SOMAIYA
VIDYAVIHAR

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

Item No: 4.A.4
A.C. Date: 05/07/2024

Autonomy Syllabus Scheme-II B

Bachelor of Technology
in
Artificial Intelligence and Data Science
(AI-DS)

Third Year

(Semester VI)

Including

Honors Degree Program
&
Internship Policy Manual

With effect from

A.Y. 2024-25

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

Program Structure Template for Third Year UG Technology (AI-DS)

Semester-VI- Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH –	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
AIC601	Artificial Neural Network	3–0–0	03	3–0–0	03	PC
AIC602	Machine Learning	3–0–0	03	3–0–0	03	PC
AIC603	Data Analytics and Visualization	3–0–0	03	3–0–0	03	PC
AIC604	Big Data Analytics	3–0–0	03	3–0–0	03	PC
AIDLC605X	Department Level Elective-2	3–0–0	03	3–0–0	03	DLE
AIL601	Artificial Neural Network Lab	0–2–0	02	0–1–0	01	PC
AIL602	Machine Learning Lab	0–2–0	02	0–1–0	01	PC
AIL603	Data Analytics and Visualization Lab	0–2–0	02	0–1–0	01	PC
AIDLL605X	Department Level Elective-2 Lab	0–2–0	02	0–1–0	01	DLE
AIPR64	Project Based Learning - Minor Project Lab-2	0–2–0	02	0–1–0	01	PBL
AIXS69	Skill Based Learning-IX (R Programming)	0–2*–0	02	0–1–0	01	SAT
AIXT610	Technology Based Learning-X	0–2*–0	02	0–1–0	01	SAT
INT 65	Internship-5	2-4 Weeks		--	#02	INT
Total		**15–14–0**	**29**	**15-7-0**	**22**	--

*SAT Hours are under Practical head but can be taken as Theory or Practical or both as per the need.

Credits not added in the total credits of semester.

PBL - Minor Project Lab 1 and 2:

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load: 1 hour per week per four groups.

Semester-VI-Examination Scheme

Course Code	Course Name	Examination Scheme Marks									
		CA				ESE	TW	O	P	P & O	Total
		T-1	T-2	Average (T1 & T2)	IA						
AIC601	Artificial Neural Network	30	30	30	10	60	--	--	--	--	100
AIC602	Machine Learning	30	30	30	10	60	--	--	--	--	100
AIC603	Data Analytics and Visualization	30	30	30	10	60	--	--	--	--	100
AIC604	Big Data Analytics	30	30	30	10	60	--	--	--	--	100
AIDLC605X	Department Level Elective-2	30	30	30	10	60	--	--	--	--	100
AIL601	Artificial Neural Network Lab	--	--	--	--	--	25	--	--	25	50
AIL602	Machine Learning Lab	--	--	--	--	--	25	-	--	25	50
AIL603	Data Analytics and Visualization Lab	--	--	--	--	--	25	--	--	25	50
AIDLL605X	Department Level Elective-2 Lab	--	--	--	--	--	25	--	--	--	25
AIPR64	Project Based Learning - Minor Project Lab-2	--	--	--	--	--	25	--	25	--	50
AIXS69	Skill Based Learning-IX (R Programming)	--	--	--	--	--	25	--	--	--	25
AIXT610	Technology Based Learning-X	--	--	--	--	--	25	--	--	--	25
INT 65	Internship-5	--	--	--	--	--	--	--	--	--	--
Total		--	--	**150**	**50**	**300**	**175**	--	**25**	**75**	**775**

Department Level Elective-2			
Group A: Computer Networks and Programming	**Group B: Applied Artificial Intelligence**	**Group C: Embedded System, Analytics and System Security**	**Group D: Bioinformatics**
AIDLC6051	AIDLC6052	AIDLC6053	AIDLC6054
AI in E-Commerce	AI in Agriculture	Internet of Things	Bioinformatics Data Management
AIDLL6051	AIDLL6052	AIDLL6053	AIDLL6054
AI in E-Commerce Lab	AI in Agriculture Lab	Internet of Things Lab	Bioinformatics Data Management Lab

Details of AI-DS Courses Common with Other Departments

Semester	Course Name	B.Tech Programs		
		COMP	IT	EXTC
III	Applications of Mathematics in Engineering-I	√	√	-
III	Discrete Structure and Graph Theory	√	-	-
III	Digital Logic and Computer Architecture	√	-	-
III	Computer Graphics	√	-	-
III	Skill Based Learning-IV	√	√	√
IV	Applications of Mathematics in Engineering-II	√	√	-
IV	Analysis of Algorithms	√	-	-
IV	Database Management Systems	√	-	-
IV	Operating Systems	√	-	-
IV	Skill Based Learning-V	√	-	-
IV	Skill Based Learning-VI	√	√	√
V	Artificial Intelligence	√	-	-
V	Business Communication and Ethics	√	√	√

Course Code	Course Name	Credits (TH+P+TUT)
AIC601	Artificial Neural Network	(3 + 0 + 0)

Prerequisite:	1. Knowledge of linear algebra, multivariate calculus, and probability theory 2. Knowledge of a programming language (PYTHON/C/C ++recommended)
Course Objectives:	1. To study basics of biological Neural Network 2. To study the architecture, learning algorithm of ANN 3. To know the issues of various feed forward and feedback ANN 4. To know application of ANN
Course Outcomes:	After successful completion of the course students will be able to: 1. Explain the biological Neural Network and its architecture. 2. Evaluate different neural networks of various architectures both feed forward and feed backward and perform the training of neural networks using various learning rules. 3. Analyze single layer perceptron and multilayer perceptron. 4. Perform the testing of neural networks and do the perform analysis of these networks for various pattern recognition applications. 5. Interpret the concepts of Associative memory networks 6. Apply the suitable neural network algorithms for real time application.

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 Human brain, Biological neurons, Neural network viewed as directed graphs, Types of activation function	CO1	02	06
	1.2 Network architectures, Knowledge representation. Linear & non-linear separable classes & Pattern classes	CO1	03	
	Applications and scope of Neural Networks	CO1	01	
2. Fundamental concepts of ANN	2.1 Models of ANN, Feed forward and feedback network,	CO2	03	08
	2.2 Learning Rules: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule,	CO2	03	
	2.3 Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner Take-All Learning Rule	CO2	03	
3. Single layer perceptron and multilayer perceptron	3.1 Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters,	CO3	02	08
	3.2 Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques,	CO3	02	
	3.3 Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment	CO3	02	
	3.4 Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection	CO3	02	

4. Self organizing Maps and Support Vector Machine	4.1 Self-Organizing Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map,	CO4	02	06
	4.2 SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification	CO4	02	
	4.3 Support Vector Machines, SVM application to Image Classification,	CO4	02	
5. Associative memory network	5.1 Introduction, Training algorithms for Pattern Association	CO5	03	07
	5.2 Auto-associative Memory Network, Hetero-associative Memory Network,	CO5	02	
	5.3 Bidirectional Associative Memory, Discrete hopfield network	CO5	02	
6. Case study on ANN	6.1 Handwritten Digit Recognition, Process Identification, Expert Systems for Low Back Pain Diagnosis, (list is not limited to above mentioned topics, case study on any recent topics with due approval will be considered)	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Jacek M. Zurada, "Introduction to Artificial Neural Systems," Jaico Publishing House. 2. Ivan N., Danilo H. , "Artificial Neural Networks- A practical course", 3rd ed. Springer International Publishing, Switzerland, 2017. 3. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing," 2nd ed. Wiley India.
Reference Books	1.Simon Haykin, "Neural Networks A Comprehensive Foundation", Pearson Education. 2.Hugh Cartwright, "Artificial Neural Networks", 2nd edition, Humana Press,2015. 3.B. Yegnanarayana, "Artificial Neural Networks", Prentice Hall of India Pvt. Ltd. 2005.

Useful Links:

1. https://nptel.ac.in/courses/127/105/127105006/
2. https://nptel.ac.in/courses/117/105/117105084/
3. https://www.coursera.org/learn/neural-networks-deep-learning

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
- Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

End Semester Examination (ESE):

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

Lab Code	Lab Name	Credits (P+TUT)
AIL601	**Artificial Neural Network lab**	**(1+0)**

Lab Prerequisite:	Knowledge of a programming language (PYTHON/C/C ++ recommended)
Lab Objectives:	1. To study different activation functions. 2. To implement a learning algorithm. 3. To implement different memory network algorithms.
Lab Outcomes (LOs):	After successful completion of the course students will be able to: 1. Implement different activation functions used in ANN. 2. Implement different Neuron models. 3. Implement Single layer and multilayer perceptron network 4. Implement a self organized feature map network. 5. Demonstrate use of Associative Memory Network to calculate weight for given pattern. 6. Case study on ANN.

Lab. No.	Experiment Title	LO mapped	Hrs/Lab
1	Implement different Activation functions.	LO1	02
2	Implement McCulloch Pitts Neuron Model.	LO2	02
3	Implement Hebbian learning.	LO2	02
4	Implement Single layer perceptron neural network.	LO3	02
5	Implement Multi-layer perceptron neural network.	LO3	02
6	Implement Error Back propagation neural network.	LO3	02
7	Implement Kohonen Self-organizing Feature Maps.	LO4	02
8	Implement Auto Associative memory network.	LO5	02
9	Implement Hetero Associative memory network.	LO5	02
10	Case Study on ANN	LO6	-

Virtual Lab Links:

1. http://vlabs.iitkgp.ernet.in/scte/index.html#
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/exp1/index.php

Term work:

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

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

Course Code	Course Name	Credits (TH+P+TUT)
AIC602	Machine Learning	(3+0+0)

Prerequisite:	1. Linear algebra, multivariate calculus and probability theory 2. Knowledge of a Python programming language 3. Information Theory and Coding
Course Objectives:	1. Learn Machine Learning concept. 2. Understand mathematical concepts required for Machine learning algorithms 3. Understand various Regression techniques. 4. Understand various Classification and Clustering techniques 5. Introduce Optimization techniques. 6. Learn dimensionality reduction techniques.
Course Outcomes:	After successful completion of the course students will be able to: 1. Explain Machine Learning concept used in real world scenarios. 2. Apply mathematical foundation of machine learning for solving problems. 3. Apply regression techniques for solving machine learning problems. 4. Apply different classification and clustering techniques for solving machine learning problems. 5. Apply different optimization techniques in machine learning applications 6. Analyse dimensionality reduction techniques.

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 Machine Learning	1.1 What is Machine Learning? Why Machine Learning? Motivations for Machine Learning, Signal Processing Vs. Machine Learning, How to choose right algorithm? Steps involved in developing a Machine Learning application, Applications of Machine Learning, Issues of Machine Learning,	CO1	03	08
	1.2. Types of Machine Learning, Examples of Supervised, Unsupervised, Reinforcement Learning, Types of Supervised Learning- Regression and Classification, Applications of Supervised Learning, Clustering and Prediction, Testing and Validation dataset, cross validation, overfitting and underfitting of model, Hypothesis in Machine Learning.		03	
	1.3 Performance Measures: Measuring Quality of Model-Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE		02	

2.Mathematics for Machine Learning	Linear Algebra: Systems of Linear Equations, Analytic Geometry: Norms, Inner Products, Lengths and distances between vectors, Orthogonal Vectors, Orthogonal projections Matrix-Decomposition: Determinant and Trace, Eigenvalues and Eigenvectors, Diagonalization	CO2	05	05
3.Learning with Regression	3.1The Least Square Method, Multiple Linear Regression, validation of regression methods Logistic Regression: Logit function	CO3	06	06
	3.2Constructing Decision Tree: Using Gini Index and ID3, Classification and Regression Trees (CART),			
4.Learning with Classification and Clustering	4.1Rule based classification, Binary Classification, Performance parameters, Naïve Bay's Classifier, Classification by Bayesian Belief Networks and Hidden Markov Models, Support Vector Machine	CO4	06	10
	4.2Clustering: K means Clustering, Hierarchical Clustering: Agglomerative clustering, Radial Basis Functions, Case Studies: Credit card fraud Detection and Healthcare		04	
5.Introduction to Optimization Techniques	Derivative based optimization- Steepest Descent, Newton method. Derivative free optimization- Random Search, Down Hill Simplex	CO5	06	06
6.Dimensionality Reduction:	Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis, Singular Value Decomposition, Image Processing applications of SVD	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:	
Text Books	1. S. Sridhar and M. Vijayalakshmi, "Machine Learning", Oxford University Press 2021 2. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press 2020. 3. Peter Harrington "Machine Learning in Action", DreamTech Press.
Reference Books	1. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition-2013 2. C. M. Bishop: Pattern Recognition and Machine Learning, Springer 1st Edition-2013. 3. Tom M. Mitchell, "Machine Learning", McGraw Hill. 4. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", Cambridge University Press.
Useful Links:	
1.NPTEL	
2. https://www.learndatasci.com/out/coursera-machine-learning/	
3. https://www.learndatasci.com/out/google-machine-learning-crash-course/	
Continuous Assessment:	
• Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.	

- Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

End Semester Examination (ESE):

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

Lab Code	Lab Name	Credits (P+TUT)
AIL602	Machine Learning Lab	(1+0)

Lab Prerequisite:	1. Python and C programming Language
Lab Objectives:	1. To introduce different machine learning tools 2. To Acquire advanced Data Analysis skill. 3. To develop ML solutions for various real life problems. 4.Understanding the nature of problems solved with Machine Learning
Lab Outcomes (LOs):	At end of successful completion of this course, student will be able to, 1. Explain different machine learning tools. 2. Apply Regression Methods. 3. Implement Classification and clustering methods. 4. Apply Optimization techniques 5. Apply the Dimensionality Reduction Techniques

Lab No.	Experiment Title	LO mapped	Hrs/Lab
I.	Lab prerequisite	---	02
1.	Study of Various ML tools Implementation of following algorithms for a given example data set-	LO1	02
2.	Data file manipulation, plotting and exploratory data analysis in Python	LO1	02
3.	Linear regression.	LO2	02
4.	Logistic regression.	LO2	02
5.	Decision tree.	LO2	02
6.	The Naïve Bayesian Classifier	LO3	02
7	Clustering using K means	LO3	02
8	Linear Discriminant Analysis	LO3	02
9.	Support Vector Machine	LO4	02
10.	Principal Component Analysis	LO5	02
11.	Optimization Technique	LO4	02
12.	Independent Component Analysis	LO5	02

Useful Lab Links:

1. https://www.learndatasci.com/out/edx-columbia-machine-learning/
2. https://www.learndatasci.com/out/oreilly-hands-machine-learning-scikit-learn-keras-and-ten sorflow-2nd-edition/
3. https://www.learndatasci.com/out/google-machine-learning-crash-course/

Term work:

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

Oral/Practical/P&O:

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

Course Code	Course Name	Credits (TH+P+TUT)
AIC603	**Data Analytics & Visualization**	**(3+0+0)**

Prerequisite:	1. Data Structure 2. Programming Language in Python and Java
Course Objectives:	1. To understand the techniques of Data analysis 2. To understand technological advancements of data visualization 3. To understand various data visualization techniques 4. To understand basics of D3.js
Course Outcomes:	At the end of the course, the students will be able to: 1. Understand the statistical learning with R Programming. 2. Analyse data with various data analysis techniques. 3. Design visualization of data with various techniques. 4. Implement data visualization with various programming techniques. 5. Implement data visualization using D3.js 6. Implement animation ad wrapping in data visualization

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.Data Wrangling	1.1Elements, Variables, and Data categorization Levels of Measurement, Data management and indexing.	CO1	01	04
	1.2Introduction to sources of data, Data collection and APIs, Exploring & fixing data, Homogenization Heterogenization, Missing data, Data transformation, Data Segmentation, Data clustering.		03	
2.Exploratory Data Analysis	2.1Introduction to Exploratory data analysis (EDA), Typical data formats, Population and samples, Types of EDA, Graphical/Non graphical methods	CO2	03	08
	2.2Statistical hypothesis generation and testing Chi-Square test, t-Test, Analysis of variance		02	
	2.3Introduction to statistical learning and R-Programming, Correlation analysis with R		03	
3.Data Visualization	3.1Introduction to Data Visualization Acquiring and Visualizing Data, Simultaneous acquisition and visualization, Applications of Data Visualization	CO3	02	14
	3.2Exploring the Visual Data Spectrum: Charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Exploring advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts, Infographics)		06	
	3.3Reading Data from Standard text files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data(Building a table, Using Semantic Table, 3.4Configuring the columns), Assuring Maximum		06	

	readability (Styling your table, Increasing readability, Adding dynamic Highlighting), Including computations, Using data tables library, relating data table to a chart			
4.Visualizing Data Programmatically	4.1Creating HTML5 CANVAS Charts (HTML5 Canvas basics, Linear interpolations, A simple column Chart, Adding animations), Starting with Google charts (Google Charts API Basics, A Basic bar chart, A basic Pie chart, Working with Chart Animations)	CO4	04	07
	4.2Getting setup with D3, Making selections, changing selection's attribute (attr()), D3 strives to be declarative, Changing methods, appending new elements, Putting all together, Selecting multiple elements with d3.selectall(), Building Bar charts with selections	CO5	03	
5.Advanced Data Visualization-I	5.1Making charts interactive and Animated: Data joins, updates and exits, interactive buttons, Updating charts, Adding transactions, using keys	CO6	03	03
6.Advanced Data Visualization-II	5.2Adding a Play Button: wrapping the update phase in a function, Adding a Play button to the page, Making the Play button go, Allow the user to interrupt the play, sequence	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery, "JavaScript and Query for Data Analysis and Visualization", WROX. 2. Ritchie S. King, "Visual storytelling with D3", Pearson 3. Dr. Ossama Embarak, "Data Analysis and Visualization Using Python", APress
Reference Books	1. A. Julie Steele and Noah Iliinsky, Designing Data Visualizations: Representing Informational Relationships, O'Relly. 2. Andy Kirk, Data Visualization: A Successful Design Process, PAKT. 3. Scott Murray, Interactive Data Visualization for Web, O'Relly

Useful Links:

1. Web Resources a. https://D3js.org
2. Artificial intelligence and expert systems: a ... - IEEE Xplorehttps://ieeexplore.ieee.org › document

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
- Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

End Semester Examination (ESE):

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

Lab Code	Lab Name	Credits (P+TUT)
AIL603	**Data Analytics and Visualization Lab**	**(1+0)**

Lab Prerequisite:	1. Discrete Structures 2. Programming Language in Python or Java and R
Lab Objectives:	1. To implement visual perception. 2. Apply core skills for visual analysis. 3. Apply visualization techniques for various data analysis tasks. 4. Design information dashboard.
Lab Outcomes (LOs):	At the end of the course, the student will be able to: 1. Implement R programming for Data Analysis. 2. Apply techniques for data manipulation. 3. Implement data visualization with various techniques. 4. Perform visualization using D3.js 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Suggested Practical List:

Lab. No.	Experiment Title	LO Mapped	Hrs/Lab
1	To perform the basic mathematical operations in R programming	LO, LO2, LO5	02
2	Implementation of vector and list data objects operations in R	LO1, LO2, LO5	02
3	Implementation and perform the various operations on data frames in R	LO1, LO2, LO5	02
4	To Create Sample (Dummy) Data in R and perform data manipulation with R	LO1, LO2, LO3, LO5	02
5	Study and implementation of Data Visualization with ggplot2 in R	LO1, LO2, LO3, LO5	02
6	To perform visualization using D3.js	LO1, LO2, LO3, LO4 , LO5	02
7	To perform data exploration using Pandas	LO1, LO3, LO5	02
8	To perform scatter plots in matplotlib and seaborn with Python	LO1, LO2, LO3, LO5	02
9	Case Study on Data Visualization using Tableau	LO1, LO3, LO5	02
10	Case Study-2	LO1, LO3, LO5	02

Text Books:	1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition 2. Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, 3rd Edition

Useful Links:

1. https://www.tutorialspoint.com/artificial_intelligence_with_python/artificial_intelligence_with_python_tutorial.pdf
2. https://stacks.stanford.edu/file/druid:qn160ck3308/qn160ck3308.pdf

Term work:

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

Oral/Practical/P&O:

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

Course Code	Course Name	Credits (TH+P+TUT)
AIC604	**Big Data Analytics**	**(3+0+0)**

Prerequisite:	1. Database Management System. 2. Data warehousing and Mining 3. Familiarity with Intermediate Python/R.
Course Objectives:	1. To provide an overview of an exciting growing field of Big Data analytics. 2. To discuss the challenges traditional data mining algorithms face when analyzing Big Data. 3. To introduce the tools required to manage and analyze Big Data like Hadoop, NoSql Map-Reduce. 4. To teach the fundamental techniques and principles in achieving Big Data analytics with scalability and streaming capability. 5. To introduce to the students several types of Big Data like social media, web graphs and data streams. 6. To enable students to have skills that will help them to solve complex real-world problems in decision support.
Course Outcomes:	1. The student will be able to explain the key issues in Big Data management and its associated applications. 2. Use Big Data frameworks and noSQL databases. 3. Apply Map-reduce algorithm in different scenarios. 4. Apply different algorithms to stream data model. 5. Apply classification algorithms and pattern mining for Big Data. 6. Use Big Data Systems for AI solutions.

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 Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	CO1	02 02 01	05
2.Frameworks: Spark	Overview of: Apache Spark, features, architecture, spark components, RDD. What is NoSQL? NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, MongoDB	CO2	02 02 02 02 02	10
3.MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix	CO3	02 02 02	08

	Multiplication, Matrix Multiplication with One MapReduce Step. Illustrating use of MapReduce with use of real life databases and applications.		02	
4.Mining Big Data Streams	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream: Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk- Motwani Algorithm, Query Answering in the DGIM Algorithm.	CO4	02 02 02	06
5.Big Data Mining Algorithms	Frequent Pattern Mining: Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with MapReduce Classification Algorithms: Parallel Decision trees, Overview SVM classifiers, Parallel SVM, K-Nearest Neighbor classifications for Big Data, One Nearest Neighbour.	CO5	02 02 01	05
6.Big Data Analytics Applications	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. Mining Social- Network Graphs: Social Networks as Graphs, Types, Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. Recommendation Engines: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	CO6	05	05
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**
Books:				

Text Books	1. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications, 2. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press. 3. Amirghodsi, Siamak, et al. Apache Spark 2. x machine learning cookbook. Packt Publishing Ltd, 2017. 4. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press. 5. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press 6. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publications
Reference Books	1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series. 2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited 3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications
Useful Links:	
1.https://spark.apache.org/	
2.https://hadoop.apache.org/	
3.https://www.mongodb.com/atlas	
Continuous Assessment:	
• Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus). • Average marks of T-1 and T-2 will be considered. • Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty	
End Semester Examination (ESE): • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.	

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC6051	**AI in E-Commerce**	**(3+0+0)**

Prerequisite:	1. Data Warehousing and Mining 2.Knowledge of a programming language like Python/R
Course Objectives:	This course aims to introduce ecommerce environment to students along with the applications of various machine learning algorithms used to improve the performance of an e-business.
Course Outcomes:	After the successful completion of this course, learners will be able to: 1.Explain about the different technologies in e-Commerce 2.Build machine learning models using different algorithms. 3.Analyse customer behavior. 4.Create a dashboard for an ecommerce web site. 5.Discuss various E-business Strategies. 6.Discuss the ethical issues in e-Commerce.

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 E-Commerce and E-Market places	Overview of E-commerce, E- Marketplaces: E-commerce Mechanisms, Infrastructure and Tools, Impacts of E-commerce. Overview of technology stack for e-commerce	CO1	03	03
2. Electronic Commerce Applications	Retailing in E-commerce - Products and services, e-tailing business models, types B2B, B2C, C2C Ecommerce, E-supply chains -CRM, Collaborative commerce and Corporate portals, Mobile commerce and Ubiquitous computing, Ecommerce Support services- E Commerce Security and fraud protection, Electronic Commerce Payment systems Web2.0 and Social Networks	CO1	10	10
3. AI applications in E-commerce-Business cases-1	Market Basket Analysis: objectives, description, exploratory analysis and model building Propensity modelling: Regression Decision tree algorithm Customer profiling using clustering Web clickstream analysis Introduction to recommendation systems	CO3	10	10
4. Web mining and security	Introduction, Web Content Mining: Crawlers, Harvest System Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining Types of Abuse and the data that can stop them, Supervised Learning for Abuse Problems, Clustering Abuse Ethics and values	CO4	06	06

5. E- Commerce Analytics/ customer review analysis	Creating Business Value using E-commerce Analytics, E-commerce Analytics Value Chain, Methods and Techniques for Ecommerce Analysis, Visualization, Dash boarding and Reporting text matching: TF-IDF modeling, Image matching: PCA analysis	CO3, CO4	06	06
6. Ecommerce Strategy and Implementation	Ecommerce Strategy and Global E-commerce, launching successful e business, Regulatory, ethical and Compliance issues in Ecommerce, Auctions and Application Development.	CO5, CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Ifrain Turban, Jae K. Lee, David King, "Electronic Commerce: A Managerial Perspective", United States Edition, 1999. 2. Judah Phillips, "Ecommerce Analytics: Analyze and Improve the Impact of Your Digital Strategy", Pearson FT Press, 2016. 3.Han, Jiawei, Jian Pei, and Micheline Kamber. *Data mining: concepts and techniques*. Elsevier, 2011. 4.Giudici, Paolo "Applied data mining: statistical methods for business and industry", John Wiley & Sons, 2005. 5.Chio, Clarence, and David Freeman "Machine learning and security: Protecting systems with data and algorithms", O'Reilly Media, Inc.", 2018. 6.E-Commerce, S.K.Mourya, Narosa Publishing House Pvt Ltd., New Delhi 2015.
Reference Books	1.Harvey M. Deitel, Paul J.Deitel, Kate Steinbuhler, e-business and e-commerce for managers, Pearson, 2011. 2.Kelly Rainer, Brad Prince,Management Information Systems, Wiley . 2.Gary P Schneider "Electronic commerce", Thomson learning & James T Peny Cambridge USA, 5th edition 2001. 3.Zhang, Z. (2019). Practical Data Processing for Social and Behavioral Research Using R. Retrievable from https://books.psychstat.org/rdata.

Useful Links:

1.http://infolab.stanford.edu/pub/papers/google.pdf

2.https://blogs.cornell.edu/info2040/2016/10/22/pagerank-on-ecommerce-sites/

3.https://lizrush.gitbooks.io/algorithms-for-webdevs-ebook/content/chapters/page-rank.html

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
- Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty

End Semester Examination (ESE):

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

Lab Code	Lab Name	Credits (P+TUT)
AIDLL6051	**AI in E-Commerce Lab**	**(1+0)**

Lab Prerequisite:	1. Data Warehousing and Mining 2. Knowledge of a programming language like Python/R
Lab Objectives:	This course aims to introduce an e-commerce environment to students along with the applications of various machine learning algorithms used to improve the performance of an e-business.
Lab Outcomes (LOs):	After the successful completion of this course, learners will be able to: 1. Explain about the different technologies in e-Commerce. 2. Build machine learning models using different algorithms. 3. Analyze customer behavior. 4. Create a dashboard for an ecommerce web site. 5. Discuss various E-business Strategies. 6. Discuss the ethical issues in e-Commerce

Lab No.	Experiment Title	LO mapped	Hrs/Lab
1	Case study on impact of AI in E-Commerce.	LO1	02
2	Case study on Electronic Commerce Applications as Mobile commerce and Ubiquitous computing.	LO2	02
3	Case study on AI applications in E-commerce Business case with the implementation of: • Regression Decision tree algorithm • Customer profiling using clustering • Web clickstream analysis	LO3	02
4	Case study on Web mining and security in E-Commerce.	LO4	02
5	Case study on customer review analysis with AI in E-Commerce.	LO5	02
6	Case study on Ecommerce Strategy and Global Ecommerce.	LO6	02

Term work:

- Term work should consist of a minimum of 6 experiments.
- Journal must include at least 2 assignments on content theory and practical of the course "AI in E-Commerce Lab".
- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
- Total 25 Marks (Experiments: 20 marks, Assignments: 05 marks)

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

Course Code	Course Name	Credits (TH+P+TU
AIDLC6052	**AI in Agriculture**	**(3+0+0)**

Prerequisite:	1. Artificial Intelligence. 2. Internet of Things
Course Objectives:	1. To provide the knowledge of Soil Engineering. 2. To apply analysis, testing principles to Crop Production and fertility 3. To demonstrate and evaluate real world management and tool in agriculture
Course Outcomes:	After the successful completion of this course, learner will be able to: 1. Identify requirements & assess the soil. 2. Identity Quality or irrigation water; essential plants nutrients 3. Explain the Agronomy of Crops and it Production . 4. Explain the concept of utilization of Fertilizer and its application equipment . 5. Identify of Harvesting equipment and tool of crops . 6. Design development system architecture of agricultural IoT.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Subtopic	Total Hrs /Module
I.Prerequisites and Course outline	Prerequisite Concepts and Course Introduction	--	02	02
1. Nature and origin of soil	1.1Definition of soil classification of rock with suitable example. Composition of rock and minerals. Soil genesis, soil taxonomy, soil orders, great group, sub-group series and family. Soil physical properties; and their importance soil textural class(particle distribution)	CO1	03	07
	1.2Soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability.		02	
	1.3Soil organic matter (SOM) SOM composition their importance on soil properties, Physical, Chemical and Biological. Characteristics of saline, saline-sodic and sodic soil and their reclamation techniques.		02	
2. Quality or irrigation water and essential plants nutrients	2.1Irrigation Quality Parameter. Suitability of irrigation water as their quality parameters. Criterion of Essential Plant nutrients. Physiology role of Essential Plant nutrients.	CO2	03	06
	2.2Identification of deficiency symptoms of external plants nutrients and measure to overcome deficiency.		03	
3. Agronomy	3.1Definition of agronomy scope and important of Agronomy. Classification of agronomical crops viz, cereals, pulses oil seeds forage crop, cash crops etc.	CO3	02	05
	3.2Effect of different weather parameters on growth and development of agronomical crops. Define of tillage, its importance.		03	
4.Fertilizer application equipment	4.1Types of fertilizer: - Inorganic fertilizer, Organic fertilizers and its forms. liquid, powder, and granule Define fertilizers with suitable	CO4	04	07

	example, Fate of major Micronutrients and trace beneficial nutrients in Soil. Organic Manures- Define, classification with example and sources. Importance of organics manures.			
	4.2Equipment:-Trolley Pump, Trailer sprayer. Combine Harvester, Cultivator, Roto Seed Drill, Manure Spreader, Rotary Tiller. sprayers, Drone Mini sprayer, and dusters, their calbration, selection, constructional features of different components and adjustments,	CO4	03	
5. Equipment/Tool/ Mulching.	5.1Types of equipment, tools, machinery for land preparation, sowing.	CO5	03	06
	5.2Harvesting threshing,Plant Protectors, seed treatments, weeding, interculturing etc.		03	
6. Development and system architecture of agricultural IoT	6.1Development and system architecture of agricultural IoT, Development of agricultural IoT sensors, Application of agricultural IoT, System architecture of agricultural Io T.	CO6	02	08
	6.2Key technologies of agricultural IoT:- Sensor perception technology, Information transmission technology, Node location technology, Wireless communication technology, Information processing technology, Radio-frequency identification, 3S technology, RS technology, GNSS technology, GIS technology		02	
	6.3Typical applications of agricultural IoT:- Water-saving irrigation. Crop growth environment monitoring. Animal and plant life information monitoring. Animal life information monitoring. Plant life information. Intelligent agricultural machinery .Agricultural product quality safety and traceability.		02	
	6.4Problems, system architecture design monitoring and feedback to end use based on Production depend on soil nutrient availability, yield function with optimal condition and its parameter		02	
II.Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	---	01	01
			Total hours	**42**

Books:

Text Books	1. Bose, T.K and S.K. Mitra. (1990). Fruits, Tropical and Subtropical. Naya Prakash, 206 Bidthan saran, Calcutta. 2. Nature and Properties of Soils, The Hardcover – Import, 1 March 2016 Publishing House Pvt Ltd, New Delhi. 3. Das, P.C. (2012). Vegetable Crops of India. Kalayani Publishers, New Delhi. 4.Bosoi, E.S. (2018). Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2). Oxonion Press Pvt. Ltd., New Delhi. 5. Donnel Hunt. Farm Machinery and management. Iowa State University
Reference Books	1. De, G.C. (1989). Fundamentals of Agronomy. Oxford & IBH Publishing Co Pvt

	Ltd, New Delhi. 2. Russel. Soil Condition and Plant Growth. ELBS, Longmans, U.K. 3.Review of agricultural IoT technology Jinyuan Xu a , Baoxing Gu a , Guangzhao Tian a,b**,**

Useful Links:

1. https://www.sciencedirect.com/journal/artificial-intelligence-in-agriculture

2. https://onlinecourses.nptel.ac.in/noc22_bt57/preview:-Biotechnology

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
- Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

End Semester Examination (ESE):

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

Lab Code	Lab Name	Credits (P+TUT)
AIDLL6052	**AI in Agriculture Lab**	**(1+0)**

Lab Prerequisite:	1. Artificial Intelligence 2. Internet of Things
Lab Objectives:	1. To provide the knowledge of Soil Engineering. 2. To apply analysis, testing principles to Crop Production and fertility 3. To demonstrate and evaluate real world management and tool in agriculture
Lab Outcomes (LOs):	After the successful completion of this course, learner will be able to: 1. Identify requirements & assess the soil. 2. Identity Quality or irrigation water; essential plants nutrients 3. Explain the Agronomy of Crops and its Production 4. Explain concept of utilization of Fertilizer and its application equipment 5. Explain the Harvesting mechanisms of crops 6. Design development system architecture of agricultural IoT

Lab No	Experiment Title	LO mapped	Hrs/Lab
1.	Identification of Rock and minerals.	LO1	02
2.	Types of soil in Maharashtra and India.	LO1	02
3.	Identification of organic manures and chemical fertilizers.	LO1	02
4.	Aquitance with Agronomical field crops and their Morphological Characteristics	LO2,	02
5.	Criteria for irrigation water requirement and Measurement.	LO2	02
6.	Studies on irrigation water Measuring and soil moisture measuring devices.	LO2	02
7.	Yield contributing characters and yield Prediction.	LO3	02
8.	Type of tillage Equipment and their significance.	LO4	02
9.	Computation of fertilizer dose to field crops viz General recommended dose of fertilizers, soil test based Yield target based.	LO5	02
10.	Implement of Prototype field operation harvesting, threshing and Processing machinery	LO5	02
11.	Implement Prototypes of system for fertilizing using IOT	LO3, LO6	02

Term work:

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

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

Course Code	Course Name Credits			Credits (TH+P+TUT)
AIDLC6053	**Internet of Things**			**(3+0+0)**
Prerequisite:	1.Micro-controllers 2.Embedded System Design 3.Computer Networks			
Course Objectives:	The objectives of this course are to: 1.Understand the design features of Internet of Things (IoT) 2.Understand importance of data handling in IoT Way. 3.Introduce multiple ways of data communication and networking. 4.Understand design issue in IoT.			
Course Outcomes:	On successful completion of the course the students will be able to: 1. Explain the concepts of Internet of Things. 2. Analyze basic multiple way of data communication and networking in IoT 3. Apply design methodology for solving IoT case studies. 4. Analyze data handling in IoT. 5. Implementation of IoT Devices. 6. Illustrate various IoT case studies.			
Module No. & Name	**Sub Topics**	**CO mapped**	**Hrs. /Subtopic**	**Total Hrs./ Module**
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to IoT	1.1 Introduction: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT	CO1	04	08
	1.2 IoT and M2M:- IoT/M2M System layers and Design Standardization, M2M, Difference between IoT and M2M		01	
	1.3 IoT Template		03	
2. Network & Communication aspects	2.1 Design Principles & Web Connectivity: Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets, (Publish–Subscribe), MQTT, AMQP, CoAP Protocols, Rabbit-MQ,	CO2	04	08
	2.2 Internet Connectivity: Internet based communication, IPaddressing in IoT, Media Access Control, and Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE M1, SIGFOX.		04	
3. IoT Design Methodology	Introduction, Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration	CO3	03	03
4.Data Handling in IoT	4.1 Data Acquiring, Organizing, Processing: - Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.		03	

	4.2 Data Collection and Storage:- Cloud Computing Paradigm for Data Collection, storage and	CO4	03	06
5. Components of IoT	5.1 Exemplary Devices: Arduino Boards, Arduino Interfacing, ESP32/ 8266, DHT Sensor, Ultrasonic Sensor, IR Sensor, NVDIA JETSON Nano	CO5	08	08
6.IoT Case Study	6.1 Home Automation, Energy Monitoring Case Study, Face Recognition, Object Detection	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
			Total hours	**42**

Books:

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

Useful Links:

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

Continuous Assessment:

- Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each.
- Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus).
- Average marks of T-1 and T-2 will be considered.
- Internal Assessment (10 Marks):Internal assessment will be based on quizzes /case study/activity conducted by the faculty

End Semester Examination (ESE):

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

Course Code	Course Name	Credits (P+TU)
AIDLL6053	Internet of Things Lab	(1+0)

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

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

Virtual Lab Links:

1. https://aws.amazon.com/
2. https://thingspeak.com/
3. https://blynk.io/

Term work:

- Term work should consist of a minimum of 8 experiments.
- Journal must include at least 2 assignments on content of theory and practical of the course "Internet of Things".

- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
- Total 25 Marks (Experiments:-20 marks, Assignments:-05 marks)

Oral/Practical/P&O:

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

Course Code	Course Name	Credits (TH+P+TUT)
AIDLC6054	Bioinformatics Data Management	(3 + 0 + 0)

Prerequisite:	Database Management System
Course Objectives:	1. To store, analyze and disseminate the biological data via bioinformatics 2. To manage the next generation sequencing data to develop bioinformatics tools. 3. To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
Course Outcomes:	After completion of this course, student will be able to 1. Explain different Omics and its applications. 2. Explain different methods for Biological Data Searching and databases. 3. Explain Biological Data Mining. 4. Explain general data cleaning method. 5. Compare three areas in biological data integration. 6. Explain Biological Data Processing In The Cloud.

Module No. & Name	Sub Topics	CO mapped	Hrs /Subtopic	Total Hrs/ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction to Bioinformatics	Introduction to Bioinformatics: Definition and History of Bioinformatics, Different Omics and its application and Current status, Internet sources for Bioinformatics, Flat file, NCBI	CO1	02 02 02	06
2. Biological Data Searching and Databases	Introduction. Biological Data Searching Using Blast DNA and Protein Databases, Metabolism Database (KEGG), MSA, A Case Study In Phylogenetic Tree Database Search, A Case Study In Rna Pseudoknot Database Search.	CO2	02 02 02 02	08
3.Biological Data Mining	Introduction, General Data Mining, Biological Data Mining, A Case Study In Biological Pattern Discovery. A Case Study In Biological Data Mining General Regulatory Network Inference.	CO3	02 02 02 02	08
4. Biological Data Cleaning	Introduction. General Data Cleaning. A Case Study In Biological Data Cleaning	CO4	02 02 02	06
5.Biological Data Integration	Introduction. General Data Integration. Three Areas In Biological Data Integration	CO5	03 03	06
6. Cloud based Biological Data Processing	Introduction. Data Processing In The Cloud. Biological Data. Processing In The Cloud	CO6	05	05
I. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01

	Total hours	**42**
Books:		
Text Books	1. Attwood T. K., Parry-Smith D. J and Phukan S. (2009). Introduction to Bioinformatics. Pearson Education. 2. Harisha S. (2019). Fundamentals of Bioinformatics. Dreamtech Press	
Reference Books	1. Bioinformatics Database Systems, by Kevin Byron & Katherine G. Herbert & Jason T. L. Wang, CRC Press Taylor & Francis Group. 2. Basics of Bioinformatics, Rui Jiang Xuegong Zhang Michael Q. Zhang , Springer	
Continuous Assessment (CA):		
• Test-1, Test-2 and Average of T-1 and T-2 (30Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. • Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus). • Average marks of T-1 and T-2 will be considered. • Internal Assessment (10 Marks): Internal assessment will be based on quizzes /case study/activity conducted by the faculty		
End Semester Examination (ESE): • End Semester Exam shall be conducted for Total 60 Marks. • Duration of End Semester Exam shall be 02 Hours 30 Minutes.		

Course Code	Course Name	Credits (P+TU)
AIDLL6052	**Bioinformatics Data Management Lab**	**(1+0)**

Lab Prerequisite:	Database Management System
Lab Objectives:	1. To store, analyze and disseminate the biological data via bioinformatics. 2. To manage the next generation sequencing data to develop bioinformatic tools. 3. To utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
Lab Outcomes (LOs):	After the completion of course 1. Explain how to construct phylogenetic trees 2. To use BLAST and its variants for the identification of very similar and divergent sequences. 3. To use database resource for understanding high-level functions and utilities of the biological system(KEGG) 4. To do the sequence analysis problems under the application layer. 5. To provide functional analysis of proteins by classifying them into families. 6. To do classification of protein domains. 7. To do visualization of proteins, nucleic acids. 8. To generate reliable three-dimensional protein structure models.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1	Multiple sequence alignment and Phylogenetic tree analysis	LO1	02
2	BLAST- BLASTn, BLASTp, primer BLAST.	LO2	02
3	Motif Finding- MEME and myhits	LO4	02
4	Secondary Structure Prediction: Interproscan	LO5	02
5	CATH and SCOP	LO6	02
6	KEGG	LO3	02
7	Tertiary Structure: PDB, Rasmol	LO7	02
8	Homology Modeling – SWISS-MODEL	LO8	02

Term work:

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

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

Project Based Learning Code	Project Based Learning Name		Credits (P+TUT)
AIPR64	Minor Project Lab-2		(1+0)
PBL Prerequisite:	1. Project Based Learning- Mini Project Lab-I 2. Project Based Learning- Mini Project Lab-II 3. Microprocessors		
PBL Objectives:	1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.		
PBL Outcomes (PROs):	Learner will be able to: 1. Identify the problem statement based on societal /research needs. 2. Design algorithms/flow chart for the system 3. Develop solution using suitable programming language 4. Apply hardware/software knowledge to develop solution 5. Excel in written and oral communication. 6. Demonstrate project management principles during project work.		
Module No.	**Module Title**	**PRO Mapped**	**Hrs./Module**
1	Problem Definition and Project Planning:1.1 Literature Survey, Problem Definition, Objectives of the project	PRO 1	02
	1.2 List of Input and Output (sensors, Actuators), list of components, Selection of icroprocessor/Microcontroller/Selection of Boards (Arduino/ ESP8266, etc.)		02
	1.3 Preparation of Gantt/PERT/CPM chart- weekly activity of mini project		02
2	2.1 Flow Chart/Algorithms: List the steps required to solve a problem, Preparation of Flow Chart/Algorthm	PRO 2	02
3	Programming: 3.1 Study of programming languages C, Embedded C, Java, Python	PRO 3	02
	3.2 Simulation using Tinkercad / Proteus/ Suitable simulator as per application		02
4	Implementation: 4.1 Design of Board- Identify, list and purchase elements of a development board, Design the board	PRO 4	02
	4.2 Solder and Interface devices like sensors, keyboards and displays to the board		02
	4.3 Integration of Hardware and Software components, Testing, Debugging using Keil/Ardiuno/python etc.		02
5	5.1 Report writing and presentation preparation: Documentation of the work done in a streamlined manner, Preparation and	PRO 5	04

	organization of a report according to a standard format, Use of IEEE format of bibliography		
6	6.1 Project presentation & Demonstration: Project Presentation using PPT and Demonstration of working model of the system	PRO 6	04
		Total hours	**26**

Books:

Reference Books	1. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd. 2. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009 3. Dr. Krishna Kumar Mohbey, Dr. Brijesh Bakariya "An Introduction to Python Programming: A Practical Approach", bpb publications

Useful Links:

1. https://ieeexplore.ieee.org/
2. https://www.electronicsforu.com/
3. https://www.keil.com/
4. https://www.tinkercad.com/
5. https://www.arduino.cc/
6. https://www.tutorialspoint.com/python/index.htm

Guidelines for Minor Project:

1. Project is a group activity and students shall form a group of 2 to 3 students. A group shall not be more than three students.
2. Project Based Learning - Minor Project Lab-1 should be implemented with hardware and/or software.
3. Students will be assigned an open-ended problem which they will finalize according to their preferences and in consultation with the faculty supervisor.
4. Project should be implementation of Applied Artificial Intelligence/ Data Science/Embedded Systems/ Societal need based / Innovative idea implementation etc.
5. Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
6. A collaborative logbook will be prepared by each group, which will be verified regularly by; guide/supervisor can verify and record notes/comments.
7. The solution to be validated with proper justification and report to be compiled in standard format of the college.
8. The focus of project will be on self-learning, innovation, addressing societal problems and based solutions.

Guidelines for Assessment of Minor Project:

1. The review/ progress monitoring committee shall be constituted by faculty members in-charge and/or senior faculty members.
2. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews per semester. Assessment also considers peer review by students and observation of ethics.
3. Report should be prepared as per the guidelines issued by the college.
4. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of examiners.
5. In the case of a major project, the evaluation will be based on fulfillment of goals by the end of semester. Students shall be motivated to participate in poster & project competition.

Term work (25 Marks):

Distribution of term work marks are,

1. Marks awarded by guide/supervisor based on logbook: 10

2. Marks awarded by review committee (Internal Presentation and TPP/Poster/ Idea Competition/etc. Participation): 10
3. Quality of Project report: 05

Practical (25 Marks):

1. Minor Projects shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
2. Students shall be motivated to publish a paper based on the work in Conferences/students competitions

Distribution of practical marks are,

1. Presentation:5
2. Project Implementation:10
3. Project Report, Performance:10

Exposure (Skill Based Learning-IX) Code	Exposure (Skill Based Learning-IX)	Credits (P+TUT)
AIXS69	**R Programming**	**(1+0)**
Prerequisite:	Engineering Mathematics	
Skill Objectives:	1. Identify and use available R packages and associated Open Source software 2. Write efficient programs using R to perform routine tasks 3. Document and collaborate on code development 4. Work with datasets for analysis and presentation	
Skill Outcomes (SOs):	1. Write simple structured programs in R. 2. Import different data formats into R using RStudio. 3. Wrangle data for analysis. 4. Query data using SQL and R. 5. Analyze a data set in R and present findings using the appropriate R packages. 6. Visualize data attributes using ggplot2 and other R packages.	

Module No. & Name	Sub Topics	SO Mapped	Hrs/ Subtopic
1.Getting Started with R	What is R? • Installing R and RStudio • RStudio Overview • Working in the Console • Arithmetic Operators • Logical Operations • Using Functions • Getting Help in R and Quitting RStudio	SO1	02
2.Basics of R	Atomic classes, Creating Variables • Numeric, Character and Logical Data, vectors, lists, factors, missing values, data frames and matrices, Special Values		02
3.Reading and storing data	Use read.table() for small and large data, calculating memory requirements, Using the readr Package, using file() connections, using textual and binary formats to store data	SO2	02
4.Data structures	Subsetting vector, matrix, lists, nested elements, multiple elements, removing NA values, Managing data frames with the dplyr package		02
5.Control structures	Control structures like if, while, and for, repeat	SO3	02
6.Functions	Functions, argument matching, evaluation, Looping the command line		02
7.Regular expressions	grep(), grepl(), regexpr(), sub(), gsub(),regexec(), the stringer package	SO4	02
8.Data exploration and visualization	Using the ggplot2 package to visualize data • Applying themes from ggthemes to refine and customize charts and graphs • Building data graphics for dynamic reporting	SO5	02
9.Debugging and profiling	Debugging tools, R profiler	SO6	02
10.Simulation	Simulating random and linear models		02
11. Data analysis case study	Data analysis and case study		02

Books:	
Text Books	1.Wickham, Hadley, and Garrett Grolemund. R for data science: import, tidy, transform, visualize, and model data. " O'Reilly Media, Inc.", 2016. Available for free at http://r4ds.had.co.nz 2.Peng, Roger D. R programming for data science. Victoria, BC, Canada: Leanpub, 2016. Available for free at R Programming for Data Science (bookdown.org).
Reference Books	1. Gardener, Mark. Beginning R: the statistical programming language. John Wiley & Sons, 2012. 2. Jones, Owen, Robert Maillardet, and Andrew Robinson. Introduction to scientific programming and simulation using R. Chapman and Hall/CRC, 2009.
Important links: 1. http://www.r-project.org/ 2. http://www.rstudio.com/ 3. http://www.statmethods.net/ 4. Google's R Style Guide: http://google-styleguide.googlecode.com/svn/trunk/ Rguide.xml	
Term Work:	
Programming labs to be conducted as 2hrs continuous theory + hands-on session. Discussion on the topics and Programs Involving the concepts mentioned will be performed during the assigned lab hours. Term work of 25 marks.	

Exposure (Technology Based Learning-X) Code	Exposure (Technology Based Learning-X) Name	Credits (P+TUT)
AIXT610	**1.Online Certification Courses**	(1+0)
	2.NPTEL certification	
	3.IITBs Spoken Tutorial	
	4.Swayam MOOCs	
	5.Coursera certification	
	6.Internshala Trainings	

Technology Prerequisite:	Basic Engineering and Technology courses
Technology Objectives:	1. To acquire competency in emerging areas of technology. 2. To create a mindset for life-long learning required to persist technological shifts and be abreast with the market trends. 3. To facilitate learning at self-paced schedules. 4. To boost time management ability and self-discipline. 5. To provide opportunities of strengthening digital footprints by showcasing the additional proficiency acquired as well as improve connectivity and networking. 6. To enhance employment and entrepreneurial opportunities requiring specialization.
Technology Outcomes (TOs):	1. Explain concepts of the emerging technology learned through the pursued course. 2. Describe social, ethical, and legal issues surrounding the learned technology. 3. Demonstrate professionalism and skills of digital age learning and working. 4. Demonstrate knowledge in entrance exams for higher technical education, placement interviews, and other avenues. 5. Analyze real-world case studies in society/industry for applicability of sustainable technological solutions. 6. Apply the acquired knowledge in developing technology-based

Guidelines:

1. Learners should enroll for an online course based on their area of interest concerning emerging areas of technology in consultation with Faculty Supervisor nominated by the Head of Department.
2. The course duration should be of minimum 04 weeks.
3. Students should watch all the videos of the course to learn the course in-depth and entirety.
4. Students should solve weekly assignments that are to be submitted online within the prescribed deadline.
5. Students should register and appear for the course certification exam on scheduled date and time.
6. Students should submit the certificate of course completion to the Faculty Supervisor.
7. Faculty Supervisor shall monitor students' participation and progress at every stage — from course enrolment to certification.

Useful Links:

https://swayam.gov.in

https://www.nptel.ac.in
https://www.coursera.org
Term Work:
Term work shall be conducted for total 25 marks

Course Code	Course Name	Hours/Duration
INT65	**Internship-V**	**2-4 Weeks**
Prerequisite:	List of probable industries and organizations offering internships on live projects. Awareness about probable solutions for identified problem areas in	
Course Objectives:	1. To understand the social, economic and administrative considerations 2. Learn to apply the Technical knowledge for solving real life problems.	
Course 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.	

SOMAIYA
VIDYAVIHAR
K J Somaiya Institute of Technology
An Autonomous Institute 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
An Autonomous Institute 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 KJSIEIT)"

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;

i) Eligibility criteria for opting the Honours Degree program:

a. Students with no backlog in semester I, II, and III

b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above

c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

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

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

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

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

3. Examination and Evaluation of Honours Degree Courses:

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

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

4. Award of Honours Degree Program:

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

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

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

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

5. Honours Degree Program Scheme and Structure:

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

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

Table 2: Honours degree Program credit and Examination Scheme

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

6.Honours Degree Programs offered for KJSIEIT:

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

Table 3: Honours Programs offered for KJSIEITs Branches

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

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

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

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

Table 5: Honours Degree Program in Block chain

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

Table 6: Honours Degree Program in Cyber Security

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

Table 7: Honours Degree Program in Data Science

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

Table 8: Honours Degree Program in Augmented and Virtual Reality

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

Table 9: Honours Degree Program in Internet of Things

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

Dr. 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
I. Prerequisite and Course Outline	**Introduction to Cryptography:** Hash functions, Public key cryptography, Digital Signature (ECDSA).	--	2	2
1. Introduction to Block chain	1.1 Structure of a Block, Block Header, Block Identifiers: Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Block chain, Merkle Trees and Simplified Payment Verification (SPV). **Self-learning Topics:** Block chain Demo.	CO1	6	6
2. Consensus and Mining	2.1 Decentralized Consensus, Byzantine General's Problem, Independent Verification of Transactions, Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block header, Mining the Block, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Block chain Forks	CO2	12	12

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

<table>
<tr><td></td><td>byAndreas Antonopoulos, Gavin Wood, Publisher(s): O'Reilly Media
3. “Blockchain revolution: how the technology behind bitcoin is changing money, business and the world $ don tapscott and alex tapscot, portfolio penguin, 856157449.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://andersbrownworth.com/blockchain/
https://andersbrownworth.com/blockchain/public-private-keys/
https://www.coursera.org/learn/cryptocurrency
https://coinmarketcap.com/</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –<table><tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr><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 (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 Three hour 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
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.

2. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.

3. https://www.hyperledger.org/use/fabric

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

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

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

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

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

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

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

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

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

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

<table>
<tr><td colspan="2">https://docs.soliditylang.org/en/v0.7.4/</td></tr>
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with Three hour 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 use 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	
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>
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<tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr>
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Continuous Assessment (30-Marks): Test-1 and Test-2 consists of two class tests of 30 marks each. Test-1 is to be conducted on approximately 40% of the syllabus completed and Test-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test-1). Duration of each test shall be one hour.
Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with Three hour duration.</td></tr>
</table>

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

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

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

Module No. & Name	Sub Topics	CO Mapped	Hrs./Subtopic	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 cryptographic algorithms.Demonstration of	CO3	08	08

	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, 2017 4. Applied Cryptography, Protocols Algorithms and Source Code in C -- Bruce			

<table>
<tr><td></td><td>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>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –
<table>
<tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr>
<tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr>
<tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr>
</table>
Continuous Assessment (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 Three hour duration.</td></tr>
</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

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

Assessment:

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

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

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

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

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

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./Subtopic	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

<table>
<tr><td>Application, Windows, and Linux security</td><td>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</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Total hours</td><td>48</td></tr>
<tr><td colspan="5">Books:</td></tr>
<tr><td>Text Books</td><td colspan="4">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.</td></tr>
<tr><td colspan="5">Reference Books:</td></tr>
<tr><td></td><td colspan="4">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.</td></tr>
<tr><td colspan="5">Online References:</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Assessment:</td><td colspan="4">Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –
<table><tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr><tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr><tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr></table>Continuous Assessment (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 Three hour duration.</td></tr>
</table>

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	LO4	9	9

	Tools: BSQL Hacker **Password Audit:** Perform the password audit on the Linux / Windows based system **Tools:** Cain & Able, John the ripper, LCP Password Auditing tools for Windows. **Active Directory and Privileges Audit:** Conduct a review of the Active Directory and the Group Policy to assess the level of access privileges allocated. **Tools:** SolarWinds **Self-Learning Topics:** Federated Database security challenges and solutions.			
5. Log Analysis	Conduct a log analysis on Server Event Log / Firewall Logs / Server Security Log to review and obtain insights Tools: graylog, Open Audit Module. **Self-Learning Topics:** Python and R-Programming scripts	LO5	6	6
6. Compliance and Observation Reporting	**License Inventory Compliance:** Identify the number of licenses and its deployment in your organization. Tools: Belarc Advisor, Open Audit Report Writing: NESSUS tool Report should contain: a. Vulnerability discovered b. The date of discovery c. Common Vulnerabilities and Exposure (CVE) database reference and score; those vulnerabilities found with a medium or high CVE score should be addressed immediately d. A list of systems and devices found vulnerable e. Detailed steps to correct the vulnerability, which can include patching and/or reconfiguration of operating systems or applications f. Mitigation steps (like putting automatic OS updates in place) to keep the same type of issue from happening again **Purpose of Reporting:** Reporting provides an organization with a full understanding of their current security posture and what work is necessary to both fix the potential threat and to mitigate the same source of vulnerabilities in the future. **Self-Learning Topics:** Study of OpenVAS, Nikto, etc.	LO6	10	10
			Total hours	**52**
Text & Reference Books and Links:				
Text Books	1. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws Paperback – Illustrated, 7 October 2011 by Dafydd Stuttard. 2. Hacking: The Art of Exploitation, 2nd Edition 2nd Edition by Jon Erickson 3. Important links of Vulnhub: Vulnhub Kioptrix Download Link: https://www.vulnhub.com/entry/basic-pentesting-1,216/ https://www.vulnhub.com/entry/kioptrix-level-1-1,22/			

	Installation Video: https://youtu.be/JupQRHtfZmw Walkthrough/solutions Video: https://youtu.be/Qn2cKYZ6kBI 4. OWASP Broken Web Application Projects https://sourceforge.net/projects/owaspbwa/. 5. Mastering Modern Web Penetration Testing By Prakhar Prasad, October 2016, Packt Publishing. Kali Linux Revealed: Mastering the Penetration Testing Distribution – June 5, 2017 by Raphael Hertzog (Author), Jim O'Gorman (Author), Offsec Press Publisher.
Term Work:	
The Term work shall consist of at least 10 to 12 practical based on the above syllabus. The term work Journal must include at least 2 assignments. The assignments should be based on real world applications which cover concepts from all above syllabus**.**	
Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)	
Practical & Oral Exam:	
An Oral & Practical exam will be held based on the above syllabus.	

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

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

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

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

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

<table>
<tr><td></td><td>4. The Security Development Lifecycle by Michael Howard Microsoft Press US; 1st edition (31 May 2006).
5. Risk Centric Threat Modeling Process for Attack Simulation And Threat Analysis, Tony Ucedavélez and Marco m. Morana, Wiley.
6. Iron-Clad Java: Building Secure Web Applications (Oracle Press) 1st Edition by Jim Manico.</td></tr>
<tr><td colspan="2">Reference Books:</td></tr>
<tr><td></td><td>1.Software Security: Building Security In by Gary McGraw Addison-Wesley Professional; 1st edition (January 23, 2006).
2.A Guide to Securing Modern Web Applications by Michal Zalewski
3.Threat Modeling: A Practical Guide for Development Teams by Izar Tarandach and Matthew J. Coles Dec 8, 2020.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://owasp.org/www-project-top-ten/
https://owasp.org/www-pdf-archive/OWASP_SCP_Quick_Reference_Guide_v2.pdf
https://pentesterlab.com/
https://app.cybrary.it/browse/course/advanced-penetration-testing
https://www.udemy.com/
https://www.coursera.org/</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
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<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 (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 Three hour duration.</td></tr>
</table>

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

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

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

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

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

Books:

Text Books	1. Hearn and Baker, "Computer Graphics- C version", 2nd edition, Pearson, 2002. 2. R. K Maurya, "Computer Graphics with Virtual Reality", 3rd Edition, Wiley India, 2018. 3. Steven M. LaVelle," Virtual Reality", Cambridge University press, 2019 4. Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley India, 2003 5. Vince, "Virtual Reality Systems", 1st Edition, Pearson Education, 2002.
Reference Books:	
	1. George Mather, "Foundations of Sensation and Perception", Psychology Press book; 3rd Edition, 2016. 2. Tony Parisi, "Learning Virtual Reality", 1st edition, O'Reilly, 2015. 3. Alan Craig and William Sherman," Understanding virtual reality: Interface, application and design", 2nd Edition, Morgan Kaufmann Publisher, 2019. 4. Peter Shirley, Michael Ashikhmin, and Steve Marschner, "Fundamentals of Computer Graphics",A K Peters/CRC Press; 4th Edition, 2016.

Online References:

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

Assessment:

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

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

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	Internal Assessment(IA): Marks will be allotted as per designed rubrics.
End Semester Theory Examination will be of 60-Marks with Three hour 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.			

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<tr><td colspan="2">End Semester Theory Examination will be of 60-Marks with Three hour duration.</td></tr>
</table>

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

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

Course Outcomes:

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

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

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

Books:

Text Books

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

Reference Books:

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

Online References:

www.nptel.ac.in
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Assessment:

Continuous Assessment (CA):

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3.	Internal Assessment	10 marks

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

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

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

Lab Outcomes:

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

Hardware & Software Requirements:

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

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

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

Text & Reference Books and Links:

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

Online Resources:

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

Term Work:

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

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

Practical & Oral Exam:

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

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

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

Course Outcomes:

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

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

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

<table>
<tr><td>Text Books</td><td>1. Beginning 3D Game Development with Unity 4 All-in-one Multi-platform Game development, 2nd Edition, Apress,Sue Backman.
2. Game Development with Unity 2nd Edition,Michelle Menard and Bryan Wagstaff.
3. Unity Game development Essentials,Will Goldstone,PACKT Publishing.
4. Unity Game Development Cookbook-Essentials for every Game,O’reilly,Paris Buttfield-Addison,Jon Manning-Tim Nugent.</td></tr>
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<tr><td></td><td>1. Introduction to Gam Development,Second Edition,Steve Rabin,CENGAGE Learning.
2. Sams Teach Yourself Unity Game Development in 24 Hours-Mike Geig.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://docs.unity3d.com/Manual/VROverview.html
https://www.coursera.org/
https://www.udemy.com/</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –<table><tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr><tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr><tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr></table>Continuous Assessment (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 Three hour 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	**5.1 Interface Electronic Circuits**	CO1,	08	08

Electronic Circuits	Introduction, Signal Conditioners, Sensor Connections, Excitation Circuits, Analog to Digital Converters, Integrated Interfaces, Data Transmission, Noise in Sensors and Circuits, Batteries for Low-Power Sensors, Types of Single board computers, various sensor interfacing with Arduino, Embedded C Programming. data communication protocol interfacing, study the properties of LDR, Build a simple LED light intensity controller, Linux on Raspberry Pi, Interfaces, and Programming. **Self-learning Topics:** Python Programming to interface sensors	CO2, 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			

<table>
<tr><td></td><td>Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://nptel.ac.in/courses/108/108/108108123/
https://nptel.ac.in/courses/108/108/108108098/
https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee41/
https://nptel.ac.in/courses/108/106/108106165/</td></tr>
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Internal Assessment(IA):
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</table>

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

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

Course Outcomes:

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

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

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

<table>
<tr><td></td><td>for the Internet of Things.
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
3. Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research and Innovation to Market.
4. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Development Copyrights ,2014.</td></tr>
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</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	CO6	10	10

<table>
<tr><td></td><td>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 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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</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, Communicating	CO1	06	06

	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)	CO5	08	08

	Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security. **Self-learning Topics:** Case study on IIoT Block chain and Security.			
6. IIOT Applications and Securities	6.1 **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			

<table>
<tr><td></td><td>(Packt Publishing).
2. “Industrial Internet of Things and Communications at the Edge”, by Tony Paine, CEO, Kepware Technologies.
3. “Architectural Design Principles For Industrial Internet of Things”, Hasan Derhamy, Luleå University of Technology, Graphic Production.</td></tr>
<tr><td colspan="2">Online References:</td></tr>
<tr><td colspan="2">https://onlinecourses.nptel.ac.in/noc20_cs69/preview
https://www.coursera.org/specializations/developing-industrial-iot
https://www.coursera.org/lecture/advanced-manufacturing-enterprise/the-industrial-internet-of-things-iiot-59EvI
https://www.coursera.org/lecture/industrial-iot-markets-security/segment-12-blockchains-l4aG9</td></tr>
<tr><td>Assessment:</td><td>Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –
<table>
<tr><td>1.</td><td>Class Test 1</td><td>30 marks</td></tr>
<tr><td>2.</td><td>Class Test 2</td><td>30 marks</td></tr>
<tr><td>3.</td><td>Internal Assessment</td><td>10 marks</td></tr>
</table>
Continuous Assessment (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 Three hour duration.</td></tr>
</table>

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

K J 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 this initiatives is enhancement of the employability skills of the students passing out from Technical Institutions.

OBJECTIVES & EXPECTED OUTCOMES:

Following are the intended objectives of internship training:

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

BENEFITS OF INTERNSHIP:

Benefits to Students:

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

Benefits to the Institute:

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

Benefits to the Industry:

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

STANDARD OPERATING PROCEDURE (SOP) FOR INTERNSHIP:

The general procedure for arranging internship is given below:

Step 1: Request Letter/ Email from the Dean, 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 is 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.

Internship Modules & Contents Across Semester 2 to Semester 8

<table>
<tr><td colspan="4">FY: (Sem II)</td></tr>
<tr><td>Internship Code</td><td>Course Name</td><td>Hours/Duration</td><td>Credits</td></tr>
<tr><td>INT21</td><td>Internship-I</td><td>80-120 hrs (2-3 Weeks)
Winter Vacation After SEM-I & during SEM-II of FY</td><td>02</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Prerequisite:</td><td colspan="3">Fundamental knowledge of Engineering and Technology</td></tr>
<tr><td>Internship Objectives:</td><td colspan="3">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.</td></tr>
<tr><td>Internship Outcomes:</td><td colspan="3">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.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="7">Activity-
Inter/Intra Institutional Activities</td><td colspan="3">Supporting Activities to be completed under Internship</td></tr>
<tr><td colspan="3">• Attending Industry Workshops organised by departments</td></tr>
<tr><td colspan="3">• Working in consultancy or research project initiated by department</td></tr>
<tr><td colspan="3">• Technical festival (participation)</td></tr>
<tr><td colspan="3">• Working in IIC Cell, Entrepreneurship Cell, NISP, IPR cell and/or any other technical professional body/cell/committee/club of the institute</td></tr>
<tr><td colspan="3">• Activities related to Incubation or Innovation</td></tr>
<tr><td colspan="3">• Learning in departmental Labs, Tinkering Lab</td></tr>
<tr><td colspan="4"></td></tr>
</table>

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>

<table>
<tr><th colspan="4">SY (Sem IV)</th></tr>
<tr><th>Internship Code</th><th>Internship Name</th><th>Hours/Duration</th><th>Credits</th></tr>
<tr><td>INT43</td><td>Internship-III</td><td>80-120 hrs (2 - 3 Weeks) Winter Vacation After SEM-III & during SEM-IV of SY</td><td>02</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Prerequisite:</td><td colspan="3">Skill sets of engineering and technology specific tools, instruments, devices and programming languages etc.</td></tr>
<tr><td>Internship Objectives:</td><td colspan="3">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.</td></tr>
<tr><td>Internship Outcomes:</td><td colspan="3">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.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="6">Activity-
Internship</td><td colspan="3">Supporting Activities to be completed under Internship</td></tr>
<tr><td colspan="3">Internships in the field of:</td></tr>
<tr><td colspan="3">● Industries</td></tr>
<tr><td colspan="3">● Government Sector</td></tr>
<tr><td colspan="3">● Non-governmental Organization (NGO)</td></tr>
<tr><td colspan="3">● MSMEs
● Rural Internship</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. 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>

<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

LY (Sem VII)			
Internship Code	**Internship Name**	**Hours/Duration**	**Credits**
INT76	**Internship-VI**	80-160 hrs (2-4 Weeks) **Summer Vacation of TY** and during **SEM-VII of LY**	**02**

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

<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