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 B

for

Bachelor of Technology (B.Tech.)

in

Artificial Intelligence and Data Science (AI-DS)

(Last Year)
(Semester VII and VIII)

Including

Honours Degree Program &
Internship Policy Manual

With effect from

A.Y. 2024-25

Somaiya Ayurvihar Complex, Eastern Express Highway, Sion (East), Mumbai. 400 022, India
Telephone: (91-22)44444400, 44444404 email: principal.tech@somaiya.edu, Web: https://kjsit.somaiya.edu.in/en

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.

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. Academic Year 2021-22 already comprises of state-of-the-art courses and laboratory sessions on emerging areas of technology. With an ideology that the root of innovation is 'interest', the curriculum offers a wide range of elective courses — grouped into core and inter-disciplinary domains. At par with international engineering education, it follows a learner-centric approach, where the students could choose to study courses concerning areas of their interests.

This curriculum introduces Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses — that assure X factor in all the students of the institute. These SAT courses, practiced across the first three years of engineering, focus on graduate attributes like work responsibilities towards society, problem-solving ability, communication skills, motivation for life-long learning, leadership and teamwork, etc. which cannot 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 was introduced with 03 newer dimensions to Scheme – I: Internship, SBL of Foreign and Indian Languages, and Honours Degree — for implementation w.e.f. from Academic Year 2022-23 across all the branches and all 04 years of engineering.

1. **Internship:** Firstly, the redesigned Scheme – II incorporates mandatory Internship for all the students, which 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 comprises 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. Such SBL and TBL courses shall also acquaint students with skills of digital age learning from online platforms, along with time management ability, ethics, and professionalism.

The KJSIT Syllabus Scheme II B introduced and effective for Second Year from the Academic Year 2023-24, and progressively thereafter, represents a minor revision of Scheme II. Specifically, it includes a new Activity-based Learning (ABL) course on Interdisciplinary Informatics, to expose learners to opportunities and effectiveness by integrating informatics with diverse disciplines such as biotechnology, healthcare, agriculture, nanotechnology, earth sciences, and more. This SAT course aims to promote interdisciplinary Research and Development, which has been one of the major goals of the institute. The Scheme II B fosters a comprehensive understanding of both theoretical and practical aspects, which equips students with the skills necessary to excel in the ever-evolving technological landscape.

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. Vivek Sunnapwar
Principal and Chairman - Academic Council

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 B of Second Year and Third 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-B from SEM-II to SEM-VIII of B.Tech AI-DS. Now in the year 2024-25 this internship policy will be applicable to TY AI-DS.

In this course, the students may have career opportunities in healthcare, business, e-Commerce, social networking companies, biotechnology, genetics and other areas. 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)	10	Prof. Sejal Shah	Member
2	Dr. Michel Mistry	Experts from outside parent university nominated by Academic council	11	Prof. G. R. Phadke	Member
3	Dr. Sanjay Shitole		12	Prof. Sarika Mane	Member
4	Dr. Madhav Chandane	One expert to be nominated by the Vice-Chancellor	13	Prof. Sheetal Jagtap	Member
5	Mr. Akhil Hada	One Representative from Industry/Corporate Sector/ Allied area relating to Placement	14	Prof. Devanand Bathe	Member
6	Dr. Vaishali Wadhe	Member	15	Prof. Ganesh Wadmare	Member
7	Prof. Pankaj Deshmukh	Member	16	Dr. Radhika Kotecha	Other member
8	Prof. Medha Asurlekar	Member	17	Dr. Namrata Gharat	Other member
9	Prof. Vidya Sagvekar	Member	18	Dr. Hariram Chavan	Other Member

Dr. Milind Nemade
HoD and Chairman, Board of Studies

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

Semester - VII-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 Learning	3.1 Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders.	CO3	03	07

	3.2 Denoising Autoencoders, Sparse Autoencoders, and 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 Extracting relationships/relations, Latent semantic analysis		02	
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 log spectrum		02	

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 & Public Key Cryptography	2.1 Data Encryption Standard-Block cipher principles-block cipher modes of operation, Advanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm	CO2	04	08
	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 (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
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. Arjun Panesar, "Machine Learning and AI for Healthcare" Big Data for Improved Health Outcomes, apress publication. 2.Arvin Agah, "Medical applications of Artificial Systems", CRC Press
Reference Books	1.Erik R. Ranschaert Sergey Morozov Paul R. Algra, "Artificial Intelligence in medical Imaging- Opportunities, Applications and Risks", Springer 2.Sergio Consoli, Diego Reforgiato Recupero, Milan Petković,"Data Science for Healthcare-Methodologies and Applications", Springer 3.Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp, Gia Nhu Nguyen, "Emerging technologies for health and medicine", Wiley. 4.Ton J. Cleophas, Aeilko H. Zwinderman, "Machine Learning in Medicine- Complete Overview", Springer
Useful Links:	1.https://www.coursera.org/learn/introduction-tensorflow?specialization=tensorflow-in-practice
	2.https://www.coursera.org/learn/convolutional-neural-networks-tensorflow ?specialization=tensorflow-in-practice
	3.https://datarade.ai/data-categories/electronic-health-record-ehr-data
	4.https://www.cms.gov/Medicare/E-Health/EHealthRecords
	5.https://www.coursera.org/learn/tensorflow-sequences-time-series-and-prediction?specialization=tensorflow-in-practice
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, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and Techniques		02	
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 sequencing, Gene prediction and counting	CO6	03	08
	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, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process		04	
3. Product Data Management (PDM)	3.1 Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	CO3	05	05
4.Virtual Product Development Tools	4.1 For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques.	CO4	03	05
	4.2 Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies		02	
5. Integration of Environmental Aspects in Product Design	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 Availability	5.1 System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics.	CO5	03	05
	5.2 Parts standardization and Interchange ability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.		02	
6. Failure Mode, Effects and Criticality Analysis	6.1 Failure mode effects analysis, severity/criticality analysis, FMECA examples.	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 Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**
Books:				
Text Books	1. K. Rainer, Brad Prince, Management Information Systems, Wiley. 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm10th Ed., Prentice Hall.			
Reference Books	1. S. Jawadekar's Management Information Systems: published by McGraw-Hill Education. 2. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall.			
Useful Links:	1.https://www.nptel.ac.in/			
	2.https://www.coursera.org/			
Continuous Assessment (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 Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	42

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	1. G. Box, J Hunter and W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, Wiley. 2. A. Dean, and D. Voss, Design and Analysis of Experiments, Springer. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.
Useful Links:	1. https://nptel.ac.in/courses/110/105/110105087/
	2.https://www.udemy.com/course/design-of-experiments-i/
Continuous Assessment (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 project planning and Sequencing models	4.1 Project Management: Phases of project management, Network construction, Critical Path Method (CPM) and Process Evaluation & Review Techniques (PERT). (Exclude Cost analysis, crashing, resource scheduling and updating)	CO4	04	07
	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 Law	CO4	08	08

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.		02	
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 (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
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, soft starters, variable speed drives.	CO3	10	10
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
I.	**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)** 1. Design and implement a CNN model for digit recognition application. 2. Design and implement a CNN model for image classification.	LO4	02

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
I.	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
I.	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 7. Laboratory.

Lab No.	Experiment Title	LO mapped	Hrs/Lab
I.	Lab Prerequisite	--	02
1	Identify the use of Sensing & actuation in Industrial IoT Application.	LO1, LO5, LO6	02
2	Identify the use of Communication and Networking in Industrial IoT Application.		02
3	Apply 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
I.	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, etc.	LO5	02

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
I.	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):	1. The Project work enables the students, 2. To develop the required skills and knowledge about research. 3. To analyze a specific problem or issue by using the latest technologies with a multidisciplinary approach. 4. To demonstrate proficiency in the design of a research project, application with appropriate research methods. 5. 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

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

ACADEMIC YEAR 2022-23

Honours Degree Programs in Engineering and Technology Manual

Introduction:

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

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

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

It is also made very clear by AICTE that areas in which Honours Degree may be offered are numerous. It is up to the Universities with the help of their Academic Board/Council to decide whether Honours. Degree is to be offered or not in any particular area, which is not mentioned above. The criteria for "Honours. Degree will cumulatively require additional 18 to 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 169 credits of 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.Vivek Sunnapwar
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 **Self-learning Topics:** Study different consensus	CO2	12	12

	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 3. "Blockchain revolution: how the technology behind bitcoin is changing			

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<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>
<tr><td>2.</td><td>Class Test 2</td><td>30 marks</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)
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	CO2, CO3, CO6	12	12

	blockchain, e-voting applications using smart contract, Dapp Architecture. Types of test-networks used in ethereum, Transferring Ethers Using MetaMask, Mist Wallet, Ethereum Frameworks, Case study of Ganache for ethereum blockchain. Deploying e-voting applications on Ganache framework. Ethereum 2., Concept of Beacon chain, POS (Proof of Stake), 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:				
1. Blockchain by Example, BellajBadr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.				

<table>
<tr><td colspan="2">2. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.
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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 Wallet), setting up development environment, use	CO3	10	10

	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/ https://docs.soliditylang.org/en/v0.7.4/				

<table>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –<table><tr><td>1.</td><td>Test 1</td><td>30 marks</td></tr><tr><td>2.</td><td>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 Test 2 is 30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus 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 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	3.1 DeFi Components: Blockchain Cryptocurrency	CO3	10	10

and Business Models	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.			
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, Borrowing, Liquidation, Price Feeds, Comptroller,	CO5	10	10

	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 13. https://consensys.net/blockchain-use-cases/decentralized-finance/ 14. https://tokenlon.zendesk.com/hc/en-us/articles/360041114431-DeFi-			

<table>
<tr><td></td><td>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/
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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 Cryptography	2.1 Private-key encryption, public key-encryption, key Exchange Protocols, Cryptographic Hash Functions & applications, steganography, biometric authentication, lightweight	CO3	08	08

	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 Hill, 2013 3.TCP/IP Protocol Suite -- B. A. Forouzan, 4th Edition, Tata Mc Graw Hill,			

<table>
<tr><td></td><td>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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Internal Assessment(IA):
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</table>

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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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, ISO 27001, OWASP, OSSTMM.	CO2	8	8

	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
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)
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 Database for SQL Injection **Tools:** BSQL Hacker	LO4	9	9

	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 **Self-learning Topics: Implement the countermeasures to the attacks using open-source**	CO2	09	09

	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). 4. The Security Development Lifecycle by Michael Howard Microsoft Press US;			

<table>
<tr><td></td><td>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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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)
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 VR environment	CO2	07	07

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	CO2	07	07

	and Tracking; Outdoor Tracking **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.			
Online References:				

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www.coursera.org</td></tr>
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</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 –

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)
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 software /Unity software	LO3	2

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 **Self-learning Topics:**Understanding the role of AI in	CO1	08	08

	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):
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<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 real-time application	CO1, CO2	08	08

	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	**5.1 Interface Electronic Circuits** Introduction, Signal Conditioners, Sensor	CO1, CO2,	08	08

Circuits	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	CO5		
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 6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127,			

<table>
<tr><td></td><td>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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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)
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:				
	1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things.			

<table>
<tr><td></td><td>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):
Marks will be allotted as per designed rubrics.</td></tr>
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</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, 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	CO6	10	10

<table>
<tr><td></td><td>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.</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Total hours</td><td>52</td></tr>
<tr><td colspan="5">Books:</td></tr>
<tr><td>Text Books</td><td colspan="4">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.</td></tr>
<tr><td colspan="5">Reference Books:</td></tr>
<tr><td></td><td colspan="4">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.</td></tr>
<tr><td colspan="5">Online References:</td></tr>
<tr><td colspan="5">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/</td></tr>
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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="5">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)
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,	CO1	06	06

	Communicating with 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	CO5	08	08

	governmental bodies, IoT security best practices, Holistic security. **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).			

<table>
<tr><td></td><td>2. “Industrial Internet of Things and Communications at the Edge”, by Tony Paine, CEO, Kepware Technologies.
3. “Architectural Design Principles For Industrial Internet of Things”, Hasan Derhamy, Luleå University of Technology, Graphic Production.</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>
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SOMAIYA
VIDYAVIHAR

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

Autonomy Syllabus Scheme-II B

Internship Manual

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

(with effect from AY 2022-2023)

SOMAIYA
VIDYAVIHAR

KJ Somaiya Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Academic Year 2022-23

INTERNSHIP MANUAL

AICTE-INTERNSHIP POLICY STATES THAT:

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

OBJECTIVES & EXPECTED OUTCOMES:

Following are the intended objectives of internship training:

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

BENEFITS OF INTERNSHIP:

Benefits to Students:

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

Benefits to the Institute:

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

Benefits to the Industry:

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

STANDARD OPERATING PROCEDURE (SOP) FOR INTERNSHIP:

The general procedure for arranging internship is given below:

Step 1: Request Letter/ Email from the Dean, IIIC/ HOD and/or IIIC members of resp. depts. of the college shall be send to industry to allot various slots of 4-6 weeks during summer vacation as internship periods for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the training. (Sample attached)

Step 2: Industry will confirm the training slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the training themselves the confirmation letter will be submitted by the students to Dean, IIIC/ HOD and/or IIIC members of resp. depts. Based on the number

of slots agreed to by the Industry, Dean, IIIC/ HOD and/or IIIC members will allocate the students to the Industry. In addition, the internship slots may be conveyed through Telephonic or Written Communication (by Fax, Email, etc.) by the Dean or other members of the IIIC who are particularly looking after the Internship of the students.

Step 3: Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.

Step 4: Students undergo industrial training at the concerned Industry / Organization. In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted to Department IIIC Member with the consent of Industry persons/ Trainers.

Step 5: Students will submit a training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully certificate will be issued by Departments, Sections, Professional bodies, Cells, Committees in collaboration with IIIC cell.

Step 8: In addition to Step 1 to Step 7, Departments, Sections, Professional bodies, Cells, Committees of KJSIT may organize in house / Industry collaborated internship of 1/2/3/4 weeks duration for students with the same procedure as stated above, with in Principal approval from Principal.

GUIDELINES FOR THE STUDENTS:

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

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

SOP FOR INTERNSHIP REPORT:

STUDENT'S DIARY/ DAILY LOG:

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

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

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

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

will be evaluated on the basis of following criteria:

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

EVALUATION BY INDUSTRY:

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

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

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

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

EXAMINATION AND EVALUATION FOR AWARD OF INTERNSHIP COMPLETION CERTIFICATE

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

COMPLIANCES FOR INTERNSHIP COMPLETION CERTIFICATION :

1. Completion of 1 internship module will reflect addition of 2 credits so total credits earned will be 2 credits x 7 internship modules = 14 credits across Semester 2 to Semester 8.
2. Mandatory to complete minimum 5 internship modules across Semester 2 to Semester 8 for award of Internship Certificate.
3. On completion of 5 Internship modules credit earned = 10
4. On completion of 6 Internship modules credit earned = 12
5. On completion of 7 Internship modules credit earned =14
6. No credits will be awarded AND / OR No Internship Completion Certificate will be issued for less than 10 credits earned throughout the degree.
7. Internship evaluation will be as per Internship module assessment process defined in Internship Manual course contents, for every individual student across Semester 2 to Semester 8.
8. Departments will submit Internship completion report and credits assigned sheet of every student signed by Department internship coordinator, Class teachers and Head of the Department to Exam Cell

during 8th Semester ESE time duration of respective batch to generate the internship completion certificate along with the regular grade sheet.

9. No further queries will be entertained if not meeting above compliances and not following the internship modules designed under the guidelines of AICTE Internship policy.

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

Semester- II-VIII

Note:

As per guidelines and suggestions by AICTE-Internship policy

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

i. Internship Modules & Contents Across Semester 2 to Semester 8

FY: (Sem II)			
Internship Code	**Course Name**	**Hours/Duration**	**Credits**
INT21	**Internship-I**	80-120 hrs (2-3 Weeks) Winter Vacation **After SEM-I & during SEM-II of FY**	**02**
Prerequisite:	**Fundamental knowledge of Engineering and Technology**		
Internship Objectives:	1. To get acquainted with institute level technical activities and initiatives. 2. To participate in department/Institute level technical learning and training initiatives through Professional cells/clubs/committees/bodies.		
Internship Outcomes:	**Upon completion of the course, students will be able to:** 1. Get practical experience of institutional setting. 2. Meet and interact with new people and learn networking, innovation and entrepreneurial skills. 3. Promote academic, professional and/or personal development.		
Activity- Inter/Intra Institutional Activities	**Supporting Activities to be completed under Internship**		
	• Attending Industry Workshops organised by departments		
	• Working in consultancy or research project initiated by department		
	• Technical festival (participation)		
	• Working in IIC Cell, Entrepreneurship Cell, NISP, IPR cell and/or any other technical professional body/cell/committee/club of the institute		
	• Activities related to Incubation or Innovation		
	• Learning in departmental Labs, Tinkering Lab		

Term Work Assessment: **Duration to be considered for assessment:** Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)	
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. For department Lab learning, FY HOD will circulate Term End report to all faculty mentors with list of student's undergone innovative learning, verified by department academic coordinator. 6. Students will submit evaluation sheet by attaching Xerox copies of Internship & other participation certificates & faculty mentor will verify the Xerox from original copy for assessment purpose.
TW Marks (25) & Certificate :	**Assessment & evaluation based on rubrics :** Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks **&** Internship and Activity Completion/Participation Certificates and Evaluating Report

<table>
<tr><td colspan="4">SY (Sem III)</td></tr>
<tr><td>Internship Code</td><td>Internship Name</td><td>Hours/Duration</td><td>Credits</td></tr>
<tr><td>INT32</td><td>Internship-II</td><td>80-120 hrs (2 -3 Weeks)
Summer Vacation After SEM-II & during SEM-III of SY</td><td>02</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Prerequisite:</td><td colspan="3">Fundamental knowledge of program specific tools, instruments, devices and programming languages etc.</td></tr>
<tr><td>Internship Objectives:</td><td colspan="3">1. To get the exposure to Innovation/IPR/ Entrepreneurship/ Startup initiatives
2. To participate & experience Incubation, Innovation & Business development culture</td></tr>
<tr><td>Internship Outcomes:</td><td colspan="3">Upon completion of the course, students will be able to:
1. Learn innovation and entrepreneurial skills to supplement engineering knowledge.
2. Integrate theoretical aspects learned in classes with the practical world
3. Develop an innovative idea to be processed as a start-up</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="3">Activity-
Innovation/
IPR/
Entrepreneurship</td><td colspan="3">Supporting Activities to be completed under Internship</td></tr>
<tr><td colspan="3">1. Participation in Innovation related competitions e.g. Hackathons etc.
2. Awareness & knowledge sessions about Development of new product/Business Plan/Registration of Start-up</td></tr>
<tr><td colspan="3">3. Participation in all activities of IIC Cell, E-Cell, NISP, IPR Cell like
● IPR workshop/
● Leadership Talk
● Idea Design
● Innovation/Business Competition</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Term Work Assessment:
Duration to be considered for assessment:
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)</td></tr>
<tr><td>Guidelines:</td><td colspan="3">1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year.
2. Students will submit the participation certificate of the activities to the faculty mentors.
3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare.
4. HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities.
5. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data
6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.</td></tr>
<tr><td>TW Marks (25) & Certificate :</td><td colspan="3">Assessment & evaluation based on rubrics:
Hours Spent for Internship: max 20 marks
Achievement/Recognition: max 05 marks
& Internship and Activity Completion /Participation Certificates and Evaluating Report</td></tr>
</table>

SY (Sem IV)			
Internship Code	**Internship Name**	**Hours/Duration**	**Credits**
INT43	**Internship-III**	80-120 hrs (2 - 3 Weeks) Winter Vacation After **SEM-III & during SEM-IV of SY**	**02**
Prerequisite:	**Skill sets of engineering and technology specific tools, instruments, devices and programming languages etc.**		
Internship Objectives:	1. To get the industrial environment expose for creating competent professionals for the industry. 2. To understand the psychology of the workers and their habits, attitudes and approach to problem solving.		
Internship Outcomes:	**Upon completion of the course, students will be able to:** 1. Get an expose to work with the future employers. 2. Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control in product development lifecycle.		
Activity- Internship	**Supporting Activities to be completed under Internship**		
	Internships in the field of:		
	● Industries		
	● Government Sector		
	● Non-governmental Organization (NGO)		
	● MSMEs		
	● Rural Internship		
Term Work Assessment: **Duration to be considered for assessment:** Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)			
Guidelines:	1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2. Students will submit the participation certificate of the activities to the faculty mentors. 3. For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4. HOD will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data 6. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.		
TW Marks (25) & Certificate :	**Assessment & evaluation based on rubrics:** Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks **&** Internship and Activity Completion/Participation Certificates and Evaluating Report.		

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

TY (Sem VI)			
Internship Code	**Internship Name**	**Hours/Duration**	**Credits**
INT65	**Internship-V**	80-160 hrs (2-4 Weeks) Winter Vacation **After SEM-V & during SEM-VI of TY**	**02**

Prerequisite:	**List of probable industries and organizations offering internships on live projects. Awareness about probable solutions for identified problem areas in rural India**
Internship Objectives:	1. To understand the social, economic and administrative considerations of working environment in industries, government, NGOs and private organizations. 2. Learn to apply the Technical knowledge for solving real life problems.
Internship Outcomes:	**Upon completion of the course, students will be able to:** 1. Get an opportunity to get hired by the Industry/ organization. 2. Decide if working in the industry or set up a start-up would be best career option to pursue.

Activity- Rural Internships & Internships	**Supporting Activities to be completed under Internship**
	1. Long Term Goal under Rural Development Internships or
	2. Mandatory internship for developing project with:
	● Industries
	● Government Sector
	● Non-governmental Organization (NGO)
	● MSMEs

Term Work Assessment:
Duration to be considered for assessment:
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)

Guidelines:	1.Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year. 2.Students will submit the participation certificate of the activities to the faculty mentors. 3.For working in cells related activities, Cell coordinator will submit list of actively involved & participated students of each department, semester wise to all department HODs, verified and authenticated by Dean Students Welfare. 4.HODs will circulate the student list to all faculty mentors for consideration of Hours spends under mentioned department activities. 5.Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data 6.Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.
TW Marks (25) & Certificate :	**Assessment & evaluation based on rubrics:** Hours Spent for Internship: max 20 marks Achievement/Recognition: max 05 marks **&** Internship and Activity Completion/Participation Certificates and Evaluating Report

<table>
<tr><th colspan="4">LY (Sem VII)</th></tr>
<tr><th>Internship Code</th><th>Internship Name</th><th>Hours/Duration</th><th>Credits</th></tr>
<tr><td>INT76</td><td>Internship-VI</td><td>80-160 hrs (2-4 Weeks) Summer Vacation of TY and during SEM-VII of LY</td><td>02</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Prerequisite:</td><td colspan="3">In depth knowledge about societal/research/innovation/entrepreneurial problems and appropriate applicable solutions available through use of technology.</td></tr>
<tr><td>Internship Objectives:</td><td colspan="3">1. To gain the experience in preparing and writing Technical documentation/ reports for product/projects.
2. To Identify and analyse the societal/research/entrepreneurial problem in detail to define its scope with problem specific data.
3. To develop clarity of presentation based on communication, teamwork and leadership skills.</td></tr>
<tr><td>Internship Outcomes:</td><td colspan="3">Upon completion of the course, students will be able to:
1. Apply the engineering and technical knowledge for problem identification, analysis, design and developing solutions.
2. Present and demonstrate the real time problem solution across national/international project competitions and conference.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="5">Activity-
PBL-Major Project A-Work/ Seminars</td><td colspan="3">Supporting Activities to be completed under Internship</td></tr>
<tr><td colspan="3">For Sem VII PBL Course-Major Project-A, selected topic:
1.Review literature through reference papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old.</td></tr>
<tr><td colspan="3">2.Participate in multiple Project Competitions presenting the Project A solution</td></tr>
<tr><td colspan="3">3.Participation in International Conferences presenting the literature review and/or hypothesis for innovative solution.</td></tr>
<tr><td colspan="3">4.Participation at institute annual International Conference on Advances in Science and Technology-ICAST & other Conferences /Journals.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Term Work Assessment:
Duration to be considered for assessment:
Week Ends/ Semester Break/End of Semester (After ESE & Before Next Term Start)</td></tr>
<tr><td>Guidelines:</td><td colspan="3">1. Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year.
2. Students will submit the participation certificate of the activities to the faculty mentors.
3. Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data
4. Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.</td></tr>
<tr><td>TW Marks (25) & Certificate :</td><td colspan="3">Assessment & evaluation based on rubrics:
Hours Spent for Internship: max 20 marks
Achievement/Recognition: max 05 marks
& Certificate Based on :
1.Project Competition certificate,
2. Participation in Conferences/Publications and/or proof of ICAST participation & presentation.</td></tr>
</table>

<table>
<tr><td colspan="4">LY (Sem VIII)</td></tr>
<tr><td>Internship Code</td><td>Internship Name</td><td>Hours/Duration</td><td>Credits</td></tr>
<tr><td>INT87</td><td>Internship-VII</td><td>80-160 hrs (2-4 Weeks) Winter Vacation of Sem VII and During SEM-VIII of LY</td><td>02</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Prerequisite:</td><td colspan="3">In depth knowledge about filling IPR/ copywriting a product/solution.</td></tr>
<tr><td>Internship Objectives:</td><td colspan="3">1. To gain the knowledge of filling patent and Copy write.
2. Presenting technology solutions across worldwide problems through competitions and publications.</td></tr>
<tr><td>Internship Outcomes:</td><td colspan="3">Upon completion of the course, students will be able to:
1. National and international recognition through IPR and/or copy writes and paper publications.
2. Convert problem solution as a business plan for entrepreneurial product.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="4">Activity-
PBL Major Project B Work/Conference Presentation</td><td colspan="3">Supporting Activities to be completed under Internship</td></tr>
<tr><td colspan="3">For Sem VIII PBL Course-Major Project-B, selected topic:
1. File for Project solution Copyright and/or
File for Project topic IRP/Patent</td></tr>
<tr><td colspan="3">2. Participate at Institute Annual Project Competition-INTECH</td></tr>
<tr><td colspan="3">3. Publish the project solution at reputed International Journals, preference should be given to UGC care list and/or SCI indexed journals.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Term Work Assessment:
Duration to be considered for assessment:
Week Ends and during Semester</td></tr>
<tr><td>Guidelines:</td><td colspan="3">1.Batch wise Faculty Supervisor who is the proctor (mentor) of the batch will be allotted as in-charge for the course, at start of the Academic year.
2.Students will submit the participation certificate of the activities to the faculty mentors.
3.Department IIIC Cell coordinator will collect, maintain each student proofs/reports from all faculty mentors, department internship analysis report will be prepared & submitted to Dean, IIIC for AICTE-CII survey data
4.Students will submit evaluation sheet by attaching Xerox copies of all participation/ IPR/ Copyright certificates & faculty mentor will verify it with original copies, for assessment purpose.</td></tr>
<tr><td>TW Marks (25) & Certificate :</td><td colspan="3">Assessment & evaluation based on rubrics:
Hours Spent for Internship: max 20 marks
Achievement/Recognition: max 05 marks
& Certificate Based on :
1.Project Copyright/ Project IRP
2. Project Competition certificate (INTECH)
3.International Journal Publication proof</td></tr>
</table>

Dr. Vivek Sunnapwar
Principal