion, students will be able to- 1. Implement of KNN using Perl/Python Assessment. 2. Implement of ANN using Perl/Python Assessment. 3. Apply Hidden Markov Model for CpG island prediction Assessment. 4. Apply HMMER package and Pfam database Assessment. 5. Apply Transformational Grammars in bioinformatics Assessment. 6. Apply SVM in bioinformatics Assessment.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
0	Lab Prerequisite	--	02
1	Calculation of sensitivity, specificity, accuracy for a given classifier 2	LO1	02
2	Implementation of crisp KNN for a microarray file	LO1	02
3	Implementation of fuzzy KNN for a microarray file	LO1	02
4	Identification tree construction using See5 and Weka	LO5	02
5	Implementation of perceptron on LOGIC GATES	LO2	02
6	Calculation of AAC and DPC for SVM and ANN input files	LO2 LO6	02
7	Calculation of pseudo amino acid composition	LO3	02
8	Implementation of ANN using SNNS software	LO2, LO3	02
9	Implementation of SVM using SVM-light, LIBSVM and Weka	LO2, LO6	02
10	Implementation of HMM for prediction of CpG islands	LO2, LO5	02
11	HMM using HMMER package Stochastic context free grammar	LO4	02

Virtual Lab Links:	1. http://hmmer.org/
	2. https://www.cs.waikato.ac.nz/ml/weka/https://nptel.ac.in/courses/106104019/26
	3. https://www.rulequest.com/download.html
Term work(TW):	1. Term work should consist of 8 experiments. 2. Journal must include at least 2 assignments. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 20-marks, and Assignments: 05-marks) **Note:** Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think

	differently.
Oral/Practical/P &O:	Practical Examination will be based on above experiment list and performance of experiments for 25 Marks

Lab Code	Lab Name	Credits			
		TH	P	TUT	Total
AIL805	Robotic Process Automation Lab	--	01	--	01

Lab Prerequisite:	Knowledge of coding languages
Lab Objectives (LBOs):	1. Understand important concepts in Robotic Process Automation. 2. Understanding of UI path studio. 3. Implement Real time automation applications.
Lab Outcomes (LOs):	After successful completion, students will be able to- 1. Set up UI Path studio environment 2. Implement basic operations on different data types. 3. Apply Arithmetic operations, different fields from an excel file 4. Validate different formats for input and output validations. 5. Develop RPA bots for web scraping Applications. 6. Develop RPA bots for real time automation applications with different file formats

Lab No.	Experiment Title	LO mapped	Hrs./Lab
0	Lab Prerequisite: Explain Process Definition Document, Solution Design Document, Project Tracking.	--	02
1	Download, Install and Activate Ui-Path Studio. Learn all the basicsof RPA(Variables, arguments and Control flow etc.)	LO1	02
2	Program to empty the trash folder in Gmail and empty the Recycle Bin	LO1	02
3	Program to perform if-activity, switch- activity (Hint: Find the smallest and biggest numbers in an array)	LO2	02
4	Program to perform while activity, do-while activity, for-each activity (Hint: How an integer variable will increase from 5 to 50 in increments of 5)	LO3	02
5	Program to perform Flowchart and Sequence activity on Scalar and Collection variables.	LO4	02
6	Program to build a static data table, dynamic data table using data scrapping.	LO4	02
7	Program to create simple calculator using a separate workflow and arguments	LO3	02
8	Program for clipboard management. (Hint: open Notepad, write some data into it, and then copy the data to the clipboard. Later extract the data from the clipboard)	LO2, LO3	02
9	Program to perform the following operations on an Excel file:i)Read cell ii)Write cell iii)Read range iv)Write range v)Append range	LO2	02
10	Program to implement Arithmetic operations in 2 Excel files	LO5	02
11	Program to read an Excel file and creating a data table by using data fromthe Excel file	LO3	02
12	Program for acting on controls using mouse and keyboard activities, screen scraping using OCR, extract Email Address	LO5	02

13	Develop a solution design document for following use cases, Develop a bot for any two of the following applications 1. Find Unicorn Name Generators. 2. Find Movie Rating. 3. Implement Amazon Data Scraping. 4. Email Automation. 5. Supplier Management System. 6. Transferring Data from one system to another. 7. Password Generator. 8. Forms Processing 9. Connecting Robot to Orchestrator 10. Extracting data from PDFs, scanned documents and other formats 11. Generating mass emails 12. Create and deliver invoices.	LO6	02

Reference Books:	1. Nandan Mullakara, Arun Kumar Asokan, *Robotic Process Automation Projects: Build real-world RPA solutions using UiPath and Automation Anywhere*, First Edition, Packt Publishing Ltd., 2020. *2,* Alok Mani Tripathi, *Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool – UiPath ,* First Edition, Packt Publishing Ltd., 2018.
Useful Links:	• https://www.udemy.com/topic/robotic-process-automation • https://nielit.gov.in/aurangabad/content/short-term-course-robotic-process-automation • https://www.coursera.org/specializations/roboticprocessautomation
Term work(TW):	1. Term work should consist of 8 experiments. (Total 6 Experiments from Lab No. 1 to 12 and Two RPA bot implementation out of 12 mentioned applications) 2. Journal must include experiment writeup and solution design document for use cases. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments with two RPA bots: 20-marks, and Solution design documents for the two used cases: 05-marks)
Oral/Practical /P&O:	Practical Examination will be based on above experiment list and performance of experiments for 25 Marks

Course Code	Course Name	Credits			
		TH	P	TUT	Total
AIPR86	Major Project Lab-B	--	06	--	06

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.
- Students should publish/present a paper based on their research/ project output. The publication should be in any good quality international conferences/non paid journals.
- 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 with the published paper copy and publication certificate
d) Term End Presentation (Internal)

The final certification and acceptance of TW of 50 marks 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 and making 2 min video • Paper publications • Idea/project completions and poster making	10

Practical & Oral:

Practical & Oral examination of Major Project Lab-B of 100 Marks should be conducted by Internal and External examiners. Students have to give a presentation and demonstration on Major Project Lab-B**.**

SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
(Formerly known as K J Somaiya Institute of Engineering and Information Technology)
An Autonomous Institute permanently affiliated to University of Mumbai

Honours Degree Program Manual

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

For

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

(with effect from AY 2022-2023)

SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
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ACADEMIC YEAR 2022-23

Honours Degree Programs in Engineering and Technology Manual

Introduction:

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

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

b) Minor specialization in EMERGING AREAS in Under Graduate Degree Courses may be allowed where a student of another Department shall take the minimum additional Credits in the range of 18-20 and get a degree with minor from another Department.

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

1. Honours Degree under KJSIT:

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

Table 1: Honours Degree Programs

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

2. Honours Degree Eligibility Criteria for Students:

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

Eligibility criteria for opting the Honours Degree program:

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

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

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

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

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

3. Examination and Evaluation of Honours Degree Courses:

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

a. The continuous assessment (CA= Average of 2 tests+ Internal Assessment (IA)) and End Sem. Examination (ESE) evaluation shall follow the same pattern as adopted for corresponding semester stated by the University/ Autonomous Institute.
b. End semester Assessment will be done as per the laid down practices by following all applicable ordinances and regulations of University of Mumbai/Rules stated in Manual of KJSIT.
c. Hons. degree courses can be treated as Audit type of courses, wherein passing marks set will be 40. If any student scored equal or more than passing marks in particular course can be declared as pass.
d. Grading of courses offered under Honours degree shall be avoided and also not included in overall CUMMULATIVE GRADE POINT AVERAGE, to bring parity with all students admitted for the basic program.
e. Hons. degree shall be conferred in addition to basic degree only after successfully completion of all courses.
f. Institute can make provision for entering pass or fail in course offered under Honours degree.

4. Award of Honours Degree Program:

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

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

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

"**B Tech (Electronics and Telecommunication Engineering) (Hons.- Internet of Things)**"

5. Honours Degree Program Scheme and Structure:

Honours degree program be offered from academic year 2022-23 onwards along with KJSITs Autonomous Scheme II syllabus.

Honours credit courses will be offered from Semester V onwards to Semester VIII as shown in Table 2.

Table 2: Honours degree Program credit and Examination Scheme

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

6. Honours Degree Programs offered for KJSIT:

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

Table 3: Honours Programs offered for KJSITs Branches

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

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

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

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

Table 5: Honours Degree Program in Block chain

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

Table 6: Honours Degree Program in Cyber Security

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

Table 7: Honours Degree Program in Data Science

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

Table 8: Honours Degree Program in Augmented and Virtual Reality

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

Table 9: Honours Degree Program in Internet of Things

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

Dr. Suresh Ukarande
Principal

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HBCC501	Bit coin and Crypto currency	04+0+0

Prerequisite:	**Introduction to Cryptography:** Hash functions, Public key cryptography, Digital Signature (ECDSA).
Course Objectives:	The course aims: 1. To get acquainted with the concept of Block and Blockchain. 2. To learn the concepts of consensus and mining in Blockchain. 3. To get familiar with the bitcoin currency and its history. 4. To understand and apply the concepts of keys, wallets and transactions in the Bitcoin Network. 5. To acquire the knowledge of Bitcoin network, nodes and their roles. To analyze the applications& case studies of Blockchain.
Course Outcomes:	

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy Level
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Block chain.	L1,L2
2	Associate knowledge of consensus and mining in Block chain.	L1,L2
3	Summarize the bit coin crypto currency at an abstract level.	L1,L2
4	Apply the concepts of keys, wallets and transactions in the Bit coin network.	L3
5	Interpret the knowledge of Bit coin network, nodes and their roles.	L1,L2
6	Illustrate the applications of Block chain and analyze case studies.	L3

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	**Introduction to Cryptography:** Hash functions, Public key cryptography, Digital Signature (ECDSA).	--	2	2
1. Introduction to Block chain	1.1 Structure of a Block, Block Header, Block Identifiers: Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Block chain, Merkle Trees and Simplified Payment Verification (SPV). **Self-learning Topics:** Block chain Demo.	CO1	6	6
2. Consensus and Mining	2.1 Decentralized Consensus, Byzantine General's Problem, Independent Verification of Transactions, Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block header, Mining the Block, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Block chain Forks	CO2	12	12

	Self-learning Topics: Study different consensus algorithms			
3. Introduction to Bit coin	3.1 What is Bit coin and the history of Bit coin, Getting the first bit coin, finding the current price of bit coin and sending and receiving bit coin, Bit coin Transactions. **Self-learning Topics:** Study the website coinmarketcap.com/	CO3	4	4
4. Concepts of Bit coin	**4.1 Keys and addresses, Wallets and Transactions:** Public Key Cryptography and Crypto currency, Private and Public Keys, Bit coin Addresses, Base58 and Base58Check Encoding, Nondeterministic (Random) Wallets, Deterministic (Seeded) Wallets, HD Wallets (BIP-32/BIP-44), Wallet Best Practices, Using a Bit coin Wallets, Transaction Outputs and Inputs, Transaction Fees, Transaction Scripts and Script Language, Turing Incompleteness, Stateless Verification, Script Construction (Lock + Unlock), Pay-to-Public-Key-Hash (P2PKH), Bitcoin Addresses, Balances, and Other Abstractions **Self-learning Topics:** Visit and use https://bitcoin.org/en/	CO4	13	13
5. Bit coin Networks	Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging "Inventory", Simplified Payment Verification (SPV) Nodes, Bloom Filters, SPV Nodes and Privacy, Encrypted and Authenticated Connections, Transaction Pools **Self-learning Topics:** Study technical papers based on bitcoin security	CO5	**7**	**7**
6. Blockchain Applications & case studies	Domain-Specific Applications: FinTech, Internet of Things, Industrial and Manufacturing, Energy, Supply chain & Logistics, Records & Identities, Healthcare Case studies related to cryptocurrencies Concept of Altcoin **Self-learning Topics:** Read Technical papers on blockchain applications	CO6	8	8
			Total hours	**48**
Books:				
Text Books	1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN" , 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN:9781491954386. 2. "Blockchain Applications: A Hands-On Approach", by ArshdeepBahga, Vijay Madisetti, Paperback – 31 January 2017. 3. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", July 19, 2016, by Arvind Narayanan, Joseph Bonneau, Edwa rdFelten, Andrew Miller, Steven Goldfeder, Princeton University Press.			
Reference Books				
	1. **"**Mastering Blockchain", by Imran Bashir, Third Edition,Packt Publishing **2. "**Mastering Ethereum: Building Smart Contracts and Dapps Paperback" byAndreas Antonopoulos, Gavin Wood, Publisher(s): O'Reilly Media			

<table>
<tr><td></td><td>3. “Blockchain revolution: how the technology behind bitcoin is changing money, business and the world $ don tapscott and alex tapscot, portfolio penguin, 856157449.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://andersbrownworth.com/blockchain/
https://andersbrownworth.com/blockchain/public-private-keys/
https://www.coursera.org/learn/cryptocurrency
https://coinmarketcap.com/</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –
<table>
<tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr>
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Continuous Assessment (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.
Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HBCC601	Block chain Platform	(04+0+0)

Prerequisite:	Introduction to Block chain and Bit coin.
Course Objectives:	The course aims: 1. Understand the blockchain platform and its terminologies. 2. Understand smart contracts, wallets, and consensus protocols. 3. Design and develop decentralized applications using Ethereum, and Hyperledger. 4. Creating blockchain networks using Hyperledger Fabric deployment. 5. Understand the considerations for creating blockchain applications. 6. Analyze various Blockchain Platforms.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Introduction to Block chain and Bit coin.	--	2	2
1. Introduction to Block chain Platforms	1.1 Why Blockchain Platform: Platform types, Public, Private, technology requirements for implementation. Introduction to Ethereum, Hyperledger and Smart Contracts. Case study of blockchain Application. **Self-learning Topics:** Study different applications of block chain.	CO1	6	6
2. Public Block chain	2.1 Introduction, Characteristics of Public Blockchain, Advantages. Examples of Public Blockchain-Bitcoin: Terminologies and Transaction, Ethereum: Smart contract, Comparison of Bitcoin and Ethereum, Other public Blockchain platforms. **Self-learning Topics:** Study any one case study on public block chain.	CO2, CO3	8	8
3. Ethereum Blockchain	3.1 Introduction, Ethereum and Its Components: Mining, Gas, Ethereum, Ether, Ethereum Virtual Machine, Transaction, Accounts. Architecture of ethereum, Smart Contract: Remix IDE, Developing smart contract for ethereum blockchain, e-	CO2, CO3, CO6	12	12

	voting applications using smart contract, Dapp Architecture. Types of test-networks used in ethereum, Transferring Ethers Using MetaMask, Mist Wallet, Ethereum Frameworks, Case study of Ganache for ethereum blockchain. Deploying e-voting applications on Ganache framework. Ethereum 2., Concept of Beacon chain, POS (Proof of Stake), Shading of Chain. **Self-learning Topics:** Study case study on any ethereum blockchain.			
4. Private Blockchain	4.1 Introduction, Key Characteristics, Need of Private Blockchain. Consensus Algorithm for private Blockchain (Ex. RAFT and PAXOS), Smart Contract in Private Blockchain, Case Study of E-commerce Website, Design Limitations. **Self-learning Topics:** Case study on private block chain.	CO4	8	8
5. Hyperledger Blockchain	5.1 Introduction to Hyperledger, tools and frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies, Distributed Ledgers. Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes etc.,Transaction Flow, Advantages of Hyperledger Fabric Blockchain, working of Hyperledger Fabric, Creating Hyperlegder network, Case Study of Supply chain management using Hyperledger **Self-learning Topics:** Case study on Hyperledger blockchain.	CO5, CO6	12	12
6. Other Blockchain platforms	6.1 Corda, Ripple, Quorum and other emerging blockchain platforms, Case Study on any of the blockchain platforms. Developing Blockchain application on Cloud(AWS/Azure) **Self-learning Topics:** Compare different blockchain platforms.	CO5	4	4
			Total hours	**48**
Books:				
Text Books	1. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and MeenaKarthikeyen, Universities press. **2.** Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.			
Reference Books	1. Blockchain for Beginners, Yathish R and Tejaswini N, SPD 2. Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress. **3.** Blockchain with Hyperledger Fabric,LucDesrosiers, Nitin Gaur, Salman A. Baset, VenkatramanRamakrishna,Packt Publishing.			
Online References:				

<table>
<tr><td colspan="2">1. Blockchain by Example, BellajBadr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
2. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.
3. https://www.hyperledger.org/use/fabric</td></tr>
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HBCC701	Block chain Development	(04+0+0)

Prerequisite:	Blockchain cryptocurrency, Blockchain platform
Course Objectives:	The course aims: 1. To understand Ethereum Ecosystem. 2. To understand aspects of different programming languages. 3. To explain how to use the solidity programming language to develop a smart contract for blockchain. 4. To demonstrate deployment of smart contracts using frameworks. 5. To understand principles of Hyperledger fabric. 6. To understand challenges to apply blockchain in emerging areas.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Blockchain cryptocurrency, Blockchain platform	--	2	2
1. Ethereum Ecosystem	1.1 Ethereum components: miner and mining node,Ethereum virtual machine,Ether,Gas,Transactions, accounts,swarm and whisper,Ethash, end to end transaction in Ethereum, architecture of Ethereum **Self-learning Topics**: Emerging blockchain platforms	CO1	4	4
2. Blockchain Programming	2.1 Types of Blockchain Programming, Solidity, GoLang,Vyper, Java, Simplicity, Rholang, Game Theory and Cryptonomics, Comparative study of different blockchain programming languages Decentralized file system-IPFS. **Self-learning Topics:** Emerging blockchain programming languages	CO2	8	8
3. Smart Contract	3.1 Solidity programming, Smart Contract programming using solidity, mapper function, ERC20 and ERC721 Tokens,comparison between ERC20 & ERC721, ICO, STOMetamask (Ethereum	CO3	10	10

	Wallet), setting up development environment, use cases of smart contract, smart Contracts: Opportunities, Risks **Self-learning Topics:** Cryptocurrencies and their security issues, Consensus mechanisms, Digital Signatures			
4. Blockchain Deployment	4.1 Ethereum client, Ethereum Network, Introduction to Go Ethereum(Geth), Geth Installation and Geth CLI, Setting up a Private Ethereum Blockchain. Introduction to Truffle, Smart Contract deployment on a Private Blockchain. Introduction to Ganache Introduction to Dapp,Dapp architecture, Daaps Scalability,testing Connecting to the Blockchain and Smart Contract, Web3js, Deployment **Self-learning Topics:** Smart Contract deployment using Ganache.	CO4	10	10
5. Hyperledger Application Development	5.1 Installing Hyperledger Fabric, Hyperledger Fabric Network, Building Your First Network, Hyperledger Fabric Demo, Hyperledger Fabric Network Configuration, Certificate Authorities, Chaincode Development and Invocation, Deployment and testing of chaincode on development network, Hyperledger Fabric Transactions. **Self-learning Topics:** Hyperledger sawtooth, Hyperledger caliper.	CO5	12	12
6. Blockchain integration and Research challenges	6.1 Integrating Blockchain with cloud, IoT, AI, ERP, End to end blockchain integration, Risks and Limitations of Blockchain: Privacy & Security. Criminal Use of Payment Blockchains, The "Dark" Side of Blockchain. Research challenges in blockchain, **Self-learning Topics**:Use Cases: Blockchain for Health Insurance, Blockchain in Supply chain management, Blockchain & PropTech, Blockchain in Banking.	CO6	6	6
			Total hours	**48**
Books:				
Text Books:	1. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly. **2.** Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press			
Reference Books:				
	1. Blockchin enabled Applications, Vikram Dhillon, Devid Metcalf, Max Hooper, Apress **2.** Building Blockchain Projects, Narayan Prusty, Packt			
Online References:				
https://ethereum.org/en/ https://www.trufflesuite.com/tutorials https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.html https://www.blockchain.com/				

<table>
<tr><td colspan="2">https://docs.soliditylang.org/en/v0.7.4/</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HBCSBL601	Private Blockchain Setup Lab(SBL)	(0+04+0)

Prerequisite:	Expertise in Programming, Basic knowledge of Computer Security, Networking.
Lab Objectives:	The Lab aims: 1. To build and test Private Ethereum Blockchain. 2. To learn the concept of the genesis block and Account in the Blockchain. 3. To get familiar with the mining blocks to create a ether. 4. To understand and apply the concepts of keys, wallets. 5. To acquire the knowledge of gateway and desktop application. 6. To analyze the applications & case studies of Blockchain.
Lab Outcomes: (LOs):	On successful completion, of lab, learner/student will be able to: 1. To understand how blockchain systems (mainly Etherum) work . 2. To create the genesis blocks using Puppeth, a CLI tool and account using Smart Contract. 3. To create mining blocks, check the account and PoW. 4. To use cryptocurrency exchanges and wallets safely. 5. To create Gateway to Blockchain Apps. 6. To use Blockchain on Mobile App and on Cloud.

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

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

10	**Application Development**	Hosting of a private blockchain on cloud(AWS/Azure)	LO6	5
			Total hours	**52**

Books:

Text Books	1. Mastering Ethereum: Building Smart Contracts and Dapps, Andreas Antonopoulos, Gavin Wood, O'Reilly Publication 2. Mastering Blockchain, Second Edition: Distributed ledger technology, decentralization, and smart contracts explained, 2nd Edition, Imran Bashir 3. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, RiteshModi, Packt publication 4. Mastering Blockchain, Imran Bashir, Second Edition,Packt Publication.
Reference Books	
	1. Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN, 2nd Edition by Andreas M. Antonopoulos, June 2017, and Publisher: O'Reilly Media, Inc. ISBN: 9781491954386. 2. Blockchain Applications: A Hands-On Approach, by ArshdeepBahga, Vijay Madisetti, Paperback – 31 January 2017. Mastering Blockchain, Imran Bashir, Packt Publication.

Online References:

1. https://geth.ethereum.org/downloads/
2. https://medium.com/@agrawalmanas09/how-to-setup-private-ethereum-blockchain-on-windows-10-machine-ab497e03d6b8
3. https://geth.ethereum.org/docs/dapp/
4. https://www.edureka.co/blog/ethereum-private-network-tutorial
5. https://docs.soliditylang.org/en/develop/index.html
6. https://metamask.io
7. https://medium.com/publicaio/a-complete-guide-to-using-metamask-updated-version-cd0d6f8c338f
8. https://docs.aws.amazon.com/blockchain-templates/latest/developerguide/blockchain-templates-create-stack.html

Term Work:

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

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

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

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HBCC801	DeFi (Decentralized Finance)	(04+0+0)

Course Objectives:	The course aims: 1. The basic concepts of Centralized and Decentralized Finance and compare them. 2. The DeFi System and its key categories. 3. The DeFi components,primitives,incentives,metrics and major business models where they are used. 4. The DeFi Architecture and EcoSystem. 5. The DeFi protocols. 6. The real time use cases of DeFi.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Blockchain & Cryptocurrency,Blockchain Platform, Blockchain Development	-	02	02
1. Introduction: Centralized and decentralized finance	Difference between Centralized and Decentralized Finance, Traditional Financial Institution- Banks: 1. Payment and Clearance systems, 2. Accessibility, 3. Centralization and Transparency, Decentralized Finance Vs Traditional Finance **Self-learning Topics:** The Potential Impact of Decentralized Finance	CO1	06	06
2. What is decentralized finance (defi)?	The DeFi Ecosystem, Problems that DeFi Solves How Decentralized is DeFi? Defi key Categories:- Stablecoins, Stable coin and pegging,Lending and Borrowing,Exchanges,Derivations, Fund Management, Lottery,Payments,Insurance **Self-learning Topics:** How Decentralized Finance Could Make Investing More Accessible.	CO2	06	06

3. DeFi Primitives and Business Models	3.1 DeFi Components: Blockchain Cryptocurrency The Smart Contract Platform Oracles Stablecoins Decentralized Applications 3.2 DeFi Primitives: Transactions Fungible Token: Equity Tokens, Utility Tokens and Governance TokensNFT: NFT Standard, Multi-token standard Custody Supply Adjustment: Burn-Reduce Supply, Mint-Increase Supply, Bonding Curve-Pricing Supply Incentives: Staking Rewards, Slashing, Direct Rewards and Keepers, Fees Swap: Order Book Matching, Automated Market Makers Collaterlized Loans Flash Loans (Uncollaterlized Loans) 3.3 DeFi Key Metrics: Total Value Locked, Daily Active Users, Market Cap 3.4 DeFi Major Business Models: Decentralized Currencies, Decentralized Payment Services, Decentralized fundraising, Decentralized Contracting **Self-learning Topics:** Study any real time Business model.	CO3	10	10
4. DeFi Architecture and EcoSystem	4.1DeFi Architecture: Consumer Layer: Blockchains, Cross-Blockchain networks, Oracles, Digital Asset Layer: Cryptocurrencies, Infrastructure Layer: Wallets and Asset Management, DEXes and Liquidity, Lending and Borrowing, Prediction Markets, Synthetic Assets, Insurance 4.2 DeFi EcoSystem and Protocols: On-chain Asset Exchange, Loanable Fund Markets on-chain assets, Stablecoins, Portfolio Management, Derivatives, Privacy-preserving mixers 4.3 DeFi Risk and Challenges: Technical Risks, Usability Risks, Centralization Risks, Liquidity Risks, Regulation Risk **Self-learning Topics:** Study of the Problems which are holding DeFi adoption back	CO4	10	10
5. DeFi Deep Dive	5.1.Maker DAO:Maker Protocol: Dai Stablecoins, Maker Vaults, Maker Protocol Auctions Maker Actors: Keepers, Price Oracles, Emergency Oracles, DAO Teams,Dai Savings Rate Dai Use case Benefits and Examples 5.2.UniSwap:UniSwap Protocol Overview: How UniSwap Works, EcoSystem Participants, Smart Contracts UniSwap Core Concepts: Swaps, Pools, Flash Swaps, Oracles 5.3. Compound:Compound Protocol: Supplying Assets, Borrowing Assets, Interest Rate Model Compound Implementation and Architecture: cToken Contracts, Interest Rate Mechanics,	CO5	10	10

	Borrowing, Liquidation, Price Feeds, Comptroller, Governance 5.4. wBTC:Need for wBTC: Tokenization and common Issues wBTC Implementation and Technology: Users, Custodian Wallet Setup, Minting, Burning wBTC Governance, wBTC vs Atomic Swaps, Fees, Legal Binding, Trust Model and Transparency **Self-learning Topics:** MakerDAO Governance,UniSwap GovernanceProtocol Math,Compound Protocol Math			
6. Use Cases	6.1Decentralized Exchanges 6.2Decentralized Stablecoins 6.3Decentralized Money Markets 6.4Decentralized Synthetix 6.5Decentralized Insurance 6.6Decentralized Autonomous Organization (DAO), **Self-learning Topics:** Stock Exchange Operations, Derivatives,Tether, Ampleforth, How to get stablecoins,Synthetix Network, Token,The Ongoing Impact of The DAO's Rise and Fall, DAO Projects	CO6	08	08
		Total hours	**52**	
Books:				
Text Books	1. How to DeFi,Darren Lau, Daryl Lau, Teh Sze Jin,Kristian Kho, Erina Azmi, TM Lee,Bobby Ong-1st Edition, March 2020 2. DeFi and the Future of Finance-Campbell R. Harvey 3. DeFi Adoption 2020 A Definitive Guide to Entering the Industry.			
Reference Books/White Papers:				
	1. Blockchain disruption and decentralized finance: The rise of decentralized business models-Yan Chen,Cristiano Bellavitis 2. SoK: Decentralized Finance (DeFi)-Sam M. Werner, Daniel Perez, Lewis Gudgeon,Ariah Klages-Mundt,Dominik Harz*‡, William J. Knottenbelt,Imperial College London, † Cornell University, Interlay 4. Decentralized Finance (DeFi) –A new Fintech Revolution? 5. https://makerdao.com/da/whitepaper/ 6. https://uniswap.org/ 7. https://compound.finance/documents/Compound.Whitepaper.pdf 8. https://wbtc.network/assets/wrapped-tokens-whitepaper.pdf 9. https://defiprime.com/exchanges 10. https://defirate.com/stablecoins/ 11. https://academy.ivanontech.com/blog/decentralized-money-markets-and-makerdao 12. https://www.gemini.com/cryptopedia/nexus-mutual-blockchain-insurance-nxm-crypto			

<table>
<tr><td></td><td>13. https://consensys.net/blockchain-use-cases/decentralized-finance/
14. https://tokenlon.zendesk.com/hc/en-us/articles/360041114431-DeFi-Explained-Synthetic-Assets,
15. https://www.blockchain-council.org/synthetix/synthetix-snx-the-biggest-ecosystem-in-decentralized-finance/</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">1. https://www.udemy.com/
2. https://www.coursera.org/</td></tr>
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</table>
Continuous Assessment (Avg, of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.
Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HCSC501	Ethical Hacking	04+0+0

Prerequisite:	Computer Networks, Databases, system security
Course Objectives:	The course aims: 1. To describe Ethical hacking and fundamentals of computer Network. 2. To understand about Network security threats, vulnerabilities assessment and social engineering. 3. To discuss cryptography and its applications. 4. To implement the methodologies and techniques of Sniffing techniques, tools, and ethical issues. 5. To implement the methodologies and techniques of hardware security. 6. To demonstrate systems using various case studies.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Sub topic	Total Hrs. /Module
I. Prerequisite	Computer Networks, Databases, system security	--	2	2
1. Introduction to Ethical Hacking	1.1 Fundamentals of Computer Networks/IP protocol stack, IP addressing and routing, Routing protocol, Protocol vulnerabilities, Steps of ethical hacking, Demonstration of Routing Protocols using Cisco Packet Tracer Self-learning Topics:TCP/IP model, OSI model	CO1	10	10
2. Introduction to	2.1 Private-key encryption, public key-encryption,	CO3	08	08

Cryptography	key Exchange Protocols, Cryptographic Hash Functions & applications, steganography, biometric authentication, lightweight cryptographic algorithms.Demonstration of various cryptographic tools and hashing algorithms **Self-learning Topics**: Quantum cryptography, Elliptic curve cryptography			
3.Introduction to network security	3.1 Information gathering, reconnaissance, scanning, vulnerability assessment, Open VAS, Nessus, System hacking: Password cracking, penetration testing, Social engineering attacks, Malware threats, hacking wireless networks (WEP, WPA, WPA-2), Proxy network, VPN security, Study of various tools for Network Security such as Wireshark, John the Ripper, Metasploit, etc. **Self-learning Topics**: Ransomware(Wannacry), Botnets, Rootkits, Mobile device security	CO2	12	12
4.Introduction to web security and Attacks	4.1 OWASP, Web Security Considerations, User Authentication, Cookies, SSL, HTTPS, Privacy on Web, Account Harvesting, Web Bugs, Sniffing, ARP poisoning, Denial of service attacks, Hacking Web Applications, Clickjacking, Cross-Site scripting and Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, SSO, Vulnerability assessments, SQL injection, Web Service Security, OAuth 2.0, Demonstration of hacking tools on Kali Linux such as SQLMap, HTTrack, hping, burp suite,Wireshark etc. **Self-learning Topics**: Format string attacks	CO4	10	10
5.Elements of Hardware Security	5.1 Side channel attacks, physical unclonable functions, Firewalls,Backdoors and trapdoors, Demonstration of Side Channel Attacks on RSA, IDS and Honeypots. **Self-learning Topics**: IoT security	CO5	6	6
6.Case Studies	6.1 Various attacks scenarios and their remedies. Demonstration of attacks using DVWA. **Self-learning Topics**: Session hijacking and man-in-middle attacks	CO6	4	4
			Total hours	**52**
Books:				
Text Books	1. Computer Security Principles and Practice --William Stallings, Seventh Edition, Pearson Education, 2017. 2. Security in Computing -- Charles P. Pfleeger, Fifth Edition, Pearson Education, 2015. 3. Network Security and Cryptography -- Bernard Menezes, Cengage Learning, 2014. 4. Network Security Bible -- Eric Cole, Second Edition, Wiley, 2011 5. Mark Stamp's Information Security: Principles and Practice --Deven Shah, Wiley, 2009.			
Reference Books	1.UNIX Network Programming –Richard Steven,Addison Wesley, 2003 2. Cryptography and Network Security -- Atul Kahate, 3rd edition, Tata Mc Graw			

<table>
<tr><td></td><td>Hill, 2013
3.TCP/IP Protocol Suite -- B. A. Forouzan, 4th Edition, Tata Mc Graw Hill, 2017
4. Applied Cryptography, Protocols Algorithms and Source Code in C -- Bruce Schneier, 2nd Edition / 20th Anniversary Edition, Wiley, 2015</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project
https://dvwa.co.uk/
http://testphp.vulnweb.com/</td></tr>
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Course Code	Course Name	Credits Assigned (TH+P+TUT)
HCSC601	Digital Forensic	04+0+0

Prerequisite:	Computer Hardware, Computer Networks, Operating Systems
Course Objectives:	The course aims: 1. To understand the various computer and cyber-crimes in the digital world. 2. To understand a significance of digital forensics life cycle, underlying forensics principles and investigation process. 3. To understand the importance of File system management with respect to computer forensics. 4. To be able to identify the live data in case of any incident handling and application of appropriate tools and practices for the same. 5. To develop the skills in application of various tools and investigation report writing with suitable evidences. 6. To be able to identify the network and mobile related threats and recommendation of suitable forensics procedures for the same.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	**Computer Hardware**: Motherboard, CPU, Memory: RAM, Hard Disk Drive (HDD), Solid State Drive (SSD), Optical drive **Computer Networks:** Introduction CN Terminology: Router, Gateway, OSI and TCP/IP Layers **Operating Systems:** Role of OS in file management, Memory management utilities, Fundamentals of file systems used in Windows and Linux.	--	2	2

1. Introduction to Cybercrime and Computer-crime	**1.1 Definition and classification of cybercrimes:** Definition, Hacking, DoS Attacks, Trojan Attacks, Credit Card Frauds, Cyber Terrorism, Cyber Stalking. **1.2 Definition and classification of computer crimes:** Computer Viruses, Computer Worms. **1.3 Prevention of Cybercrime**: Steps that can be followed to prevent cybercrime, Hackers, Crackers, Phreakers. **Self-learning Topics:** Steps performed by Hacker.	CO1	4	4
2. Introduction to Digital Forensics and Digital Evidences	**2.1 Introduction to Digital Forensics:** Introduction to Digital Forensics and lifecycle, Principles of Digital Forensic. **2.2 Introduction to Digital Evidences:** Challenging Aspects of Digital Evidence, Scientific Evidence, Presenting Digital Evidence. **2.3 Digital Investigation Process Models:** Physical Model, Staircase Model, Evidence Flow Model. **Self-learning Topics:** Digital Investigation Process Models comparison and its application, Rules of Digital Evidence.	CO2	5	5
3. Computer Forensics	**3.1 OS File Systems Review:** Windows Systems-FAT32 and NTFS, UNIX File Systems, MAC File Systems **3.2 Windows OS Artifacts:** Registry, Event Logs. **3.3 Memory Forensics :** RAM Forensic Analysis, Creating a RAM Memory Image, Volatility framework, Extracting Information **3.4 Computer Forensic Tools:** Need of Computer Forensic Tools, Types of Computer Forensic Tools, Tasks performed by Computer Forensic Tools **Self-learning Topics:** Study of 'The Sleuth Kit' Autopsy tool for Digital Forensics.	CO3	7	7
4. Incident Response Management, Live Data Collection and Forensic Duplication	**4.1 Incidence Response Methodology:** Goals of Incident Response, Finding and Hiring IR Talent. **4.2 IR Process:** Initial Response, Investigation, Remediation, Tracking of Significant Investigative Information. **4.3 Live Data Collection:** Live Data Collection on Microsoft Windows. **4.4 Forensic Duplication:** Forensic Duplicates as Admissible Evidence, Forensic Duplication Tools: Creating a Forensic evidence, Duplicate/Qualified Forensic Duplicate of a Hard Drive. **Self-learning Topics:** Live Data Collection on Unix-Based Systems.	CO4	10	10
5.Forensic Tools and Report Writing	**5.1 Forensic Image Acquisition in Linux :** Acquire an Image with dd Tools, Acquire an Image with Forensic Formats, Preserve Digital Evidence with Cryptography, Image Acquisition over a Network, Acquire Removable Media **5.2 Forensic Investigation Report Writing:** Reporting Standards, Report Style and Formatting,	CO5	10	10

	Report Content and Organization. **Self-learning Topics:** Case study on Report Writing			
6.Network Forensics and Mobile Forensics	**6.1 Network Forensics:** Sources of Network-Based Evidence, Principles of Internetworking, Internet Protocol Suite, Evidence Acquisition, Analyzing Network Traffic: Packet Flow and Statistical Flow, Network Intrusion Detection and Analysis, Investigation of Routers, Investigation of Firewalls **6.2 Mobile Forensics:** Mobile Phone Challenges, Mobile phone evidence extraction process, Android OS Architecture, Android File Systems basics, Types of Investigation, Procedure for Handling an Android Device, Imaging Android USB Mass Storage Devices. **Self-learning Topic:** Elcomsoft iOS Forensic Toolkit, Remo Recover tool for Android Data recovery.	CO6	14	14
			Total hours	**52**
Books:				
Text Books	1. Digital Forensics by Dr. Dhananjay R. Kalbande Dr. Nilakshi Jain, Wiley Publications, First Edition, 2019. 2. Digital Evidence and Computer Crime by Eoghan Casey, Elsevier Academic Press, Third Edition, 2011. 3. Incident Response & Computer Forensics by Jason T. Luttgens, Matthew Pepe and Kevin Mandia, McGraw-Hill Education, Third Edition (2014). 4. Network Forensics : Tracking Hackers through Cyberspace by Sherri Davidoff and Jonathan Ham, Pearson Edu,2012 5. Practical Mobile Forensic by Satish Bommisetty, Rohit Tamma, Heather Mahalik, PACKT publication, Open source publication, 2014 ISBN 978-1-78328-831-1 6. The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory by Michael Hale Ligh (Author), Andrew Case (Author), Jamie Levy (Author), AAron Walters (Author), Publisher : Wiley; 1st edition (3 October 2014).			
Reference Books:				
	1. Scene of the Cybercrime: Computer Forensics by Debra Littlejohn Shinder, Syngress Publication, First Edition, 2002. 2. Digital Forensics with Open Source Tools by Cory Altheide and Harlan Carvey, Syngress Publication, First Edition, 2011. 3. Practical Forensic Imaging Securing Digital Evidence with Linux Tools by Bruce Nikkel,NoStarch Press, San Francisco,(2016) 4. Android Forensics : Investigation, Analysis, and Mobile Security for Google Android by Andrew Hogg, Elsevier Publication,2011			
Online References:				
1. https://www.pearsonitcertification.com/articles/article.aspx?p=462199&seqNum=2 2. https://flylib.com/books/en/3.394.1.51/1/ 3. https://www.sleuthkit.org/autopsy/ 4. http://md5deep.sourceforge.net/md5deep.html 5. https://tools.kali.org/ 6. https://kalilinuxtutorials.com/ 7. https://accessdata.com/product-download/ftk-imager-version-4-3-0 8. https://www.amazon.in/Art-Memory-Forensics-Detecting-Malware/dp/1118825098				
Research Papers: Mobile Forensics/Guidelines on Cell Phone Forensics				

<table>
<tr><td colspan="2">1.Computer Forensics Resource Center: NIST Draft Special Publication 800-101 : https://csrc.nist.gov/publications/detail/sp/800-101/rev-1/final
2.https://cyberforensicator.com/category/white-papers
3.https://www.magnetforensics.com/resources/ios-11-parsing-whitepaper/
4.Samarjeet Yadav , Satya Prakash , Neelam Dayal and Vrijendra Singh, "Forensics Analysis WhatsApp in Android Mobile Phone", Electronic copy available at: https://ssrn.com/abstract=3576379.</td></tr>
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Internal Assessment(IA):
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Course Code	Course Name	Credits Assigned (TH+P+TUT)
HCSC701	Security Information Management	04+0+0

Prerequisite:	
Course Objectives:	The course aims: 1. The course is aimed to focus on cybercrime and need to protect information. 2. Understand the types of attacks and how to tackle the amount of risk involved. 3. Discuss the role of industry standards and legal requirements with respect to compliance. 4. Distinguish between different types of access control models, techniques and policy. 5. Awareness about Business Continuity and Disaster Recovery. 6. Awareness about Incident Management and its life cycle.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Sub topic	Total Hrs. /Module
I. Prerequisite	Vulnerability Assessment for Operating Systems, Network (Wired and Wireless). Tools for conducting Reconnaissance.	--	2	2
1. Basics of Information Security	**1.1** What is Information Security & Why do you need it? – **1.2** Basics Principles of Confidentiality, Integrity **1.3** Availability Concepts, Policies, procedures, Guidelines, Standards **1.4** Administrative Measures and Technical Measures, People, Process, Technology, IT ACT 2000, IT ACT 2008 **Self-learning Topics:** Impact of IT on organizations, Importance of IS to Society	CO1, CO2	6	6
2. Current Trends in Information Security	**2.1** Cloud Computing: benefits and Issues related to information Security. **2.2** Standards available for InfoSec: Cobit, Cadbury,	CO2	8	8

	ISO 27001, OWASP, OSSTMM. **2.3** An Overview, Certifiable Standards: How, What, When, Who. **Self-learning Topics:** Cloud Threats, Impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.			
3. Threat & Risk Management	**3.1** Threat Modelling**:** Threat, Threat-Source, Vulnerability, Attacks. Risk Assessment Frameworks**:** ISO 31010, NIST-SP-800-30, OCTAVE Risk Assessment and Analysis: Risk Team Formation, Information and Asset Value, Identifying Threat and Vulnerability, Risk Assessment Methodologies Quantification of Risk, Identification of Monitoring mechanism, Calculating Total Risk and Residual Risk. **Self-learning Topics:** Risk management trends today and tomorrow.	CO3	8	8
4. Identity and Access Management	**4.1** Concept**s** of Identification, Authentication, Authorization and Accountability. **4.2** Access Control Models: Discretionary, Mandatory, Role based and Rule-based. **4.3** Access Control Techniques: Constrained User, Access control Matrix, Content-dependent, Context – dependent **4.4** Access Control Methods: Administrative, Physical, Technical, Layering of Access control **4.5** Access Control Monitoring: IDS and IPS and anomaly detection. **4.6** Accountability: Event-Monitoring and log reviews. Log Protection **4.7** Threats to Access Control: Various Attacks on the Authentication systems. **Self-learning Topics:** challenges and solutions in identity and access management	CO4	10	10
5. Operational Security	**5.1** Concept of Availability, High Availability, Redundancy and Backup. **5.2** Calculating Availability, Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR) **5.3** Incident Management**:** Detection, Response, Mitigation, Reporting, Recovery and Remediation **5.4** Disaster Recovery: Metric for Disaster Recovery, Recovery Time Objective (RTO), Recovery Point Objective (RPO), Work Recovery Time (WRT), Maximum Tolerable Downtime (MTD), Business Process Recovery, Facility Recovery (Hot site, Warm site, Cold site, Redundant site), Backup & Restoration **Self-learning Topics:** Challenges and Opportunities of Having an IT Disaster Recovery Plan	CO5	10	10
6. Web	**6.1** Types of Audits in Windows Environment	CO6	8	8

Application, Windows, and Linux security	**6.2** Server Security, Active Directory (Group Policy), Anti-Virus, Mails, Malware **6.3** Endpoint protection, Shadow Passwords, SUDO users, etc. **6.4** Web Application Security: OWASP, Common Issues in Web Apps, what is XSS, SQL injection, CSRF, Password Vulnerabilities, SSL, CAPTCHA, Session Hijacking, Local and Remote File Inclusion, Audit Trails, Web Server Issues, etc. **Self-learning Topics:**, Network firewall protection, Choosing the Right Web Vulnerability Scanner			
			Total hours	**48**

Books:

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

Reference Books:

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

Online References:

https://www.ultimatewindowssecurity.com/securitylog/book/Default.aspx
http://www.ala.org/acrl/resources/policies/chapter14
https://advisera.com/27001academy/what-is-iso-27001/
https://nvlpubs.nist.gov/nistpubs/legacy/sp/nistspecialpublication800-30r1.pdf
http://www.diva-portal.org/smash/get/diva2:1117263/FULLTEXT01.pdf

Assessment:

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

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

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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins. duration.

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HCSSBL601	Vulnerability Assessment Penetration Testing (VAPT) Lab (SBL)	0+04+0

Prerequisite:	Computer Networks, Basic of Network Security.
Lab Objectives:	The Lab aims: 1. To identify security vulnerabilities and weaknesses in the target applications. 2. To discover potential vulnerabilities which are present in the system in network using vulnerability assessment tools. 3. To identify threats by exploiting them using penetration test attempt by utilizing the vulnerabilities in a system. 4. To recognize how security controls can be improved to prevent hackers gaining access controls to database. 5. To test and exploit systems using various tools and understands the impact in system logs. 6. To write a report with a full understanding of current security posture and what work is necessary to both fix the potential threat and to mitigate the same source of vulnerabilities in the future.

Lab Outcomes:

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

Hardware & Software Requirements:

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

Lab. No. and Module Name	Experiment Title	LO mapped	Hrs/ Lab	Total Hrs. /Module
I.Prerequisite	Computer Network, Basics of Network Security, Ethical Hacking, Digital Forensics	---	2	2
1. Human Security (Social Engineering) Assessment	**Visibility Audit: C**ollecting information through social media and internet. Collecting contact details (like phone number, email ID, What's App ID, etc) **Active Detection Verification:** Test if the phone number, email id etc are real by test message. Test whether the information is filtered at point of reception. Test if operator / person assistance can be obtained. **Device Information:** IP Address, Port details, Accessibility, Permissions, Role in business **Trust Verification:** Test whether the information can be planted in form of note / email / Message (Phishing) **Test Subjects:** College Staff, Reception, PA to Director / Principal. To conduct information gathering to conduct social engineering audit on various sections in your college. Self-Learning Topics: **Networking Commands**	LO1	8	8
2. Network & Wireless Security Assessment	**Network Discovery:** Using various tools to discover the various connected devices, to get device name, IP Address, relation of the device in network, Detection of Active port, OS Fingerprinting, Network port and active service discovery **Tools:** IP Scanner, Nmap etc **Network Packet Sniffing:** Packet Sniffing to detect the traffic pattern, Packet capturing to detect protocol specific traffic pattern, Packet capturing to reassemble packet to reveal unencrypted password **Tools:** Wireshark **Self-Learning Topics:** Learning the CVE database for vulnerabilities detected.	LO2	8	8
3. Setting up Pentester lab	Including an attacker machine preferably Kali and in the same subnet victim machines either DVWA/ SEEDlabs/ multiple VULNHUB machines as and when required. Understanding Categories of pentest and legalities/ ethics. Installed Kali machine on VM environment with some VULNHUB machines and we can find out vulnerability of Level 1-VULNHUB machine like deleted system files, permissions of files. **Self learning Topics:** Vulnerability exploitation for acquire root access of the Kioptrx machine	LO3	9	9
4. Database and Access Control Security Assessment	**Database Password Audit:** Tool based audit has to be performed for strength of password and hashes. **Tools:** DBPw Audit **Blind SQL Injection:** Test the security of the	LO4	9	9

	Database for SQL Injection **Tools:** BSQL Hacker **Password Audit:** Perform the password audit on the Linux / Windows based system **Tools:** Cain & Able, John the ripper, LCP Password Auditing tools for Windows. **Active Directory and Privileges Audit:** Conduct a review of the Active Directory and the Group Policy to assess the level of access privileges allocated. **Tools:** SolarWinds **Self-Learning Topics:** Federated Database security challenges and solutions.			
5. Log Analysis	Conduct a log analysis on Server Event Log / Firewall Logs / Server Security Log to review and obtain insights Tools: graylog, Open Audit Module. **Self-Learning Topics:** Python and R-Programming scripts	LO5	6	6
6. Compliance and Observation Reporting	**License Inventory Compliance:** Identify the number of licenses and its deployment in your organization. Tools: Belarc Advisor, Open Audit Report Writing: NESSUS tool Report should contain: a. Vulnerability discovered b. The date of discovery c. Common Vulnerabilities and Exposure (CVE) database reference and score; those vulnerabilities found with a medium or high CVE score should be addressed immediately d. A list of systems and devices found vulnerable e. Detailed steps to correct the vulnerability, which can include patching and/or reconfiguration of operating systems or applications f. Mitigation steps (like putting automatic OS updates in place) to keep the same type of issue from happening again **Purpose of Reporting:** Reporting provides an organization with a full understanding of their current security posture and what work is necessary to both fix the potential threat and to mitigate the same source of vulnerabilities in the future. **Self-Learning Topics:** Study of OpenVAS, Nikto, etc.	LO6	10	10
			Total hours	**52**
Text & Reference Books and Links:				

Text Books	1. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws Paperback – Illustrated, 7 October 2011 by Dafydd Stuttard. 2. Hacking: The Art of Exploitation, 2nd Edition 2nd Edition by Jon Erickson 3. Important links of Vulnhub: Vulnhub Kioptrix Download Link: https://www.vulnhub.com/entry/basic-pentesting-1,216/ https://www.vulnhub.com/entry/kioptrix-level-1-1,22/ Installation Video: https://youtu.be/JupQRHtfZmw Walkthrough/solutions Video: https://youtu.be/Qn2cKYZ6kBI 4. OWASP Broken Web Application Projects https://sourceforge.net/projects/owaspbwa/. 5. Mastering Modern Web Penetration Testing By Prakhar Prasad, October 2016, Packt Publishing. Kali Linux Revealed: Mastering the Penetration Testing Distribution – June 5, 2017 by Raphael Hertzog (Author), Jim O'Gorman (Author), Offsec Press Publisher.

Term Work:
The Term work shall consist of at least 10 to 12 practical based on the above syllabus. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above syllabus**.**
Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)
Practical & Oral Exam:
An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HCSC801	Application Security	04+0+0

Prerequisite:	
Course Objectives:	The course aims: 1. The terms and concepts of application Security, Threats, and Attacks. 2. The countermeasures for the threats wrt Application security. 3. The Secure Coding Practices. 4. The Secure Application Design and Architecture. 5. The different Security Scanning and testing techniques. 6. The threat modeling approaches.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Sub topic	Total Hrs. /Module
I. Prerequisite	Operating System, DBMS, Computer Network, Web Programming, OOP	-	02	02
1. Introduction to Application Security, Threats, and Attacks	Introduction to Web Application Reconnaissance, Finding Subdomains, API Analysis, Identifying Weak Points in Application Architecture **Offense:** Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), XML External Entity (XXE) Injection, Injection Attacks, Denial of Service (DoS), Cross-Origin Resource Sharing Vulnerabilities **Self-learning Topics: Simulate the attacks using open-source tools in virtual environment**	CO1	05	05
2. Defence and tools	Securing Modern Web Applications, Secure Application Architecture, Reviewing Code for Security, Vulnerability Discovery, Defending Against XSS Attacks, Defending Against CSRF Attacks, Defending Against XXE, Defending Against Injection attacks, Defending Against DoS, Defending against CORS based attacks	CO2	09	09

	Self-learning Topics: Implement the countermeasures to the attacks using open-source tools			
3. Secure Coding Practices	Security Requirements, Encryption, Never Trust System Input, Encoding and Escaping, Third-Party Components, Security Headers: Seatbelts for Web Apps, Securing Your Cookies, Passwords, Storage, and Other Important Decisions, HTTPS Everywhere, Framework Security Features, File Uploads, Errors and Logging, Input Validation and Sanitization, Authorization and Authentication, Parameterized Queries, Least Privilege, Requirements Checklist **Self-learning Topics: OWASP Secure Coding Practices**	CO3	09	09
4. Secure Application Design and Architecture	**Secure Software Development Lifecycle** Averting Disaster Before It Starts, Team Roles for Security, Security in the Software Development Lifecycle, **Design Flaw vs. Security Bug,** **Secure Design Concepts,** **Segregation of Production Data,** **Application Security Activities** **Self-learning Topics: Secure Hardware architecture**	CO4	09	09
5. Security Scanning and testing	Testing Your Code, Testing Your Application, Testing Your Infrastructure, Testing Your Database, Testing Your APIs and Web Services, Testing Your Integrations, Testing Your Network, Dynamic Web Application Profiling **Self-learning Topics: Open-source Application Security Tools, IAST, RASP and WAF, Selenium**	CO5	09	09
6.Threat Modeling	**Objectives and Benefits of Threat Modeling**, Defining a Risk Mitigation Strategy, Improving Application Security, Building Security in the Software Development Life Cycle **Existing Threat Modeling Approaches** Security, Software, Risk-Based Variants **Threat Modeling Within the SDLC** Building Security in SDLC with Threat Modeling, Integrating Threat Modeling Within the Different Types of SDLCs, **Self-learning Topics: The Common Vulnerability Scoring System (CVSS)**	CO6	09	09
			Total hours	**52**
Books:				
Text Books	1. Alice and Bob Learn Application Security, by Tanya Janca Wiley; 1st edition (4 December 2020). 2. Web Application Security, A Beginner's Guide by Bryan Sullivan McGraw-Hill Education; 1st edition (16 January 2012). 3. Web Application Security: Exploitation and Countermeasures for Modern Web Applications by Andrew Hoffman Shroff/O'Reilly; First edition (11 March 2020).			

<table>
<tr><td></td><td>4. The Security Development Lifecycle by Michael Howard Microsoft Press US; 1st edition (31 May 2006).
5. Risk Centric Threat Modeling Process for Attack Simulation And Threat Analysis, Tony Ucedavélez and Marco m. Morana, Wiley.
6. Iron-Clad Java: Building Secure Web Applications (Oracle Press) 1st Edition by Jim Manico.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td></td><td>1.Software Security: Building Security In by Gary McGraw Addison-Wesley Professional; 1st edition (January 23, 2006).
2.A Guide to Securing Modern Web Applications by Michal Zalewski
3.Threat Modeling: A Practical Guide for Development Teams by Izar Tarandach and Matthew J. Coles Dec 8, 2020.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://owasp.org/www-project-top-ten/
https://owasp.org/www-pdf-archive/OWASP_SCP_Quick_Reference_Guide_v2.pdf
https://pentesterlab.com/
https://app.cybrary.it/browse/course/advanced-penetration-testing
https://www.udemy.com/
https://www.coursera.org/</td></tr>
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</table>
Continuous Assessment (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.
Internal Assessment(IA):
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<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HVARC501	Virtual Reality	04+0+0

Prerequisite:	Basic C programming
Course Objectives:	The course aims: 1. To understand primitives of computer graphics fundamental. 2. To analyze various Hardware devices suitable for VR. 3. To analyze visual physiology and issues related to it. 4. To apply the knowledge of Visual rendering. 5. To evaluate problems faced due to audio scattering in VR. 6. To create different interface in VR environment.
Course Outcomes:	

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Sub topic	Total Hrs. /Module
I. Prerequisite	Functioning of human sensory organs – EYE, Ear, Touch etc. Light and Lenses Basic functioning of camera Matrix multiplication	-	02	02
1. Geometry of Virtual World	1.1 Geometric Modeling, 2D transformations, Homogenous coordinate system, 3D rotation and 6 degree of freedom, Viewport Transformation **Self:** Eye Transformation, demo of 2D transformation	CO1	10	10
2. Introduction to VR	2.1 Introduction to VR and definitions and its components. Hardware components: Display devices: LCD, OLED Audio: Speakers, Earphones, Bone conduction Touch: Haptic Device GPU and CPU, Input devices like game controller, data glows, Joysticks Tracking Hardware: Industrial measurement Unit-IMU, Gyroscope, accelerometer Software component: Java3D, VRML **Self:** Feedback mechanisms in	CO2	07	07

	VR environment			
3. Visual Physiology, perception and tracking	3.1 Functioning of Eye with photoreceptors, Resolution for VR, Eye movements and issues with it in VR, Neuroscience of vision, Depth and motion perception, Frame rates and display, Orientation tracking, tilt and yaw drift correction, Tracking with camera **Self:** Light House approach	CO3	08	08
4. Visual Rendering	4.1 Overview, shading models, rendering pipelines, rasterization, pixel shading, Distortion shading, post rendering image wrap **Self:** Rendering for VR application	CO4	09	09
5. Audio	5.1 Physics of Audio, Auditory Perception, localization, rendering, Problems due to scattering of audio **Self:** Study reaction of audio and other senses for VR environment	CO5	10	10
6. Interfaces	6.1 Locomotion, Manipulation, system control, social interaction using open-source tool like Gopro VR etc. **Self:** Explore tools for UI in VR	CO6	06	06
			Total hours	**52**

Books:

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

Reference Books:

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

Online References:

https://nptel.ac.in/courses/121/106/121106013/#
http://msl.cs.uiuc.edu/vr/
http://lavalle.pl/vr/

Assessment:

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

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

Continuous Assessment (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.

	Internal Assessment(IA): Marks will be allotted as per designed rubrics.
End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins. duration.	

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HVARC601	AR and Mix Reality	(04+0+0)

Prerequisite:	Programming Language, Computer Graphics, Virtual Reality
Course Objectives:	The course aims: 1. To understand the concepts of Augmented Reality and related technologies. 2. To understand the AR tracking system and use of computer vision in AR/MR. 3. To describe the technology for multimodal user interaction and authoring in AR. 4. To use different AR toolkits and apply them to develop AR applications. 5. To demonstrate AR Applications using Mobile AR Toolkits and SDKs. 6. To understand the use of AR/MR in interdisciplinary immersive applications.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Basics of Computer Graphics, Coordinate Systems, VR Introduction, Tracking in VR	--	02	02
1. Introduction to Augmented Reality and Mixed Reality	Definition and Scope, A Brief History of Augmented Reality, AR Architecture, Related Fields of AR (like Mixed Reality, Virtual Reality, Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality **Self-Learning Topics**: How AR/MR are related to Ubiquitous Computing, Multidimensional Systems.	CO1	06	06
2. Tracking and Computer Vision for AR and MR	Multimodal Displays; Visual Perception; Spatial Display Model; Visual Displays; Tracking, Calibration and Registration; Coordinate Systems; Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking; Multiple Camera Infrared Tracking; Natural Feature Tracking by Detection; Incremental Tracking; Simultaneous Localization and Tracking; Outdoor Tracking	CO2	07	07

	Self-Learning Topics: Indoor Tracking, Full Body Tracking			
3. Interaction, Modeling and Annotation and Authoring	Basics of Computer Graphics, Coordinate Systems, VR Introduction, Tracking in VR.	CO3	08	08
4. Software Architecture in AR and AR Development Toolkits	Definition and Scope, A Brief History of Augmented Reality, AR Architecture, Related Fields of AR (like Mixed Reality, Virtual Reality, Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality **Self-Learning Topics**: How AR/MR are related to Ubiquitous Computing, Multidimensional Systems.	CO4	10	10
5. Mobile AR	Types of Mobile Apps, AR Browsers for Smartphones, Point of Interests (POI) in Mobile AR, POI Authoring and Publishing Tools, AR Applications for Android, AR Games for Android, Mobile AR Toolkits and SDKs, Developing Mobile AR Applications, AR Application Development for Android Smartphone **Self-Learning Topics**: AR Applications for iOS, AR Games for iOS, AR Application Development for iOS Smartphone	CO5	10	10
6. Applications of AR/MR and Human Factors, Legal and Social Considerations	Applications of AR/MR in: Edutainment, Medical, Military, Production and Manufacturing, Navigation, Astronomical Observation, E-commerce; What are Human Factors, Physical Side Effects, Visual Side Effects, Legal Considerations, Moral and Ethical Considerations. **Self-Learning Topics**: Applications of AR/MR in Civil Construction and Architecture, Collaboration, Information Control and Big Data Visualization.	CO6	07	07
			Total hours	**50**
Books:				
Text Books	1.Dieter Schmalsteig and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc. 2016 Edition. 2.Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition. 3.Alan B. Craig, "Understanding Augmented Reality – Concepts and Applications", Morgan Kaufmann, Elsevier, 2013 Edition.			
Reference Books:				
	1.Borko Furht, "Handbook of Augmented Reality", Springer, 2011 Edition. 2.Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities- Theory and Practice for Next-Generation Spatial Computing", O'Reilly Media, Inc., 2019 Edition. **3.**Jens Grubert, Dr. Raphael Grasset, "Augmented Reality for Android Application Development", PACKT Publishing, 2013 Edition.			

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www.coursera.org</td></tr>
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Internal Assessment(IA):
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<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HVARC701	ARVR Application-I	04+0+0

Prerequisite:	Programming Language, Computer Graphics, Virtual Reality
Course Objectives:	The course aims: 1.To learn the underlying concepts of Virtual Reality, Augmented Reality and related technologies. 2.To analyse the principles of VR design, prototype. 3.To analyse the principles of AR design, prototype. 4.To design Graphical User interface using VR 5.To identify trends in XR, key issues in XR and XR Tools. 6.To analyse privacy, ethical, social concern on AR/VR problem.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Fundamental Concept and Components of Virtual Reality,Augmented Reality and Mixed Reality Technologie,Authoring in AR	--	02	02
1. AR/VR Concepts and Technologies	1.1 Difference between AR and VR , Rendering for VR/AR, Challenges with AR,AR systems and functionality **Augmented Reality Application Development** :Types of Augmented Reality Application (Location Based AR Apps Marker-Based AR Applications), three-dimensional modeling and computer vision ,displays & tracking technologies **Self-learning Topic:** Case study on Retail shopping using AR	CO1	08	08
2. VR Design Overview	2.1 Principles of VR design, Overview of guidelines, methods, tools & design problem, Physical Prototyping for VR- Physical prototype of potential solution, Digital	CO2	09	09

	Prototyping for VR- tool choices, digital prototype of (key aspects of) solution **Self-learning Topic:** Study of 3D navigation , layout and contents			
3. AR Design Overview	3.1 Principles of AR design, Overview of guidelines, methods, tools & design problem, Physical Prototyping for AR - Physical prototype of potential solution, Digital Prototyping for AR- tool choices, digital prototype of (key aspects of) solution. **Self-learning Topic:** Use of Anchors in AR	CO3	09	09
4. 3 D interaction with VR	4.1 3-D interaction Overview and types, Navigation in VR, Object interaction, Graphical User interface using VR, Challenges in VR interaction, Tools **Self-learning Topic:** Case study of Mobile applications using 3D interface	CO4	10	10
5. XR Application Development	5.1 XR overview, XR development Approach, XR design process, Trends in XR, key issues in XR, Tools **Self-learning Topic:** Difference between, AR, VR, MR and XR	CO5	10	10
6. Privacy and security	6.1 Privacy, Ethical, and Social Implications, and the Future of AR/VR **Self-learning Topic:** Case study on Privacy and security issues using AR and VR	CO6	04	07
			Total hours	**52**

Books:

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

Reference Books:

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

Online References:

www.nptel.ac.in
www.coursera.org

Assessment:

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

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3.	Internal Assessment	10 marks

Continuous Assessment (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of

	the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour. **Internal Assessment(IA):** Marks will be allotted as per designed rubrics.
End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins. duration.	

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HVARSBL601	ARVR Lab (SBL)	0+04+0

Prerequisite:	VR,AR and MR concepts
Lab Objectives:	The lab course aims: 1. To Understand the definition and significance of the VR,AR and MR. 2. To Design various applications in VR . 3. To Examine various audio tools for audio embedded in scene. 4. To Explore AR and MR applications in real world. 5. To develop interface for VR and AR applications. 6. To Explore the interconnection and integration of the physical world and able to design & develop Mobile applications.

Lab Outcomes:

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

Hardware & Software Requirements:

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

Lab. No.	Experiment Title	LO mapped	Hrs/Lab
Prerequisite:	ARVR lab will describe the Designing of VR and AR applications using different Tools. It starts with installation of software and then learner learns how to design background of various applications. Now a day's audio implementation in VR scenes is also getting lots of attention so this aspect is also covered in the lab experiments. AR and MR are important concepts where learners design the applications for desktop as well as mobile environment.	---	----
1	To install Open source software /Unity with its functionality	LO1	2
2	Select real world application and design background for the same	LO2	2
3	To add sound in the selected application using Open source	LO3	2

	software /Unity software		
4	To study interface requirements and apply for the selected application	LO3	2
5	Creating Your Digital Prototype of your objects/environment – (WebVR/ Sketchup / Blender/Unity/Keynote/Figma)	LO6	2
6	To implement a depth map with Python and OpenCV and using Unity	LO5	2
7	Identify multiple surfaces and move objects between them using ARCore	LO3	2
8	To study Interact with AR objects and detect collisions.	LO2	2
9	Marker less Object Placement - WebAR	LO4	2
10	In a group of three to five students develop one real world application in VR/ AR or MR with object details and sound with good user interface	LO6	2

Text & Reference Books and Links:

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

Online Resources:

https://nptel.ac.in/courses/121/106/121106013/#
http://msl.cs.uiuc.edu/vr/
http://lavalle.pl/vr
http://nptel.ac.in
www.coursera.org

Term Work:

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

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

Practical & Oral Exam:

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

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HVARC801	Game Development with VR	04+0+0

Prerequisite:	Basics of VR
Course Objectives:	The course aims: 1. The different genres of game and explain the Unity UI Basics. 2. The use of navigation and cursor control to create a game environment. 3. How to import assets, interact with them using action objects and manage object states. 4. To build transitions by scripting events, using physics, particle systems, and other Unity functionality action sequences with UnityGUI design. 5. To build the game project together by handling mecanim, using dialogue trees,creating and setting up the game environment and menus for the game. 6. The VR development in Unity.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Basics of VR	--	02	02
1. Game Development and Unity UI Basics	The Adventure Genre, Fast Forward to Real-Time, What Draws People to This Genre? Designing Your Game: Defining a Style, Compartmentalizing Environments, First-Person or Third? Animation, Basic Human Characteristics Make for Fun? Managing Your Project, Tips for Completing the Game,Real Time vs. Pre-render.AI in Gaming-AI Guidelines, a simple workflow. Unity UI:The Layout,Toolbar,Menus,Creating Simple Objects,Selecting and Focusing,Transforming Objects In 3D,Snaps,Scene Gizmo.Lights,3D Objects,Materials Scripting:What is a script?Components of a Script,Picking an Object in the Game,Conditionals and State,Order of Evaluation	CO1	08	08

	Self-learning Topics: Understanding the role of AI in gaming.			
2. Navigation and Cursor Control	Creating Environments,Navigation-Arrow Navigation and Input,Fun with Platforms,Collision Walls,Cursor visibility,Custom cursors, GUI Texture Cursor,Hardware Cursor,UnityGUI Cursor,Object-to-Object Communication,Mouseover Cursor Changes,Object Reaction to Mouseover **Self-learning Topics:**Multimodal Gaming for Navigation Skills in Players Who Are Blind	CO2	06	06
3. Imported Assets, Objects & Managing states	Imported Assets:3D Art Assets,Setting Up Materials,Shadows. Action Objects:Colliders,Triggering Animation,Adding Sound F/X, Managing States:Identifying the Action Objects,Developing a State Machine,Lookup Table,Scripting in Unity,Picking a script Editor,Fundamentals of scripting in Unity.The Object Lookup Script,Action-Related Messages **Self-learning Topics:**Study the new Asset Import Pipeline: Solid foundation for speeding up asset imports,Effects of scripting on dialogues.	CO3	09	09
4. Transitions, Text Management	Processing the Auxiliary Objects,Handling Object Visibility,Ensuring Player Focus, Adding New Assets,Physics,Combining Physics and Keyframe Animation,Particle systems, GUI Skin,Text Visibility,Using Layers,Creating the Inventory Screen,Adding Inventory Icons,Managing the inventory. **Self-learning Topics:**Importance of effective Text management in Gaming	CO4	09	09
5. Game Deployment	Dialogue Trees,The Scenario,Starting a Conversation,Mecanim and Characters,Game Environment,Setting up the game,Menus and levels **Self-learning Topics:** Branching dialogue trees and its effect in Gaming.Study of different UI designs for Menus in Games.	CO5	09	09
6. XR development in Unity	Unity platform and services, XR Getting started with AR development in Unity, Getting started with VR development in Unity, XR Plug-in Framework, Configuring your Unity Project for XR, Universal Render Pipeline compatibility in XR, XR API reference, Single Pass Stereo rendering (Double-Wide rendering), VR Audio Spatializers, VR frame timing ,Unity XR SDK, Open-source repositories using Bitbucket, Asset Store Publishing, use of unity as library in other application. **Self-learning Topics:** Study any open source tool for VR Development.	CO6	09	09
			Total hours	**52**
Books:				

<table>
<tr><td>Text Books</td><td>1. Beginning 3D Game Development with Unity 4 All-in-one Multi-platform Game development, 2nd Edition, Apress,Sue Backman.
2. Game Development with Unity 2nd Edition,Michelle Menard and Bryan Wagstaff.
3. Unity Game development Essentials,Will Goldstone,PACKT Publishing.
4. Unity Game Development Cookbook-Essentials for every Game,O'reilly,Paris Buttfield-Addison,Jon Manning-Tim Nugent.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td></td><td>1. Introduction to Gam Development,Second Edition,Steve Rabin,CENGAGE Learning.
2. Sams Teach Yourself Unity Game Development in 24 Hours-Mike Geig.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://docs.unity3d.com/Manual/VROverview.html
https://www.coursera.org/
https://www.udemy.com/</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –
<table><tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr><tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr><tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr></table>Continuous Assessment (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.
Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HIoTC501	IOT Sensor Technologies	04+0+0

Prerequisite:	1. Basics of Electrical and Electronics Engineering 2. Applied Mechanics , 3. Applied Physics, 4. Applied Chemistry
Course Objectives:	The course aims: 1. To provide in depth knowledge about the sensing mechanism. 2. To make students understand about the use of sensors in design of IoT based systems. 3. To familiarize students various types of sensors used to measure the physical quantities. 4. To develop reasonable level of competence in the design, construction and development of sensor suitable to the system requirements. 5. To introduce students the current state of the art in sensor technology. 6. To familiarize students with electronics used to interface with sensors.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	1. Basics of Electrical and Electronics Engineering, 2. Applied Mechanics, 3. Applied Physics, 4. Applied Chemistry	CO 1, CO2, CO3, CO4, CO5	02	02
1. Sensor Fundamentals and Properties	**Sensor Fundamentals and Properties:** Introduction to IoT, Need for sensors in IoT, Data Acquisition – sensor characteristics – electric charges, fields, potentials – capacitance – magnetism – inductance – resistance – piezoelectric – pyroelectric – Hall effect thermoelectric effects – sound waves – heat transfer – light – dynamic models of sensors. Need of actuators, all types of actuators and their working. Identification of sensor and actuator for	CO1, CO2	08	08

	real-time application **Self-learning Topics: IoT Systems, Transfer function and modelling of sensors**			
2. Optical, radiation and Displacement sensors	**2.1 Optical, radiation and Displacement sensors** Photosensors: Photodiode, phototransistor and photo resistor, imaging sensors, UV detectors, Basic Characteristics of radiation sensors, Thermal infrared sensors, X-ray and Nuclear Radiation Sensors, Fibre Optic Sensors, Capacitive and Inductive Displacement Sensor, Electromagnetism and Inductance, Magnetic Field Sensors. **Self-learning Topics:** Optical sources and detectors, Sensors based on polymer optical fibers, Micro-structured and solid fibers.	CO1, CO2, CO3, CO4	08	08
3. Presence, force, Pressure, Flow Sensors	**3.1 Presence, force, Pressure, Flow Sensors** Potentiometric Sensors, Piezoresistive Sensors, Capacitive Sensors for presence, Inductive and Magnetic Sensors, Strain gages, Pressure sensitive films, piezoelectric force sensor, Piezoelectric Cables, Concept of Pressure, Mercury Pressure Sensor, Bellows, Membranes, and Thin Plates, Piezo resistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Pressure Sensors, Indirect Pressure Sensor, Vacuum Sensors, Basics of Flow Dynamics, Pressure Gradient Technique, Thermal Transport Sensors, Ultrasonic Sensors, Level Sensors **Self-learning Topics:** Vibration energy harvesting with Piezoelectric, MEMS systems. Develop a sensor system for force measurement using piezoelectric transducer. Develop Resistance Temperature Detector	CO1, CO2, CO3, CO4	09	09
4. Humidity, Moisture Chemical and Biological Sensors	**4.1 Humidity, Moisture Chemical and Biological Sensors** Microphones: Characteristics, Resistive, condenser, Electret, Optical, Pizoelectric, Dynamic, Concept of humidity, Capacitive Humidity Sensors, Resistive Humidity Sensors, Thermal Conductivity Sensors, Optical Hygrometers, Oscillating Hygrometer, Soil Moisture Chemical Sensor Characteristics, Electrical and Electrochemical Sensors, Photoionization Detectors, Physical Transducers, Spectrometers, Thermal Sensors, Optical Transducers, Multi-sensor Arrays Artificial Microsystems for Sensing Airflow, Temperature, and Humidity by Combining MEMS and CMOS Technologies **Self-learning Topics:** Biosensors for biomedical applications	CO1, CO2, CO3, CO4, CO5	08	08

5. Interface Electronic Circuits	**5.1 Interface Electronic Circuits** Introduction, Signal Conditioners, Sensor Connections, Excitation Circuits, Analog to Digital Converters, Integrated Interfaces, Data Transmission, Noise in Sensors and Circuits, Batteries for Low-Power Sensors, Types of Single board computers, various sensor interfacing with Arduino, Embedded C Programming. data communication protocol interfacing, study the properties of LDR, Build a simple LED light intensity controller, Linux on Raspberry Pi, Interfaces, and Programming. **Self-learning Topics:** Python Programming to interface sensors	CO1, CO2, CO5	08	08
6. Current Trends in sensors and Technology	6.1 **Current Trends in sensors and Technology** **Smart Sensors:** Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, The Automation Sensor Technologies: Introduction, Film Sensors, Thick Film Sensors, Thin Film Sensors, Semiconductor IC Technology—Standard Methods, Microelectromechanical Systems (MEMS), Nano-sensors Sensor Applications: Onboard Automobile sensors, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring **Self-learning Topics:** Energy Harvesting, Self-powered Wireless Sensing in ground, Ground penetrating sensors	CO1, CO2, CO3, CO4, CO5, CO6	09	09
			Total hours	**52**
Books:				
Text Books	1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York. 2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland 3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003 4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014.			
Reference Books:				
	1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press 2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003 3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York. 5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0			

<table>
<tr><td></td><td>6. Nathan Ida, “Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://nptel.ac.in/courses/108/108/108108123/
https://nptel.ac.in/courses/108/108/108108098/
https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee41/
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</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HIoTC601	IoT System Design	04+0+0

Prerequisite:	Basics of Embedded System,IoT Sensors, Digital design.
Course Objectives:	1. The course aims: 2. To learn basic principles, concepts, and technologies for internet of things. 3. To understand various architectures of IOT. 4. To train the students to build IoT systems using sensors, single board computers and open source IoT platform for given application. 5. To learn and implement various networking and communication protocols. 6. To design and analyze IoT for given applications. 7. To Evaluate performance of given IoT system.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Comment (Prerequisite syllabus should not be considered for paper setting) Basics of Embedded System,IoT Sensors, Digital design	--	2	2
1. Overview of IoT System	1.1 What is IoT System? IoT Impact, Current Trends in IoT , IoT Challenges, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack How are IoT Systems different from traditional system Values and Uses of IoT Functional View and Infrastructure view of IoT Systems **Self-learning Topics:** *Understanding the Issues and Challenges of a More Connected World*	CO1, CO2	6	6
2. Networking Protocols	2.1 OSI Model for the IoT/M2M System Lightweight M2M Communication Protocols, Internet based Communications, IP addressing in IoT, Network Model, TCP & UDP, Client-Server architecture **Self-learning Topics:** *How to choose correct protocol for our network.*	CO3	8	8

3. Communication Protocols	3.1 IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols.M2M Communication Protocols , Bluetooth BR/EDR and Bluetooth low energy .RFID IoT System , RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), Message Communication protocols for connected devices Data exchange formats: JSON & XML, Node-Red, Flow control using Node-Red, learning the different nodes of Node-RED for implementing the Communication Protocols **Self-learning Topics:** *Types of Communication*	CO3, CO4	10	10
4. Sensor Interfaces	4.1 Digital Interfaces : UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi **Self-learning Topics:** *SMART SENSOR INTERFACES.*	CO4	10	10
5. Design principles for prototyping	5.1 Design solution for ubiquitionos and utility, Interface design for user experience, Desiging for data privacy, Interfacing – Apps & Webs, Designing for Affordability, Cost v/s Ease of Prototyping, Prototypes and Production, Selection of embedded platform, Prototype and Mass personalization, Open Source v/s Closed Source ,Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration. **Self-learning Topics:** Principles for Prototyping and moving towards Product Development.	CO5	8	8
6. IoT, case studies	6.1 Arduino Programming for Ethernet and Wifi connectivity , Networking and Datalogging with Raspberry Pi Applications-Agriculture, Medical,Fire detection, Air pollution prediction, Earthquake early detection; for smart environmental care, smart traveling, Home Automation. **Self-learning Topics**: *IoT enabled Business solution in Supply Chain*	CO6	8	8
			Total hours	**52**
Books:				
Text Books	1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press. 2. Adrian McEwen and Hakim Cassimally, ―Designing the Internet of Things‖, John Wiley and Sons Ltd, UK, 2014. 3. Milan Milenkovic, Internet of Things: Concepts and System Design, Springer International Publishing,May 2020cation 4. Dr.Raj Kamal,Internet of Things(IoT) , Architecture and Design Principles.McGraw Hill Education.			
Reference Books:				

<table>
<tr><td></td><td>1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things.
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
3. Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research and Innovation to Market.
4. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014.</td></tr>
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Internal Assessment(IA):
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<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
</table>

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HIoTC701	Dynamic Paradigm in IoT	03+0+0

Prerequisite:	Basics of Cloud Computing, Basics of Machine learning and primitives of cryptography.
Course Objectives:	The course aims: 1. To explore the role of the cloud in Internet of Things deployment. 2. To introduce the usage of different machine learning algorithms on IoT Data. 3. To explore data analytics and data visualization on IoT Data. 4. To explore the role of Fog computing in Internet of Things. 5. To explore design issues and working principles of various security measures and various standards for secure communication in IoT. 6. To develop the ability to integrate IoT with Dev-ops.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	Basics of Cloud Computing, Basics of Machine learning and primitives of cryptography	--	2	2
1. IoT and CLOUD	1.1 **Cloud Computing Concept**, **Grid/SOA and Cloud Computing, Cloud Middleware NIST's SPI Architecture and Cloud Standards, The Cloud of Things--**The Internet of Things and Cloud Computing **The Cloud of Things Architecture**-- Four Deployment Models, Vertical Applications, Fifteen Essential Features, Four Technological Pillars, Three Layers of IoT Systems, Foundational Technological Enabler **Cloud Providers and Systems** -- Microsoft Azure IoT, Amazon Web Services, Google's cloud IoTs. **Self-learning Module:** IBM Watson Cloud.	CO1	10	10

2. IoT and Machine Learning	2.1 **Advantages of IoT and Machine Learning Integration, Implementation of Supervised Algorithm-** Regression (Linear and Logistic), SVM for IoT-Neural Network **on case study:** Agriculture and IoT, Smart Home etc. **Self-Learning Module:** Regression, SVM	CO2	06	06
3. IoT and Data Analytics	3.1 **Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud**-Microsoft Azure overview– Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets, Managing Data lakes, The data retention strategy. **Communicating with Others- Visualization and Dash boarding-** Designing visual analysis for IoT data, creating a dashboard –creating and visualizing alerts. **Self-learning Topics:** Study real time case study on IoT Analytics.	CO3	08	08
4. IoT and Fog Computing	4.1 **Fog computing Basics, The Hadoop philosophy for Fog computing, Fog Computing versus Edge Computing versus cloud computing, Open Fog Reference Architecture Application services**-- Application support, Node management and software backplane, Hardware virtualization, Open Fog node security, Network Accelerators Compute, Storage Hardware platform infrastructure, Protocol abstraction, Sensors, actuators, and control systems, Fog Topology. **Self-learning Module:** Amazon Green grass and Lambda (implementation)	CO4	08	08
5. IoT and it's Security	5.1 Cyber security vernacular Attack and threat terms, Defense terms, Anatomy of IoT cyber attacks – Mirai, Stuxnet, Chain Reaction, Physical and hardware security, Root of Trust, Key management and trusted platform modules, Processor and memory space, Storage security, Network stack – Transport Layer Security, Software defined perimeter, Software-Defined Perimeter architecture, **Self-learning Module:** OWASP-Existing Security attacks and its prevention methods.	CO5	08	08
6. IoT and Devops	6.1 **Introduction to DevOps, DevOps application - business scenarios, DevOps process** -- Source Code Management (SCM), Code review, Configuration Management, Build management, Artifacts repository management, Release management, Test automation, Continuous integration, Continuous delivery, Continuous deployment, Infrastructure as Code, Routine automation, Key application performance monitoring/indicators. **DevOps frameworks--** DevOps maturity life cycle, DevOps maturity map, DevOps progression framework/readiness model,	CO6	10	10

	DevOps maturity checklists, Agile framework for DevOps process projects, Agile ways of development **Tool for IoT—**Chef and Puppet, Setting up Chef and Puppet, Multi-tier Application Deployment, NETCONF-YANG Case Studies- Steps for IoT device management with NETCONF-YANG, Managing Smart irrigation IoT system with NETCONF-YANG, Managing Home Intrusion Detection IoT system with NETCONF-YANG **Self-learning Topics:** Compare different tool of IoT.			
			Total hours	**52**

Books:	
Text Books	1. The Internet of Things in the Cloud A Middleware Perspective, Honbo Zhou – CRC Publication. 2. Analytics for the Internet of Things (IoT), Andrew Minteer, Packt Publication 2017. 3. Internet of Things- Hands on Approach, Arshdeep Bagha, Vijay Medisetti, Published by Arshdeep Bagha and Vijay Medisetti,2014. 4. Hands-on DevOps, Sricharan Vadapalli, Packt Publication, 2017. Internet of things For Architects, Perry Lea Packt Publication,2018.
Reference Books:	
	1. Enterprise Cloud Computing, Gautam Shroff, Cambridge,2010 2. Mastering Cloud Computing -Foundations and Applications Programming, Raj Kumar Buyya, Christian Vecchiola, S. Thamarai Selvi, MK Publication, 2013. 3. Machine Learning in Action‖, Peter Harrington, DreamTech Press 4. Introduction to Machine Learning‖, Ethem Alpaydın, MIT Press 5. Learning AWS IoT- Effectively Manage Connected Devices on the AWS Cloud Using Services Such as AWS Greengrass, AWS Button, Predictive Analytics and Machine Learning, Agus Kurniawan, Packt Publication,2018 **6.** Practical Dev-Ops, Joakim Verona, Packt Publication, 2016.
Online References:	
https://hub.packtpub.com/25-datasets-deep-learning-iot/ https://data.world/datasets/iot https://dashboard.healthit.gov/datadashboard/data.php https://www.data.gov/ https://dev.socrata.com/data/ https://www.kaggle.com/	
Assessment:	**Continuous Assessment (CA):** The distribution of Continuous Assessment marks will be as follows – 1. Class Test 1 — 30 marks 2. Class Test 2 — 30 marks 3. Internal Assessment — 10 marks **Continuous Assessment** (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour. **Internal Assessment(IA):** Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HIOTSBL601	Interfacing & Programming with IoT Lab (SBL)	0+04+0

Prerequisite:	IoT introduction course: Basics of IoT, Introduction to Embedded systems
Lab Objectives:	The Lab aims: 1. To Understand the definition and significance of the Internet of Things. 2. To Discuss the architecture, operation, and business benefits of an IoT solution. 3. To Examine the potential business opportunities that IoT can uncover. 4. To Explore the relationship between IoT, cloud computing, and DevOps. 5. To Identify how IoT differs from traditional data collection systems. 6. To Explore the interconnection and integration of the physical world and able to design & develop IOT Devices.

Lab Outcomes:

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

Hardware & Software Requirements:

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

This lab will describe the market around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Divided into four main modules, we will learn by doing. We will

start with simple examples and integrate the techniques we learn into a class project in which we design and build an actual IoT system. The client will run in an emulated ARM environment, communicating using common IoT protocols with a cloud enabled backend system with DevOps integration.

Lab. No.	Experiment Title	LO mapped	Hrs/Lab
1	To study and implement interfacing of different IoT sensors with Raspberry Pi/Arduino/ModeMCU…	LO1	4
2	To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper word)	LO2	4
3	To study and demonstrate Contiki OS for RPL (like Create 2 border router and 10 REST clients, Access border router from other network (Simulator))	LO3	4
4	To study and demonstrate use of IoT simulators (like Beviswise) on any real time device (LED/stepper motor)	LO3	4
5	Select any one case study (in a group of 2-3) and perform the experiments 5 to 10. The sample case studies can be as follows: 1. Smart home automation system 2. Healthcare management system 3. Smart traffic management system & so on… Write a program on Raspberry Pi to push and retrieve the data from cloud like thingspeak, thingsboard, AWS, Azure etc.	LO4	8
6	To install MySQL database on Raspberry Pi and perform basic SQL queries for analysis data collected.	LO4	6
7	To study and implement IoT Data processing using Pandas.	LO4	4
8	To study and implement Continuous Integration using Jenkins on IoT data and also perform interfacing of Raspberry Pi into Jenkins.	LO6	6
9	To study and implement Continuous Deployment (Infrastructure as a code) for IoT using Ansible.	LO6	6
10	To study MQTT Mosquitto server and write a program on Arduino/Raspberry Pi to publish sensor data to MQTT broker.	LO5	6

Text & Reference Books and Links:

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

Online Resources:

https://spoken-tutorial.org/watch/Arduino/Introduction+to+Arduino/English/
https://pythonprogramming.net/introduction-raspberry-pi-tutorials/
https://iotbytes.wordpress.com/basic-iot-actuators/
http://www.contiki-os.org/
https://www.bevywise.com/iot-simulator/

https://mqtt.org/
Term Work:
The Term work shall consist of at least 10 to 12 practical based on the above syllabus. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above syllabus**.**
Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)
Practical & Oral Exam:
An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Credits Assigned (TH+P+TUT)
HIoTC801	Industrial IoT	04+0+0

Prerequisite:	IOT Concepts, Sensor Technology, IOT Stack and Protocols, Design IoT systems, WSN etc.
Course Objectives:	The course aims: 1.To learn the concepts of Industry 4.0 and IIOT. 2.To learn reference Architecture of IIOT. 3.To learn Industrial Data Transmission and Industrial Data Acquisition. 4.To learn middleware and WAN technologies. 5.To learn IIOT Block chain and Security. 6.To learn different applications and securities in IIOT.

Course Outcomes:

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	Total Hrs. /Module
I. Prerequisite	IOT Concepts, Sensor Technology, IOT Stack and Protocols, Design IoT systems, WSN etc	--	02	02
1. Introduction	1.1 Overview of Industry 4.0 and Industrial Internet of Things, Industry 4.0: Industrial Revolution: Phases of Development, Evolution of Industry 4.0, Environment impacts of industrial revolution, Industrial Internet, Basics of CPS, CPS and IIOT, Design requirements of Industry 4.0, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Cyber security, Impacts of Industry 4.0, Industrial Internet of Things: Basics, IIOT and Industry 4.0, Industrial Internet Systems, Industrial Sensing, Industrial Processes, IIOT Challenges – Identifying Things within the internet, Discovering Things and the Data they possess, Managing massive amount of data, Navigating Connectivity Outages, IIOT Edge - Leveraging the Power of Cloud Computing, Communicating with	CO1	06	06

	Devices on the Edge, Determining a Request/Response Model **Self-learning Topics:** Study real time IIoT challenges in industry.			
2. IIOT Reference Architecture	2.1 The IIC Industrial Internet Reference Architecture - Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints - Functional, Operational, Information Application and Business Domain of IIAF. The Three-Tier Topology, Key Functional Characteristics of Connectivity. Software Architectural Style for the Industrial Internet of Things - Software Architecture Practice, Advanced Architectural Styles, Systems of Systems, Challenges of Software Engineering in IIoT, Principles for Software Architecture design in IIoT, The Principled Decomposition, The Architectural Style **Self-learning Topics:** Study IIoT Architecture.	CO2	08	08
3. Industrial Data Transmission and Industrial Data Acquisition	3.1 Introduction, (Features and Components of - Foundation Fieldbus, Profibus, HART,Interbus, Bitbus, CC-Link, Modbus, Batibus, DigitalSTROM, Controller Area Network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa and LoRaWAN) NB-IoT, IEEE 802.11AH, Distributed Control System, PLC, SCADA **Self-learning Topics:** Study SCADA, PLC in detail.	CO3	10	10
4. IIOT Middleware and WAN Technologies	4.1 (From Industrial Application Perspective) Examining Middleware Transport Protocols (TCP/IP, UDP, RTP, CoAP), Middleware Software Patterns (Publish Subscribe Pattern, Delay Tolerant Networks), Software Design Concepts – Application Programming Interface – A Technical Perspective, Why Are APIs Important for Business? Web Services, IIOT Middleware Platforms – Middleware Architecture IIOT WAN Technologies and Protocols - IIoT Device Low-Power WAN Optimized Technologies for M2M, SigFox,LoRaWAN,nWave, Dash7 Protocol, Ingénue RPMA, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio **Self-learning Topics:** Study different IIoT Middleware and WAN Technologies.	CO4	10	10
5. IIOT Blockchain and Security	5.1 Blockchains and cryptocurrencies in IoT, Bitcoin (blockchain-based), IOTA- distributed ledger (directed a cyclical graph-based), Government regulations and intervention, US Congressional Bill – Internet of Things (IoT) Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security.	CO5	08	08

	Self-learning Topics: Case study on IIoT Block chain and Security.			
6. IIOT Applications and Securities	**The IoT Security Lifecycle-** The secure IoT system implementation lifecycle, Implementation and integration, IoT security CONOPS document, Network and security integration, System security verification and validation (V&V), Security training, Secure configurations, Operations and maintenance, Managing identities, roles, and attributes, Security monitoring, Penetration testing, Compliance monitoring, Asset and configuration management, Incident management, Forensics, Dispose, Secure device disposal and zeroization, Data purging, Inventory control, Data archiving and records management Securing the Industrial Internet - Security in Manufacturing, PLCs and DCS, Securing the OT (Operation Technology), Network, System Level: Potential Security Issues, Identity Access Management Develop New Business Models – Adopt Smart Architectures and Technologies, Sensor-Driven Computing, Industrial Analytics, Intelligent Machine Applications, Transform the Workforce Case Studies – Healthcare Applications in Industries – Challenges associated with Healthcare, Introduction, Smart Devices, Advanced technologies used in Healthcare. Inventory Management and Quality Control – Introduction, Inventory Management and IIOT, Quality Control Manufacturing Industry, Automotive Industry and Mining Industry **Self-learning Topics:** Study real time IIoT application.	CO6	08	08
			Total hours	**52**
Books:				
Text Books	1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress) 2. "Introduction to Industrial Internet of Things and Industry 4.0",by Sudip Misra, Chandana Roy And Anandarup Mukherjee, CRC Press (Taylor & Francis Group) 3. "Internet **of Things** Principles and Paradigms", by Rajkumar Buyya, Amir Vahid Dastjerdi, ELSEVIER Inc. 4. Internet of things For Architects, Perry Lea Packt Publication,2018.			
Reference Books:				
	1. "Practical Internet of Things Security", by Brian Russell, Drew Van Duren (Packt Publishing). 2. "Industrial Internet of Things and Communications at the Edge", by Tony Paine, CEO, Kepware Technologies.			

<table>
<tr><td></td><td>3. “Architectural Design Principles For Industrial Internet of Things”, Hasan Derhamy, Luleå University of Technology, Graphic Production.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://onlinecourses.nptel.ac.in/noc20_cs69/preview
https://www.coursera.org/specializations/developing-industrial-iot
https://www.coursera.org/lecture/advanced-manufacturing-enterprise/the-industrial-internet-of-things-iiot-59EvI
https://www.coursera.org/lecture/industrial-iot-markets-security/segment-12-blockchains-l4aG9</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –
<table>
<tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr>
<tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr>
<tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr>
</table>
Continuous Assessment (Avg. of T1 and T2: 30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.
Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with 2 hours and 30 mins duration.</td></tr>
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