Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Computer Engineering

Final Year Scheme & Syllabus

(R-2023)

(As per AICTE guidelines, with effect from the Academic Year 2026-27)

<<Draft copy of R2023 Final Year Scheme and Syllabus. To be approved in 10th Academic Council>>

Preamble

The National Education Policy (NEP) framework aims to break the mould from teacher centric to student centric educational practices. It empowers the students with flexibility in terms of choosing courses across different faculties and mode of learning.

This multidisciplinary approach will encourage learners to follow their passion and inherent interests. The learner is free to learn at a pace that he/ she is comfortable with, and this enables lifelong learning. It also enhances the scope for holistic personality development.

This premise is truly reflected in preamble of the NEP document, "The future of nation is decided in the classrooms of the schools and colleges today".

Details of implementation:

NEP curriculum framework enables us to accelerate change, redesign systems with equity in mind, respond to feedback, encourage collaboration, catch and pollinate ideas and create a culture of research and development. It will allow us to offer the required academic flexibility which will focus on improving competency level of students with diverse strengths.

The curriculum planned by VIT has vertical Programme Courses consisting of Program Core Courses (PCC) of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. This vertical also includes Program Elective Courses (PEC) which offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique program elective courses based on industrial requirements and organizing them into tracks is a special feature of this curricula ensuring employability.

The vertical Multidisciplinary Courses consists of Open Elective Courses (OEC) and Multidisciplinary Minor (MDM). Special vocational and skill development courses are included as a part of Skill courses vertical that make student capable to work in industrial environment.

The student is expected to demonstrate their ability through course in Experiential Learning Courses (ELC) vertical like internships/On Job Training, Community Engagement Project, Real Industry Project/ research problem. Our curriculum also introduces Social Service Internship and Internship with other institutes of repute along with courses like Design Thinking. This will lead to creation of products and/ or patents through this program.

For holistic development of students, apart from technical courses, Ability Enhancement Courses, Entrepreneurship/Economics/Management Courses, Indian Knowledge System and Value Education courses from vertical Humanities and Social Science and Management develop the required soft-skills and attitude amongst learners.

In Liberal Learning vertical. courses like Various Dance Forms, Global citizenship Education, Facets of Astronomy etc. aims to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

In addition, our framework offers Honors/ Minor/ Honours by Research degree in each UG programme of engineering. It includes specialized courses along with field/ domain study that make student capable of working on industry relevant problems.

Chairman, Board of Studies
Department of Computer Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Final Year B. Tech. Computer Engineering **Preferred Semester: VII**

Course Structure and Assessment Guidelines

Vertical_ Subvertical	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
PC_PCC	PCCE17	Programming with R	Practical	1	25	-	25	050
PC_PCC	PCCE19	DevOps	Theory+ Practical	2	50	-	25	075
PC_PEC	PECEXX*	Programme Elective-4	As per list below	3	As per list below			
PC_PEC	PECEXX*	Programme Elective-5	As per list below	3	As per list below			
PC_PEC	PECEXX*	Programme Elective-6	As per list below	3	As per list below			
ELC_PRJ	PRJCE03	Project-2 (Final)	Practical	4	75	-	50	125
MDC_MDM	MDM02	Skill and Competency Development 2	Practical	1	50	-	-	050
MDC_MDM	MDMXX#	MDM Course3 of chosen Title	As per list below	4	45	30	50	125
Total Credits				**21**				
Course credits completed during the previous inter-semester break will appear in this semester's marksheet								
ELC_OJT	OJT01	Industry Internship 1	Internship	5	75	-	75	150

*Selection based on the subset of courses made available by the Institute for the semester.

#Selection based on the MDM Title chosen by the student.

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Programme Elective-4 Courses (PECEXXT and PECEXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PECE05T	Natural language processing	Theory	2	15	20	40	075
	PECE05P	Natural language processing Lab	Practical	1	25	-	25	050
Data Science (DS)	PECE07T	Text, Web & Social Media Analytics	Theory	2	15	20	40	075
	PECE07P	Text, Web & Social Media Analytics Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PECE17T	IoT & Edge Computing	Theory	2	15	20	40	075
	PECE17P	IoT & Edge Computing Lab	Practical	1	25	-	25	050
Computer Security (CSec)	PECE12T	Web Application Security	Theory	2	15	20	40	075
	PECE12P	Web Application Security Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Programme Elective-5 Courses (PECEXXT and PECEXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PECE09T	Advance Machine Learning	Theory	2	15	20	40	075
	PECE09P	Advance Machine Learning Lab	Practical	1	25	-	25	050
Data Science (DS)	PECE14T	Big Data Analytics	Theory	2	15	20	40	075
	PECE14P	Big Data Analytics Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PECE19T	IoT Security & Trust	Theory	2	15	20	40	075
	PECE19P	IoT Security & Trust Lab	Practical	1	25	-	25	050
Computer Security (CSec)	PECE15T	Malware Analysis	Theory	2	15	20	40	075
	PECE15P	Malware Analysis Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Programme Elective-6 Courses (PECEXXT and PECEXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PECE13T	Deep learning	Theory	2	15	20	40	075
	PECE13P	Deep learning Lab	Practical	1	25	-	25	050
Data Science (DS)	PECE18T	Recommendation System	Theory	2	15	20	40	075
	PECE18P	Recommendation System Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PECE20T	Industrial IoT	Theory	2	15	20	40	075
	PECE20P	Industrial IoT Lab	Practical	1	25	-	25	050
Computer Security (CSec)	PECE16T	Mobile and Wireless Security	Theory	2	15	20	40	075
	PECE16P	Mobile and Wireless Security Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Multidisciplinary Elective Course-3 (MDMXX)

MD M Title	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Bioinformatics	MDMBI03	Machine Learning Applications in Bioinformatics	Theory+ Tutorial	4	45	30	50	125
Innovation, Entrepreneurial and Venture Development	MDMIE03	Innovation Management and Scaling Startups	Theory+ Tutorial	4	45	30	50	125
Business Development, Marketing and Finance	MDMBD03	Strategic Marketing and Business Planning	Theory+ Tutorial	4	45	30	50	125
Robotics	MDMRB03	Intelligent Mobile Robotics	Theory+ Practical	4	45	30	50	125

Final Year B. Tech. Computer Engineering **Preferred Semester: VIII**

Course Structure and Assessment Guidelines

Vertical_ Subvertical	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
ELC_OJT	OJT02	Industry Internship 2	Internship	7	100	-	100	200
ELC_RM	RM01	Research Methodology	Theory	3	20	30	50	100
MDC_OE	OECXX*	Any Open Elective-2 course	Theory	2	As per list below			
Total Credits				**12**				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

*Selection based on the subset of courses made available by the Institute for the semester.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

List of Open Elective-2 Courses (OECXX)

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OEC02	Cyber Law	Theory	2	15	20	40	075
OEC03	Project Management	Theory	2	15	20	40	075
OEC04	Product Lifecycle Management	Theory	2	15	20	40	075
OEC05	Sustainability Management	Theory	2	15	20	40	075
OEC06	Renewable Energy Management	Theory	2	15	20	40	075

Detailed Syllabus of Third Year Semester-VII

Course Name: Programming with R

Course Code: PCCE17

Vertical_Sub-Vertical: PC_PCC

Preamble:

R Programming for Data Science equips students with the essential skills for data analysis and statistical computing. This course covers fundamental R syntax, data manipulation, visualization techniques, and machine learning applications. Students will learn to apply statistical methods and predictive modeling to real-world datasets. By the end, they will be proficient in using R to extract insights and solve data-driven problems.

Pre-requisites:

Structured Programming (VSEC01), Object Oriented Programming (VSEC02), Engineering Mathematics-II (BSC03)

Course Objectives:

- Develop proficiency in R programming for data handling, manipulation, and visualization.
- Apply statistical methods and hypothesis testing to analyze and interpret data effectively.
- Implement machine learning techniques using R for predictive modelling and clustering.
- Design and execute real-world data science projects using R, from data preprocessing to model deployment.

Course Outcomes:

Learner will be able to:
CO1: Recall fundamental R concepts, data structures (vectors, matrices, data frames), and basic syntax.
CO2: Explain data manipulation techniques (dplyr), visualization (ggplot2), and statistical concepts (hypothesis testing, regression)
CO3: Apply R programming to import/export data, perform statistical tests, and implement basic machine learning models.
CO4: Evaluate model performance (cross-validation, ROC-AUC) and optimize R code for efficiency (data.table, parallel computing).
CO5: Compare different machine learning algorithms and select appropriate models for real-world datasets.
CO6: Design and implement an end-to-end data science project using R, from data cleaning to model deployment.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to R & Data Handling	○ **Introduction to R & RStudio:** Why R is essential for Data Science & Analytics?. Setting up R, RStudio, and essential packages (tidyverse). ○ **R Basics & Data Structures:** Vectors, Matrices, Lists, Data Frames, Factors. Subsetting, Indexing, and Vectorized Operations. ○ **Control Flow & Functions:** Loops (for, while), if-else, switch. Writing efficient functions and error handling (tryCatch). ○ Handling missing values (NA, NULL, NaN)	5
2	Data Manipulation & Visualization	○ **Data Import/Export:** Reading CSV, Excel, JSON, SQL Databases. Writing Data to Files. ○ **Data Manipulation with** dplyr: select(), filter(), mutate(), group_by(), summarize() .Joins (inner_join, left_join). ○ **Data Visualization with** ggplot2: Bar Plots, Histograms, Scatter Plots, Box Plots. Customizing Plots (Labels, Themes, Colors). ○ **Interactive Visualizations (plotly, shiny basics).**	6
3	Statistical Analysis & Hypothesis Testing	○ **Descriptive & Inferential Statistics:** Central tendency, dispersion, skewness, kurtosis. Confidence intervals, p-values, effect size. ○ **Hypothesis Testing:** t-tests (one-sample, two-sample, paired). ANOVA, Chi-square, Wilcoxon tests. ○ **Regression Analysis:** Linear & Logistic Regression. Model diagnostics (R^2, RMSE, multicollinearity).	5

Module No.	Module Name	Content	No of Hours
4	Machine Learning with R	○ **Supervised Learning:** Linear & Logistic Regression, Decision Trees (rpart),Random Forest (randomForest), SVM (e1071), XGBoost (xgboost). ○ **Unsupervised Learning:** K-Means, Hierarchical Clustering, PCA for Dimensionality Reduction. ○ **Model Evaluation & Tuning:** Cross-validation (caret), Hyperparameter tuning, ROC-AUC, Precision-Recall, Confusion Matrix.	5
5	Advanced R for Big Data & Optimization	○ **Working with Big Data:** data.table for Fast Operations, Parallel Computing (parallel, foreach). ○ **Functional Programming in R:** apply(), lapply(), sapply(), Writing Efficient R Code. ○ **Web Scraping & APIs:** rvest for Web Scraping, Connecting to REST APIs (httr).	5
6	Applying R to Real-World Challenges	○ **End-to-End Data Science Project:** Problem Definition → Data Cleaning → Modeling → Visualization. ○ **R in Industry (Case Studies):** Finance, Healthcare, E-commerce Applications.	4
Total			**30**

Textbooks:

1. Hadley Wickham and Garrett Grolemund, “R for Data Science”, First Edition, O’Reilly Media.
2. Norman Matloff, “The Art of R Programming: A Tour of Statistical Software Design”, First Edition, No Starch Press.

Reference Books:

1. Hadley Wickham, “Advanced R”, Second Edition, Chapman and Hall/CRC.
2. Garrett Grolemund, “Hands-On Programming with R: Write Your Own Functions and Simulations”, First Edition, O’Reilly Media.
3. Peter Bruce, Andrew Bruce, and Peter Gedeck, “Practical Statistics for Data Scientists”, Second Edition, O’Reilly Media.

Course Name: DevOps Lab

Course Code: PCCE19

Vertical_Sub-Vertical: PC_PCC

Preamble:
Study of DevOps sets the stage for a holistic approach to software development and delivery, where collaboration, automation, and continuous improvement are the guiding principles in achieving greater agility, efficiency, and resilience in the modern digital era.

Pre-requisites: Operating System (PCCE07), Software Engineering with Web Development (PCCE12).

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory + Practical
1	2	2

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory + Practical	50	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Course Objectives:

- To understand DevOps practices which aims to simplify Software Development Life Cycle.
- To be aware of different Version Control tools like GIT, CVS or Mercurial.
- To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment.
- To be familiarized with selenium tool, which is used for continuous testing of applications deployed.
- To use Docker to Build, ship and manage applications using containerization.
- To understand the concept of Infrastructure as a code and install and configure Ansible tool.

Course Outcomes:

CO No.	Statements	Related Module/s
CO1	To understand the fundamentals of DevOps engineering and be fully proficient with DevOps terminologies, concepts, benefits, and deployment options to meet your business requirements	1
CO2	To obtain complete knowledge of the "version control system" to effectively track changes augmented with Git and GitHub	2
CO3	To understand the importance of Jenkins to Build and deploy Software Applications on server environment	3
CO4	Understand the importance of Selenium and Jenkins to test Software Applications	4
CO5	To understand concept of containerization and Analyze the Containerization of OS images and deployment of applications over Docker	5
CO6	To Synthesize software configuration and provisioning using Puppet or Ansible.	6

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	**Introduction to DevOps**	Basics of Software Development Lifecycle: Learn about the phases of Software Lifecycle (Scrum, Kanban, Agile). Basics of DevOps: Learn about the core concepts of DevOps, the practices and principles followed including continuous integration, continuous delivery, automation, and collaboration between development and operations teams. *Learning Outcome 1.1 - Analyze the phases of the Software Development Lifecycle (SDLC) and differentiate between Agile, Scrum, and Kanban methodologies in real-world scenarios. (CO1) (PI 2.3.3)* *Learning Outcome 1.2 - Apply core DevOps principles such as Continuous Integration, Continuous Delivery, automation, and cross-team collaboration to improve software development processes. (CO1) (PI 5.1.1)*	2
2	**Version Control by GIT**	Fundamentals of GIT, GIT Installation, Version Control, working with repository, Git commands. *Learning Outcome 2.1 - Explain the fundamentals of Git, including version control concepts and the purpose of working with remote repositories. (CO2) (1.4.1)* *Learning Outcome 2.2 - Manage version control using Git by working with remote repositories, performing push/pull*	4

		operations, and collaborating through branching strategies. (CO2) (PI 5.1.1)	
3	**Continuous Integration using Jenkins**	Understand CI concepts and Jenkins architecture, installation, and basic configuration. Create and manage jobs, integrate Git, configure build triggers, and automate builds using Maven/Gradle. *Learning Outcome 3.1 - Define and describe Continuous Integration (CI) concepts and Jenkins architecture, installation process, and basic configuration. (CO3) (PI 1.4.1)* *Learning Outcome 3.2 - Explain how Jenkins integrates with Git, build tools (Maven/Gradle), and build triggers to automate the CI process. (CO4) (PI 5.1.1)* *Learning Outcome 3.3 - Implement and manage Jenkins jobs by configuring build triggers, integrating source code repositories, and automating builds using Maven/Gradle. (CO3) (3.4.2)*	6
4	**Continuous Testing with Selenium**	Introduction to Selenium, Installing Selenium, Writing Tests scripts, Creating Test Cases in Selenium WebDriver, Run Selenium Tests in Jenkins Using Maven. *Learning Outcome 4.1 - Explain* the fundamentals of Selenium, its components (Selenium WebDriver), installation process, and the role of continuous testing in CI pipelines. *(CO4) (PI 1.4.1)* *Learning Outcome 4.2 - Develop and execute Selenium WebDriver test cases and integrate them with Jenkins using Maven to automate test execution. (CO4) (3.4.2)*	4
5	**Continuous Deployment: Containerization with Docke**r	Docker, container and various operations performed on it. Introduction to Docker Architecture and Container Life Cycle, Docker Desktop, Docker Hub and Docker Commands. *Learning Outcome 5.1 - Define key concepts of Docker including images, containers, Docker architecture, and container lifecycle. (CO5) (PI 1.4.1)* *Learning Outcome 5.2 - Explain Docker architecture and describe the different stages in a container lifecycle along with common container operations. (CO5) (PI 2.2.2)* *Learning Outcome 5.3 - Implement and manage Docker containers by performing operations such as building images, running containers, and managing container states. (CO5) (PI 5.1.1)*	4
6	**Automation System**	Puppet Architecture, Puppet Master Slave Communication, Puppet Blocks. *Learning Outcome 6.1 - Define Puppet architecture, its components, and key building blocks (manifests, modules, resources). (CO6) (PI 1.4.1)* *Learning Outcome 6.2 - Explain Puppet Master–Slave*	6

		communication and the workflow of configuration management (CO6) (PI 2.2.2) Learning Outcome 6.3 - Implement basic automation tasks using Puppet by creating manifests and managing configurations across nodes. (CO6) (PI 5.1.1)	
Total			**30**

Suggested List of Practical:

Sr No.	Title of Practical
1.	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities.
2.	To understand Version Control System / Source Code Management, install git and create a GitHub account. To Perform various GIT operations on local and Remote repositories using GIT Cheat-Sheet.
3.	To understand Continuous Integration, install and configure Jenkins with Maven/Ant/Gradle to set up a build Job.
4.	To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an application over the tomcat or nginx server.
5.	To understand Jenkins Master-Slave Architecture and scale your Jenkins standalone implementation by implementing slave nodes.
6.	To Setup and Run Selenium Tests in Jenkins Using Maven.
7.	To understand Docker Architecture and Container Life Cycle, install Docker and build a running container for Mini Project by integrating it with Jenkins.
8.	To learn Dockerfile instructions, build an image for a sample web application / Mini Project Application using Docker Hub and Docker Desktop.
9.	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet Manifest.
10.	To install and configure Ansible Push Software Configuration Management and provision serverless architecture using YAML playbook.
11.	Presentation on new technologies used in DevOps, Cloud and Big Data.

Course Outcome (CO) Statements mapping with Learning Outcome (LO):

COs	Mapped to Learning Outcomes
CO1	1.1, 1.2
CO2	2.1, 2.2
CO3	3.1, 3.2, 3.3
CO4	4.1, 4.2
CO5	5.1, 5.2, 5.3
CO6	6.1, 6.2, 6.3

Assessment Criteria of Learning Outcomes:

Learning Outcomes: The Learner will:	**Assessment Criteria:** The Learner can:	**Evaluated under ISA/MSE/ESE/LAB**
1.1 Analyze the phases of the SDLC and differentiate between Agile, Scrum, and Kanban methodologies in real-world scenarios. *(P.I. - 2.2.3 and 3.2.1) (CO1)*	Understand	ISA
1.2 Apply core DevOps principles such as CI/CD automation, and cross-team collaboration to improve software development processes. *(P.I. - 3.4.2 and 5.1.1) (CO1)*	Apply	LAB, ESE
2.1 Explain the fundamentals of Git, including version control concepts and the purpose of working with remote repositories. *(P.I. - 1.4.1 and 2.1.2) (CO2)*	Remember	ISA
2.2 Manage version control using Git by working with remote repositories, performing push/pull operations, and collaborating through branching strategies. *(P.I. - 3.4.2 and 9.2.1) (CO2)*	Apply	LAB, ESE
3.1 Define and describe Continuous Integration (CI) concepts and Jenkins architecture, installation process, and basic configuration. *(P.I. - 2.1.2 and 3.1.1) (CO3)*	Apply, Create	ISA
3.2 Explain how Jenkins integrates with Git, build tools (Maven/Gradle), and build triggers to automate the CI process. *(P.I. - 3.4.1 and 5.2.1) (CO3)*	Apply, Analyze	LAB, ESE
3.3 Implement and manage Jenkins jobs by configuring build triggers, integrating source code repositories, and automating builds using Maven/Gradle. *(P.I. - 3.4.2 and 4.2.1) (CO3)*	Apply, Create	LAB, ESE
4.1 Explain the fundamentals of Selenium, its Selenium WebDriver, installation process, and the role of continuous testing in CI pipelines. *(P.I. - 4.1.2 and 5.2.1) (CO4)*	Remember, Apply	ISA
4.2 Develop and execute Selenium WebDriver test cases and integrate them with Jenkins using Maven to automate test execution. *(P.I. - 3.4.2 and 4.3.1) (CO4)*	Apply, Analyze	LAB, ESE

5.1 Define key concepts of Docker including images, containers, Docker architecture, and container lifecycle. *(P.I. - 1.4.1 and 2.1.2) (CO5)*	Understand	ISA
5.2 Explain Docker architecture and describe the different stages in a container lifecycle along with common container operations. *(P.I. - 2.2.2 and 3.4.1) (CO5)*	Remember	LAB, ESE
5.3 Implement and manage Docker containers by performing operations such as building images, running containers, and managing container states. *(P.I. - 3.4.2 and 5.1.1) (CO5)*	Apply, Create	LAB, ESE
6.1 Define Puppet architecture its components, and key building blocks (manifests, modules, resources). *(P.I. - 1.4.1 and 2.1.2) (CO6)*	Understand	ISA
6.2 Puppet Master–Slave communication and the workflow of configuration management. *(P.I. - 2.2.1 and 3.4.1) (CO6)*	Understand	ISA
6.3 Implement basic automation tasks using Puppet by creating manifests and managing configurations across nodes. *(P.I. - 3.4.2 and 5.1.1) (CO6)*	Apply, Evaluate	LAB, ESE

Textbooks:

1. DevOps Bootcamp, Sybgen Learning
2. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
3. Len Bass, Ingo Weber, Liming Zhu," DevOps, A Software Architects Perspective", Addison Wesley-Pearson Publication.
4. John Ferguson Smart,"Jenkins, The Definitive Guide", O'Reilly Publication.

Reference Books:

1. Sanjeev Sharma and Bernie Coyne," DevOps for Dummies", Wiley Publication
2. Httermann, Michael, "DevOps for Developers", Apress Publication.
3. Joakim Verona, "Practical DevOps", Pack publication
4. Puppet 5 Essentials - Third Edition: A fast-paced guide to automating your infrastructure by Martin Alfke Packt Publishing; 3rd Revised edition (September 13, 2017)
5. Alan Clements, "Principles of Computer Hardware", 4th edition, Oxford University Press
6. Natalia Olifer & Victor Olifer, "Computer Networks: Principles, Technologies & Protocols for Network Design", Wiley India
7. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", 2nd Edition, The Morgan Kaufmann Series in Networking

Course Name: Natural Language Processing

Course Code: PECE05T

Vertical_Sub-Vertical: PC_PEC (PE4 of AIML Track)

Preamble:

Natural Language Processing (NLP) is a foundational field at the intersection of Artificial Intelligence and Linguistics, concerned with the design and development of algorithms that enable computers to understand, interpret, and generate human language. With the increasing demand for intelligent systems that can process text and speech, NLP has become an essential area in computer science and data science. This course introduces the theoretical and practical aspects of NLP, covering linguistic fundamentals, core text analysis techniques, parsing, semantics, discourse processing, and real-world applications. Emphasis is also placed on the challenges of processing Indian languages and the development of interpretable NLP systems.

Pre-requisites:

PCCE13 (Machine Learning), PECE01 (Soft Computing) and PCCE15 (System Programming and Compiler Design).

Course Objectives:

- Understand the fundamental concepts of Natural Language Processing, including language structure, morphology, grammar, ambiguities, and foundational language modeling techniques.
- Apply various parsing algorithms, semantic analysis, and word representation models to process and analyze natural language data in both English and regional Indian languages.
- Analyze neural network-based language models and embedding techniques such as Word2Vec, GloVe, LSTM, and attention mechanisms for NLP tasks.
- Evaluate and implement NLP applications like machine translation, text summarization, sentiment analysis, and question answering using modern tools and deep learning approaches.

Course Outcomes:

Learner will be able to:

CO1: Recall fundamental concepts of NLP such as stages of language processing, grammar, and basic text preprocessing techniques like tokenization and stemming.
CO2: Explain morphological, syntactic, and semantic components of language using appropriate models and tools.
CO3: Apply parsing algorithms and semantic techniques (like WSD and discourse resolution) to analyze linguistic structures.
CO4: Analyze the structure and relationships in lexical resources (e.g., WordNet, BabelNet) and evaluate semantic similarity and ambiguity.
CO5: Evaluate the performance of various neural language models and word embedding techniques on language tasks.
CO6: Design and implement real-world NLP applications like machine translation or sentiment analysis using advanced deep learning models.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Foundations of NLP and Language Modelling	Language, Knowledge and Grammar in language processing; Stages in NLP; Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP; Applications of NLP. Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Morphological Models: Dictionary lookup, finite state morphology; Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing: Laplace Smoothing, Good-Turing Discounting. ***Self-Learning Topics***: *Variety types of tools for regional languages pre-processing and other functionalities, Noisy channel models, various edit distance, Advance Issues in Language Modelling.*	6
2	Parsing Techniques and Syntax Modelling	Parsers: Top down and bottom up; Modelling constituency; Bottom-Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; TopDown Parser: Early Parser, Predictive Parser. ***Self-Learning Topics***: *Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks*	5
3	Semantics, and Discourse	Introduction, meaning representation; Lexical Semantics; Corpus study; Knowledge Graphs &	5

		Ontologies; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Semantic Similarity and Relatedness. Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs Algorithm ***Self-Learning Topics***: *Dictionaries for regional languages, Topic Models, Discourse segmentation, Conference resolution*	
4	Word Representations and Embedding Models	Word2Vec, CBOW and Skip-Gram Models, One word learning architecture, Forward pass for Word2Vec, Matrix Operations, Word Representation: Word2Vec & fastText, Word Representation: GloVe, Tokenization Strategies	6
5	Neural Language Models and Sequence Learning	Neural Language Models - CNN, RNN, RNN - Based Language Model, LSTM, GRU, Sequence-to-Sequence Models, Greedy Decoding, Beam search, Other Decoding Strategies: Nucleus Sampling, Temperature Sampling, Top-k Sampling, Attention in Sequence-to-Sequence Models	5
6	Applications of NLP in Real-World Scenarios	Case studies on (preferable in regional language): Machine translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system ***Self-Learning Topics***: *Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.*	3
		Total	**30**

Textbooks:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing", 3e, Pearson Education, 2018
2. Christopher D.Manning and Hinrich Schutze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
3. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
4. Daniel and James H. Martin "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Second Edition, Prentice Hall of India, 2008.

Reference Books:

1. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing
3. James Allen “Natural Language Understanding”, Pearson Publication 8th Edition. 2012

Course Name: Natural Language Processing Lab

Course Code: PCCE05P

Vertical_Sub-Vertical: PC_PEC (PE4 of AIML Track)

Preamble:

Natural Language Processing (NLP) is a foundational field at the intersection of Artificial Intelligence and Linguistics, concerned with the design and development of algorithms that enable computers to understand, interpret, and generate human language. With the increasing demand for intelligent systems that can process text and speech, NLP has become an essential area in computer science and data science. This course introduces the theoretical and practical aspects of NLP, covering linguistic fundamentals, core text analysis techniques, parsing, semantics, discourse processing, and real-world applications. Emphasis is also placed on the challenges of processing Indian languages and the development of interpretable NLP systems.

Pre-requisites:

PCCE13 (Machine Learning), PECE201 (Soft Computing) and PCCE15 (System Programming and Compiler Design).

Lab Objectives:

- To understand the key concepts of NLP.
- To design and implement various language models and POS tagging techniques.
- To understand various NLP Algorithms
- To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc.
- To design and implement applications based on natural language processing

Course Outcomes:

Learner will be able to:

LO1. Apply various text processing techniques.

LO2. Design language model for word level analysis.

LO3. Design, implement and analyze NLP algorithms.

LO4. To apply NLP techniques to design real world NLP applications such as machine translation, sentiment analysis, text summarization, information extraction, Question Answering system etc.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Build a Tokenizer and Stemmer for English and a selected Indian regional language (e.g., Hindi or Tamil).
2	Implement a language model to predict the next word using Trigram with Laplace smoothing.
3	Linguistic Analysis using POS Tagging and Named Entity Recognition
4	Feature Extraction: TF-IDF, N-grams, and Word Embeddings
5	Build a Word Sense Disambiguation (WSD) tool using dictionary-based and machine learning approaches.
6	Develop an Anaphora Resolver using Hobbs' Algorithm for English narratives.
7	Train Word2Vec (CBOW and Skip-Gram) models on a regional language corpus.
8	Build and train an RNN-based language model to generate simple sentences from a dataset.
9	Create a Seq2Seq translation model with attention for English to regional language (e.g., English to Hindi).
10	Design a sentiment analysis system for product reviews in a regional language using LSTM.

Textbooks:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing", 3e, Pearson Education, 2018
2. Christopher D.Manning and Hinrich Schutze, — Foundations of Statistical Natural Language Processing —, MIT Press, 1999.
3. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
4. Daniel and James H. Martin "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Second Edition, Prentice Hall of India, 2008

Reference Books:

1. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) — The Handbook of Computational Linguistics and Natural Language Processing
3. James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012

Course Name: Text, Web and Social Media Analytics

Course Code: PECE07T

Vertical_Sub-Vertical: PC_PEC (PE4 of DS Track)

Preamble:

In today's data-driven world, understanding insights from unstructured and dynamic sources such as text, web, and social media has become vital for organizations. This course introduces the foundational concepts and advanced techniques in Text, Web & Social Media Analytics. Students will explore the structure of social networks, analyze user actions, hyperlinks, and geospatial trends, and apply modern tools for visualizing and interpreting online behavior. The course bridges traditional analytics with the evolving landscape of digital interaction. By the end, students will be equipped to design actionable strategies using analytics tools across multiple online platforms.

Pre-requisites:

Web Design Lab (PCCE12P), Data Warehousing and Data Mining (PECE02)

Course Objectives:

- To provide foundational knowledge of social media platforms, their core characteristics, and the evolving landscape that drives the need for Social Media Analytics (SMA) in business contexts.
- To equip students with analytical skills for interpreting social network structures and applying network analysis tools to understand influence, engagement, and connectivity in digital environments.
- To develop competency in extracting actionable insights from social media text, user behavior (actions), and hyperlink structures using modern text and action analytics techniques.
- To introduce students to location-based and search engine analytics by exploring data sources, privacy concerns, user query behaviour, and relevant analytics tools and dashboards.
- To enable learners to design data-driven strategies through web analytics, recommendation systems, KPI measurement, and privacy-conscious approaches for managing social media and web presence effectively

Course Outcomes:

Learner will be able to:
CO1: Understand the concepts, characteristics, and evolving trends of social media and its analytics.
CO2: Apply appropriate techniques to analyze social media data, including text, actions, and networks.
CO3: Use tools and platforms to perform social media, web, and search engine analytics effectively.
CO4: Analyze user behavior, content diffusion, and engagement metrics across social and web platforms.
CO5: Evaluate the impact of social media analytics on strategic decision-making and digital marketing.
CO6: Design ethical, privacy-aware, and data-driven strategies for social media and web-based environments.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Social Media Analytics: An Overview	○ Core Characteristics of social media, social media landscape and trends, Need for Social Media Analytics for small & large organizations. ○ Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools.	6
2	Social Network Structure, Measures & Visualization	Introduction to social network structures including nodes, edges, and ties. Network measures such as degree distribution, density, connectivity, centralization, tie strength, and trust. Basics of network visualization including graph layouts, visualization of features, and scale-related challenges. Key graph terminologies such as hubs, authorities, bridges, ego networks, modularity, clustering coefficient, and homophily. Introduction to network analysis tools such as Gephi, NodeXL, and SocNetV.	6
3	Social Media Text, Action & Hyperlink Analytics	Social Media Text Analytics - Types, purpose of text analytics in extracting user sentiment, intent, and trends and tools. Steps in social media text analytics including data collection, cleaning, tokenization, sentiment detection, and topic modeling. Action analytics —definition, scope, and significance of analyzing user actions and tools. Hyperlink analytics—types of hyperlinks used in social platforms, categories of hyperlink analysis (inbound, outbound, anchor text, etc.), and tools.	8

4	Social Media Location and Search Engine Analytics	Location Analytics- sources of location data in social media, including GPS tags, check-ins, and user metadata, categories of location analytics, privacy concerns related to location-based. Search engine analytics, exploring types of search engines like crawler-based and metasearch engines, methods for analyzing user queries and search behaviors, and popular tools such as Google Analytics, Search Console, and SEMrush.	6
5	Social Information Filtering	Social Sharing and filtering, Type of Recommendation Traditional vs social recommendation systems, understanding social media and Business Alignment, social media KPI, formulating a Social Media Strategy, Managing Social Media Risks. Privacy policies	6
6	Web Analytics	Fundamentals of web analytics, user behavior metrics such as page views, bounce rate, and session duration. Search engine performance analysis using rank positions, click-through rates, and keyword tracking. challenges like spam content and techniques to ensure data accuracy and quality	5
Total			**30**

Textbooks:

1. Matthew Ganis and Avinash Kohirkar, "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media", First Edition, IBM Press..
2. Marshall Sponder, "Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics", First Edition, McGraw-Hill Education.

Reference Books:

1. Charu C. Aggarwal, "Social Network Data Analytics", First Edition, Springer.
2. Glen L. Urban, "Digital Marketing Strategy: Analytics, Technology, and Customer Engagement", First Edition, Pearson Education.
3. S. Srinivasan, "Web and Social Media Analytics: A Practical Guide to Data Collection and Analysis", First Edition, Wiley.

Course Name: Text, Web and Social Media Analytics Lab

Course Code: PECE07P

Vertical_Sub-Vertical: PC_PEC (PE4 of DS Track)

Preamble:

In today's data-driven world, understanding insights from unstructured and dynamic sources such as text, web, and social media has become vital for organizations. This course introduces the foundational concepts and advanced techniques in Text, Web & Social Media Analytics. Students will explore the structure of social networks, analyse user actions, hyperlinks, and geospatial trends, and apply modern tools for visualizing and interpreting online behaviour. The course bridges traditional analytics with the evolving landscape of digital interaction. By the end, students will be equipped to design actionable strategies using analytics tools across multiple online platforms.

Pre-requisites:

Web Design Lab (PCCE12P), Data Warehousing and Data Mining Lab (PECE02P)

Course Objectives:

- To provide foundational knowledge of social media platforms, their core characteristics, and the evolving landscape that drives the need for Social Media Analytics (SMA) in business contexts.
- To equip students with analytical skills for interpreting social network structures and applying network analysis tools to understand influence, engagement, and connectivity in digital environments.
- To develop competency in extracting actionable insights from social media text, user behavior (actions), and hyperlink structures using modern text and action analytics techniques.
- To introduce students to location-based and search engine analytics by exploring data sources, privacy concerns, user query behaviour, and relevant analytics tools and dashboards.
- To enable learners to design data-driven strategies through web analytics, recommendation systems, KPI measurement, and privacy-conscious approaches for managing social media and web presence effectively

Course Outcomes:

Learner will be able to:
CO1: Understand the concepts, characteristics, and evolving trends of social media and its analytics.
CO2: Apply appropriate techniques to analyze social media data, including text, actions, and networks.
CO3: Use tools and platforms to perform social media, web, and search engine analytics effectively.
CO4: Analyze user behavior, content diffusion, and engagement metrics across social and web platforms.
CO5: Evaluate the impact of social media analytics on strategic decision-making and digital marketing.
CO6: Design ethical, privacy-aware, and data-driven strategies for social media and web-based environments.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr No.	Title of Practical
1.	Sentiment Analysis of YouTube Comments
2.	Visualize a Twitter Follower Network Using Gephi
3.	Trend and Sentiment Analysis for a Twitter Hashtag.
4.	Analyze Social Media Metrics of a Brand Page.
5.	Explore tools like Hootsuite, Brandwatch, and Sprinklr and compare them based on features and usability.
6.	Follower Engagement Network for Instagram Influencer
7.	Location Heatmap using Social Media Metadata.
8.	Web Analytics Dashboard Interpretation.
9.	Design a content recommendation system based on user preferences and sentiment data collected from YouTube video interactions or tweets liked/shared.
10.	Perform tokenization, stop word removal, stemming, and vectorization on sample tweets or posts.
11.	Conduct a case-based discussion or prepare a brief report on data privacy, consent, and platform policies when scraping user data.

Textbooks:

1. Matthew Ganis and Avinash Kohirkar, "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media", First Edition, IBM Press.
2. Marshall Sponder, "Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics", First Edition, McGraw-Hill Education.

Reference Books:

1. Charu C. Aggarwal, "Social Network Data Analytics", First Edition, Springer.
2. Glen L. Urban, "Digital Marketing Strategy: Analytics, Technology, and Customer Engagement", First Edition, Pearson Education.

Course Name: Internet of Things and Edge Computing

Course Code: PECE17T

Category: PC_PEC (PE4 of IoT Track)

Preamble:

This course explores the convergence of Internet of Things (IoT) and Edge Computing, delving into the technologies and applications that are transforming our world. This course delves into the rapidly evolving landscape where everyday objects are becoming intelligent and interconnected. Students will explore how sensors, actuators, and embedded systems are weaving a web of data, transforming how we live, work, and interact with the environment.

The course will equip students with a foundational understanding of IoT, its core technologies, and communication protocols. Students will delve into the power of Edge Computing, a paradigm shift that brings processing capabilities closer to the data source, enabling real-time analytics, faster decision-making, and improved efficiency.

Pre-requisites:

- C Programming
- Microprocessor and Microcontroller
- IoT Sensor Technology

Course Objectives:

- To understand the core concepts of the Internet of Things (IoT) and its key components & Levels.
- Analyze the role of Edge Computing in distributed processing and data analysis within the IoT ecosystem**.**
- Evaluate the security challenges and potential vulnerabilities within IoT deployments.
- Understand the fundamental concepts of IoT, CPS, and their convergence.

Course Outcomes:

Student will be able to:

CO1: Understand the interaction between IoT devices, cloud platforms, and physical systems in CPS.
CO2: Apply principles of Edge Computing to analyze data at the network edge.
CO3: Analyze the role of Edge Computing in distributed processing and data analysis within the IoT ecosystem.
CO4: Identify and discuss security best practices for secure IoT deployments.
CO5: Analyze the role of cloud computing in managing and processing data from IoT device
CO6: Develop creative applications of IoT technology in chosen fields.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to IoT and CPS	1.1 Introduction to Cyber-Physical Systems (CPS) 1.2 Characteristics and applications of CPS 1.3 Convergence of IoT and CPS: creating intelligent systems	5
2	Introduction to Edge Computing	2.1 What is Edge Computing? 2.2 Benefits of Edge Computing in the IoT ecosystem (e.g., reduced latency, improved efficiency) 2.3 Edge Computing architectures (e.g., edge nodes, fog computing) Resource constraints and limitations of edge devices	5
3	Edge Computing Applications and Programming	3.1 Case studies of Edge Computing applications in IoT (e.g., predictive maintenance, autonomous vehicles) 3.2 Introduction to Edge Computing development tools and frameworks 3.3 Programming for edge devices (e.g., embedded systems programming)	5
4	Security Considerations in IoT	4.1 Security vulnerabilities in IoT deployments 4.2 Authentication and authorization mechanisms 4.3 Data encryption and privacy concerns 4.4 Secure coding practices for IoT devices	5
5	Cloud Computing for IoT	5.1 Cloud service models for IoT (IaaS, PaaS, SaaS) 5.2 Benefits of cloud computing in managing and processing IoT data (scalability, security, etc.) 5.3 Cloud platforms for IoT (e.g., AWS IoT, Azure IoT)	5

		5.4 Data pipelines for transferring and processing sensor data in the cloud	
6	Future Trends in IoT CPS and Edge Computing	6.1 Emerging technologies (e.g., Artificial Intelligence, Block chain) in IoT 6.2 Impact of 5G on IoT and Edge Computing 6.3 Ethical considerations and responsible development of CPS solutions	5
Total			**30**

Text Books:

1. "Cyber-Physical Systems: Design and Analysis" by Lee E. Miller (2013)
2. "Cloud Computing for Cyber Physical Systems: Enabling Technologies and Applications" by Vijayakumar Gayathri, et al. (2019)
3. "Hands-On Internet of Things with Arduino and Raspberry Pi: Building Practical Applications" by Dr. Srinivas Upputuri (2020)
4. "Building IoT Projects with ESP8266 and ESP32" by Pradeeka Kumar (2020)
5. "Edge Computing for the Internet of Things: Secure and Scalable Distributed Intelligence" by Michael Dieterich (2020)
6. "Cyber-Physical Systems Prototyping with Lego Mindstorms" by Wesley Plugge et al. (2014)

Reference Books:

1. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally (2014)
2. "Edge Computing: Networking and Security for the Internet of Things" by Yuhui Xu, et al. (2018)
3. "Fog Computing: Theory, Practice, and Applications" by Tom Pfeifer and Dominic Grulich (2019)

Course Name: Internet of Things and Edge Computing Lab

Course Code: PECE17P

Category: PC_PEC (PE4 of IoT Track)

Preamble:

This laboratory course delves into the practical applications of the Internet of Things (IoT), Edge Computing, Cloud Computing, and Cyber-Physical Systems (CPS). Students will gain hands-on experience by working with real-world scenarios and exploring the interaction between these technologies

The lab will equip students with the skills to:

- Design and implement basic IoT systems
- Utilize Edge Computing platforms for data processing closer to the source
- Leverage cloud services for data storage, analysis, and visualization
- Integrate IoT devices with Cyber-Physical Systems for real-world applications

Pre-requisites:

C Programming, Microprocessor and Microcontroller and IoT Sensor Technology

Course Objectives:

- Gain practical experience in setting up and configuring IoT devices.
- Understand and implement data collection and processing techniques on edge devices.
- Analyze and visualize data generated by IoT devices using cloud platforms.
- Design and implement basic Cyber-Physical Systems using IoT and cloud integration.
- Apply security best practices in developing and deploying IoT solutions.

Course Outcomes:

Student will be able to:

CO1: Successfully configure and program various IoT devices (sensors, actuators).

CO2: Utilize Edge Computing platforms for data processing tasks on edge nodes.

CO3: Develop data pipelines to transfer data from IoT devices to the cloud.

CO4: Analyze and visualize sensor data using cloud-based tools and services.

CO5: Design and prototype a basic Cyber-Physical System with IoT and cloud integration.

CO6: Implement secure communication protocols for data transmission in an IoT system.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

List of Practical's:

Experiment 1: Setting Up an IoT Development Environment

- Familiarize with development boards (e.g., Arduino, Raspberry Pi)
- Install necessary software and libraries

Experiment 2: Sensor Interfacing and Data Acquisition

- Interface various sensors (e.g., temperature, humidity) with the development board
- Write code to collect and record sensor data

Experiment 3: Communication Protocols for IoT

- Experiment with different communication protocols (e.g., Wi-Fi, Bluetooth)
- Develop code to send and receive data between devices

Experiment 4: Introduction to Edge Computing Platforms

- Explore popular Edge Computing platforms (e.g., AWS Greengrass, Azure IoT Edge)
- Deploy simple applications for data processing on edge devices

Experiment 5: Cloud Integration for IoT Data

- Connect IoT devices to a cloud platform (e.g., AWS IoT, Azure IoT Hub)
- Develop code to send sensor data to the cloud

Experiment 6: Data Visualization with Cloud Services

- Utilize cloud platform tools to visualize sensor data in real-time (e.g., dashboards, charts)

Experiment 7: Introduction to Cyber-Physical Systems (CPS)

- Simulate a basic CPS scenario (e.g., smart home, industrial automation)
- Integrate IoT devices with actuators to control physical processes

Experiment 8: Security Considerations in IoT Systems

- Implement secure communication protocols (e.g., encryption)
- Understand best practices for securing data transmission and storage in IoT

Mini Projects / Case Study:-

Design and develop a complete IoT-based system with Edge Computing and Cloud integration

Text Books:

1. "Cyber-Physical Systems: Design and Analysis" by Lee E. Miller (2013)
2. "Cloud Computing for Cyber Physical Systems: Enabling Technologies and Applications" by Vijayakumar Gayathri, et al. (2019)
3. "Hands-On Internet of Things with Arduino and Raspberry Pi: Building Practical Applications" by Dr. Srinivas Upputuri (2020)
4. "Building IoT Projects with ESP8266 and ESP32" by Pradeeka Kumar (2020)
5. "Edge Computing for the Internet of Things: Secure and Scalable Distributed Intelligence" by Michael Dieterich (2020)
6. "Cyber-Physical Systems Prototyping with Lego Mindstorms" by Wesley Plugge et al. (2014)

Reference Books:

1. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally (2014)
2. "Edge Computing: Networking and Security for the Internet of Things" by Yuhui Xu, et al. (2018)
3. "Fog Computing: Theory, Practice, and Applications" by Tom Pfeifer and Dominic Grulich (2019)

Course Name: Web Application Security

Course Code: PECE12T

Category: PC_PEC (PE4 of CSec Track)

Preamble:

This course focuses on identifying, analysing, and mitigating vulnerabilities specific to web applications. It empowers students with practical skills using industry-standard tools and frameworks and promotes secure web development practices aligned with OWASP and modern threat landscapes.

Pre-requisites: Web Design Lab (PCCE12P)

Course Objectives:

- To reveal the underlying web application.
- To identify and aid in fixing any security vulnerabilities during the web development process.
- To understand the security principles in developing a reliable web application.

Course Outcomes:

Learner will be able to:

1. Identify the vulnerabilities in the web applications
2. Identify the various types of threats and mitigation measures of web applications.
3. Apply the security principles in developing a reliable web application.
4. Use industry standard tools for web application security.
5. Create detailed reports on findings, mitigations, and secure design.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Overview of Web Applications	Introduction history of web applications interface and structure benefits and drawbacks of web applications Web application Vs Cloud application, Web architecture, HTTP/HTTPS, sessions, cookies, authentication, same-origin policy, common attack vectors.	4
2	Web Application Security Fundamentals	Security Fundamentals: Input Validation - Attack Surface Reduction Rules of Thumb- Classi- fying and Prioritizing Threads, Origin Policy - Exceptions to the Same-Origin Policy - Cross-Site Scripting and Cross-Site Request Forgery - Reflected XSS - HTML Injection.	7
3	Web Application Vulnerabilities	Understanding vulnerabilities in traditional client server applications and web applications, client state manipulation, cookie-based attacks, SQL injection, cross domain attack (XSS/XSRF/XSSI) http header injection. SSL vulnerabilities and testing - Proper encryption use in web application - Session vulnerabilities and testing - Cross-site request forgery, OWASP Top 10: SQLi, XSS, CSRF, IDOR, File Inclusion, SSRF, XXE. Understanding root causes and testing techniques	6
4	Tools for Security Testing	Burp Suite, ZAP Proxy, Nikto, WFuzz, HTTP interceptors, crawling, fuzzing, authentication testing	6
5	Secure Website Design	Secure website design: Architecture and Design Issues for Web Applications, Deployment Considerations Input Validation, Authentication, Authorization, Configuration Management, Sensitive Data, Session Management, Cryptography, Parameter Manipulation, Exception Management, Auditing and Logging, Design Guidelines, Forms and validity, technical implementation	4
6	Case Studies and Emerging Trends	Recent high-profile web application breaches, evolving attack trends (e.g., API abuse, supply chain), real-world secure architecture examples	3
Total			**30**

Textbooks:

1. Stuttard, D., & Pinto, M. (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws (2nd ed.). Indianapolis: Wiley Publishing. ISBN: 978-1118026472
2. Gowadia, V., & Parekh, A. (2022). Web Application Security: Exploitation and Countermeasures for Java, Python, and Node.js. Berkeley, CA: Apress. ISBN: 978-1484285066

Reference Books:

1. Shema, M. (2014). Hacking Web Apps: Detecting and Preventing Web Application Security Problems. Waltham, MA: Syngress. ISBN: 978-0124166004
2. Erickson, J. (2008). Hacking: The Art of Exploitation (2nd ed.). San Francisco, CA: No Starch Press. ISBN: 978-1593271442
3. Andress, J. (2014). The Basics of Information Security: Understanding the Fundamentals of InfoSec (2nd ed.). Waltham, MA: Syngress. ISBN: 978-0128007440

Online Resources for Learning:

1. OWASP Foundation. Web Security Testing Guide (WSTG). Retrieved from https://owasp.org/www-project-web-security-testing-guide/
2. PortSwigger. Web Security Academy (Interactive Learning Platform). Retrieved from https://portswigger.net/web-security

Course Name: Web Application Security Lab

Course Code: PECE12P

Category: PC_PEC (PE4 of CSec Track)

Preamble:

This course focuses on identifying, analysing, and mitigating vulnerabilities specific to web applications. It empowers students with practical skills using industry-standard tools and frameworks and promotes secure web development practices aligned with OWASP and modern threat landscapes.

Pre-requisites:

Course Objectives:

- To reveal the underlying web application.
- To identify and aid in fixing any security vulnerabilities during the web development process.
- To understand the security principles in developing a reliable web application.

Course Outcomes:

Learner will be able to:

1. Identify the vulnerabilities in the web applications
2. Identify the various types of threats and mitigation measures of web applications.
3. Apply the security principles in developing a reliable web application.
4. Use industry standard tools for web application security.
5. Create detailed reports on findings, mitigations, and secure design.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

1. Web application reconnaissance and spidering using ZAP/Burp Suite
2. Exploit SQL Injection on a vulnerable application (DVWA or Juice Shop)
3. Detect and exploit Cross-Site Scripting (XSS)
4. Perform vulnerability scans using Nikto or ZAP
5. Analyse secure HTTP headers and apply security configurations (CSP, HSTS, etc.)
6. Build and Deploy a Secure Login Module (Design login with input sanitization, secure cookies, and rate-limiting.)
7. Prepare a Security Assessment Report

Course Name: Advance Machine Learning

Course Code: PECE09T

Category: PC_PEC (PE5 of AIML Track)

Preamble:

Advanced Machine Learning is designed to equip undergraduate students with cutting-edge techniques and practical skills in machine learning. Building on foundational ML knowledge, it covers advanced topics such as ensemble methods, probabilistic models, graph-based learning, meta learning, and AutoML. Through a blend of theory and hands-on applications, students will learn to develop, interpret, and deploy sophisticated ML models for real-world challenges. The course aims to bridge the gap between academic concepts and industry-ready expertise.

Pre-requisites:

Machine Learning (PCCE13T), Analysis of Algorithms (PCCE04T), Engineering Mathematics-III (BSC05), Machine Vision using Python Lab (PCCE18).

Course Objectives:

- Recall key concepts of advanced ML techniques (regularization, kernels, ensembles, clustering, text analysis) and explain their mathematical foundations (GLMs, EM algorithm, bias-variance tradeoff).
- Implement ML pipelines in Python (e.g., regularized regression, SVM kernels, ensemble models) and compare the performance of clustering, dimensionality reduction, and feature selection methods.
- Assess model robustness through statistical testing, hyperparameter optimization, and concept drift detection to ensure reliability in production systems.
- Design and deploy an end-to-end ML solution integrating advanced techniques while addressing ethical implications (bias, privacy) and sustainability (computational efficiency).

Course Outcomes:

Learners will be able to:
CO1: Recall key concepts of advanced ML techniques including regularization methods, kernel functions, ensemble models, clustering algorithms, and text analysis approaches.
CO2: Explain mathematical foundations of GLMs, kernel tricks, bias-variance tradeoff, EM algorithm, and feature importance methods.
CO3: Implement ML pipelines using Python for regularized regression, SVM with custom kernels, ensemble methods, clustering, and text classification.
CO4: Compare performance of different ML techniques including clustering algorithms, dimensionality reduction methods, and feature selection approaches.
CO5: Assess model robustness through statistical testing, hyperparameter optimization, and monitoring for concept drift in production systems.
CO6: Design and deploy an end-to-end ML solution integrating advanced techniques while considering ethical and sustainability aspects

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Advanced Supervised Learning	• Advanced Regression:Ridge, Lasso, Elastic Net (L1/L2 Regularization), Generalized Linear Models (GLMs) • Support Vector Machines (SVM) – Advanced:Kernel Methods (RBF, Polynomial, Sigmoid), Multiclass SVM (One-vs-Rest, One-vs-One) • Ensemble Learning – Beyond Basics:Gradient Boosting (XGBoost, LightGBM, CatBoost), Stacking & Blending Meta-Models	6
2	Model Evaluation & Hyperparameter Tuning	• Advanced Model Metrics: Precision-Recall Curves, AUC-ROC, Fβ-Score, Statistical Significance Testing (McNemar's Test). • Bias-Variance Tradeoff: Learning Curves, Overfitting Remedies, Hyperparameter Optimization: Grid Search, Random Search, Bayesian Optimization.	5
3	Unsupervised Learning – Beyond Clustering	• Advanced Clustering: Gaussian Mixture Models (EM Algorithm), Hierarchical & Spectral Clustering • Density-Based Methods: HDBSCAN, OPTICS • Dimensionality Reduction: t-SNE, UMAP (vs. PCA)	6
4	Text Analysis with Classical ML	• Topic Modeling: Latent Dirichlet Allocation (LDA), Non-Negative Matrix Factorization (NMF) • Text Classification: Naive Bayes for Text,SVM & Logistic Regression for NLP.	7

		• Sentiment AnalysisLexicon-Based Methods (VADER), Machine Learning Approaches	
5	Feature Engineering & Selection	• Feature Importance:SHAP, LIME (Model Interpretability) • Feature Selection:Recursive Feature Elimination (RFE), Mutual Information & Chi-Square Tests.	5
6	Optimization & ML Systems	• Advanced Optimization:Stochastic Gradient Descent (SGD) Variants,Proximal Methods (for Sparsity) • ML in Production:Concept Drift, Model Monitoring	2
Total			**30**

Textbooks:

1. Ethem Alpaydın, "Introduction to Machine Learning", 4th edition, MIT Press
2. Peter Harrington, "Machine Learning in Action", 1st Edition, Manning Publication
3. Ian Goodfellow, Yoshua, "Deep Learning", 1st Edition, MIT Press

Reference Books:

1. Harsh Bhasin, "Machine Learning for beginners", BPB Publication.
2. Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw Hill.

Course Name: Advance Machine Learning Lab

Course Code: PECE09P

Category: PC_PEC (PE5 of AIML Track)

Preamble:

Advanced Machine Learning Lab is designed to provide hands-on experience with modern machine learning techniques that go beyond the basics. It focuses on regularization methods, kernel-based models, ensemble learning, model evaluation metrics, hyperparameter tuning, clustering, dimensionality reduction, topic modeling, and real-time deployment considerations such as concept drift and monitoring.

Pre-requisites:

Machine Learning Lab (PCCE13P), Analysis of Algorithms Lab (PCCE04P), Machine Vision using Python Lab (PCCE18).

Lab Objectives:

- To understand and apply regularization techniques (Ridge, Lasso, Elastic Net) in regression problems.
- To explore the effect of different SVM kernels on classification tasks
- To build and evaluate ensemble learning models using XGBoost, LightGBM, and CatBoost.
- To analyze classification models using evaluation metrics such as Precision-Recall, AUC-ROC, and Fβ-score.
- To optimize machine learning models through Grid Search, Random Search, and Bayesian Optimization techniques.
- To compare Gaussian Mixture Models with K-Means clustering using real-world datasets.

Lab Outcomes:

Learners will be able to:

CO1: Apply regularization techniques such as Ridge, Lasso, and Elastic Net to improve model generalization and interpret their impact on coefficients.

CO2: Implement and evaluate classification models using SVM with various kernel functions and ensemble techniques like XGBoost, LightGBM, and CatBoost.

CO3: Use advanced evaluation metrics such as Precision-Recall, AUC-ROC, and Fβ-Score to analyze model performance and support decision-making.

CO4: Perform hyperparameter tuning using Grid Search, Random Search, and Bayesian Optimization to improve model accuracy and robustness.

CO5: Apply unsupervised learning algorithms (GMM, K-Means) and dimensionality reduction techniques (PCA, t-SNE, UMAP) for clustering and visualization.

CO6: Design ML pipelines incorporating feature selection (RFE, SHAP), topic modeling (LDA), sentiment analysis, and concept drift detection for real-world deployment.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Implementation of Ridge, Lasso, and Elastic Net Regression
2	SVM with Different Kernels (RBF, Polynomial, Sigmoid) for Classification
3	Gradient Boosting (XGBoost, LightGBM, CatBoost) for Predictive Modeling
4	Model Evaluation with Precision-Recall Curves and AUC-ROC Analysis
5	Hyperparameter Tuning using Grid Search, Random Search, and Bayesian Optimization
6	Gaussian Mixture Models (GMM) vs. K-Means Clustering
7	Dimensionality Reduction using PCA, t-SNE, and UMAP
8	Topic Modeling with LDA and Sentiment Analysis using VADER
9	Feature Selection using Recursive Feature Elimination (RFE) and SHAP
10	Concept Drift Detection and Model Monitoring in ML Systems

Textbooks:

1. Ethem Alpaydın, "Introduction to Machine Learning", 4th edition, MIT Press
2. Peter Harrington, "Machine Learning in Action", 1st Edition, Manning Publication
3. Ian Goodfellow, Yoshua, "Deep Learning", 1st Edition, MIT Press

Reference Books:

1. Harsh Bhasin, "Machine Learning for beginners", BPB Publication.
2. Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw Hill.

Course Name: Big Data Analytics

Course Code: PCCE14T

Category: PC_PEC (PE5 of DS Track)

Preamble:

In today's digital era, organizations generate and process enormous volumes of structured and unstructured data. Big Data Analytics has emerged as a critical area in computing to extract actionable insights and support data-driven decisions. This course equips students with foundational knowledge and hands-on skills to handle Big Data using modern platforms and tools like Hadoop, MapReduce, NoSQL, and Apache Spark. It bridges theoretical understanding with industry-relevant applications across domains like e-commerce, healthcare, transportation, and finance.

Pre-requisites:

Data Warehousing and Data Mining (PECE02T), Distributed System (PCCE16T), Advanced Databases (PECE06T), Python Programming (VSEC03)

Course Objectives:

- Introduce the fundamental concepts, characteristics, and architecture of Big Data systems including HDFS, NoSQL, and Spark components
- Explain the working principles and models of distributed storage and processing frameworks like HDFS, MapReduce, and stream mining systems.
- Provide practical exposure to implementing distributed algorithms, similarity metrics, and stream data processing techniques.
- Equip students to design and develop scalable Big Data solutions by integrating storage, computation, and analytics for real-world applications.

Course Outcomes:

Learners will be able to:
CO1: Recall fundamental concepts: Big Data characteristics (5Vs), HDFS components, NoSQL database types, stream mining algorithms, and Spark architecture.
CO2: Explain the working of HDFS, MapReduce model, NoSQL types, and Big Data stream algorithms with examples.
CO3: Implement MapReduce algorithms (Word Count, Join), streaming algorithms (like Bloom filters, DGIM, and Flajolet-Martin), similarity metrics, and Spark transformations.
CO4: Analyze trade-offs between traditional vs. Big Data systems, CAP theorem applications, stream algorithm efficiency, and clustering performance (CURE).
CO5: Design integrated Big Data solutions using HDFS/NoSQL storage, MapReduce/Spark processing, real-time stream mining, and similarity/clustering analytics for real-world applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Big Data and Hadoop	Introduction to Big Data & Its characteristics (5 Vs); Type of Big Data; Traditional vs Big Data systems; Hadoop architecture; Core Hadoop Components; Hadoop Limitations. (CO1, CO2).	6
2	HDFS & MapReduce	HDFS: Namenode, Datanode, block storage, replication; Reading & Writing Mechanism in HDFS; MapReduce programming model: mapper, reducer, combiner; Algorithms: Word Count, Matrix multiplication, Union, Join.	5
3	NoSQL	Need for NoSQL database; Types of NoSQL: Document, Key-Value, Columnar, Graph; CAP Theorem.	4
4	Mining Data Streams	Stream processing model & Examples of Stream Sources; Stream Queries & Issues in Stream Processing; Filtering Streams: Bloom Filter with Analysis; Counting distinct elements: Flajolet-Martin algorithm; Counting frequent items in a stream, decaying windows; Counting ones in a sliding window: DGIM algorithm.	5
5	Similarity Measures & Clustering	Similarity Measures: Euclidean, Jaccard, Cosine, Edit distance, and Hamming distance; Frequent Itemset Mining: Apriori Algorithm, Algorithm of Park Chen-Yu; Clustering algorithms in big data; CURE algorithm	5
6	Introduction to Apache Spark	Spark architecture: RDDs, DataFrames, DAG; Transformations & Actions; Spark SQL	4
Total			**30**

Textbooks:

1. Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets||, Cambridge UniversityPress
2. Alex Holmes —Hadoop in Practice||, Manning Press, Dreamtech Press
3. Dan Mcary and Ann Kelly - Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.
4. DT Editorial Services, —Big Data Black Book, Dreamtech Press
5. EMC Education Services, Data Science and Big Data Analytic, Wiley

Reference Books:

1. Bill Franks,- Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams with Advanced Analytic, Wiley.
2. Chuck Lam, - Hadoop in Action, Dreamtech Press
3. Jared Dean, - Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, - Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, - Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition,2010.
6. Ronen Feldman and James Sanger, - The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
7. Vojislav Kecman, - Learning and Soft Computing, MITPress, 2010.

Course Name: Big Data Analytics Lab

Course Code: PECE14P

Category: PC_PEC (PE5 of DS Track)

Preamble:

In today's data-driven world, traditional data processing systems are unable to handle the volume, variety, and velocity of big data. The Big Data Lab aims to equip learners with practical skills in distributed computing, data stream processing, NoSQL databases, and large-scale data analysis frameworks.

Pre-requisites:

Data Warehousing and Data Mining Lab (PECE02P), Distributed System Lab (PCCE16P), Advanced Databases Lab (PECE06P), Python Programming (VSEC03)

Lab Objectives:

- To understand the architecture and working of big data processing frameworks like Hadoop and Spark.
- To perform HDFS operations and implement distributed computing using MapReduce.
- To explore and interact with NoSQL databases like MongoDB.
- To implement streaming algorithms for frequency and distinct element estimation.
- To analyze similarity and pattern detection using distance measures and frequent itemset mining.
- To design complete big data pipelines involving ingestion, processing, and visualization using open-source tools.

Lab Outcomes:

Learners will be able to:
LO1: Install and configure big data environments such as Hadoop and Spark and perform basic HDFS and RDD operations.
LO2: Develop and execute distributed applications using MapReduce for data aggregation and joining tasks.
LO3: Perform CRUD operations and visualize semi-structured data using NoSQL systems like MongoDB.
LO4: Implement stream processing algorithms (Bloom Filter, Flajolet-Martin, DGIM) to handle data with high velocity.
LO5: Analyze large datasets using similarity metrics, clustering, and frequent itemset mining to extract meaningful patterns and insights.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Install and configure Hadoop in pseudo-distributed mode.
2	Perform file operations (upload, read, delete) in HDFS using CLI.
3	Implement Word Count using MapReduce.
4	Implement Reduce Side Join using MapReduce.
5	Perform CRUD operations on MongoDB and visualize documents.
6	Implement Bloom Filter for stream filtering
7	Implement Flajolet-Martin and DGIM algorithms for stream frequency and distinct counting
8	Apply similarity metrics (Jaccard, Cosine, Edit Distance) on sample datasets.
9	Implement Apriori algorithm for frequent itemset mining.
10	Set up Apache Spark and execute RDD transformations and actions.
11	Perform clustering using CURE or KMeans algorithm and visualize clusters.
12	Capstone Project: Design an End-to-End Big Data Solution – Ingest, process, analyse, and visualize a large dataset using Hadoop/Spark, and NoSQL

Textbooks:

1. Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets, Cambridge
2. University Press
3. Alex Holmes —Hadoop in Practice‖, Manning Press, Dream Tech Press
4. Dan Mcary and Ann Kelly - Making Sense of NoSQL – A guide for managers and the
5. rest of us, Manning Press.
6. DT Editorial Services, —Big Data Black Book, Dream Tech Press
7. EMC Education Services, Data Science and Big Data Analytic, Wiley

Reference Books:

1. Bill Franks,- Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams with Advanced Analytic, Wiley.
2. Chuck Lam, - Hadoop in Action, Dreamtech Press

3. Jared Dean, - Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, - Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, - Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition,2010.
8. Ronen Feldman and James Sanger, - The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
9. Vojislav Kecman, - Learning and Soft Computing, MITPress, 2010.

Course Name: Internet of Things Security and Trust

Course Code: PECE19T

Category: PC_PEC (PE5 of IoT Track)

Preamble:

The modern world is becoming increasingly interconnected through a technology called Internet of Things (IoT). IoT is rapidly evolving field that is transforming the way we live, work, and interact with the real world. This course is useful for learning security aspects of IoT applications. Security is a major requirement for IoT applications since variety of devices and networks are involved in IoT application. This course teaches fundamental aspects of security and different techniques for providing security to IoT application.

Pre-requisites:

C Programming
Object Oriented Programming
Microprocessor and Microcontroller

Course Objectives:

- To understand the core concepts of the IoT security.
- To explore different types of vulnerabilities and threats.
- To gain a foundational knowledge of testing.
- To gain foundation knowledge of tools and framework.
- To get understanding of firmware security aspects.
- To gain knowledge of common attack vectors.

Course Outcomes:

Student will be able to:

CO1: Understand the concepts of security in IoT system.
CO2: Implement mechanism to handle IoT Vulnerabilities and Threats.
CO3: Perform testing of IoT systems.
CO4: Use monitoring tools for providing IoT security.
CO5: Use techniques for efficient firmware design of IoT application.
CO6: Identify different attacks.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction	Overview of industrial control systems (ICS), ICS operation & components, Perdue model, SCADA systems, Cyber-physical systems (CPS) & IoT	4
2	IoT Vulnerabilities and Threats	STRIDE methodology, OWASP Iot vulnerabilities, Privacy & trust, Insufficient authentication/authorization, Insufficient access control, Attacks on IoT data, Attacks on IoT layered architecture, Security concerns in IoT applications, Security concerns in SCADA	6
3	IoT Pen Testing	Active vulnerability analysis tools, Port scanning, Operating system fingerprinting and version scanning, Penetration testing, Attack surface mapping	6
4	Monitoring Tools	Exploitation using I2C & SPI, JTAG debugging and exploitation, Boundary scan, Test access ports	6
5	Firmware Implementation	Understanding firmware, Extracting firmware, Manual firmware extraction, Automated file system extraction, Firmware internals, Backdooring a firmware, Static & dynamic analysis	4
6	Attack Surfaces	Software defined radio, Exploiting ZIGBEE & BLE, Power analysis attack, Invasive attack, Perturbation -attacks, Electromagnetic side channel attack, fault injection attack, timing attack, covert channel attacks	4
Total			**30**

Text Books:

1. "Securing the Internet of Things", Shancang Li, Li Da Xu, Syngress, Elsevier, 2017.
2. "Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", Edited by Fei Hu, CRC Press, 2016.

3. "IoT Security Guide", DSCI, August 2022.

Reference Books:

1. "Practical Internet of Things Security", Brian Russell Drew Van Duren, Packt Publishing, 2016

Course Name: Internet of Things (IoT) Security and Trust Lab

Course Code: PECE19P

Category: PC_PEC (PE5 of IoT Track)

Preamble:

The modern world is becoming increasingly interconnected through a technology called Internet of Things (IoT). IoT is rapidly evolving field that is transforming the way we live, work, and interact with the real world. This course is useful for learning security aspects of IoT applications. Security is a major requirement for IoT applications since variety of devices and networks are involved in IoT application. This course teaches implementation of different security techniques for IoT application. It also enables learner to use standard tools and frameworks for developing efficient security solutions.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the core concepts of the IoT security.
- To explore different types of vulnerabilities and threats.
- To gain a foundational knowledge of testing.
- To gain foundation knowledge of tools and framework.
- To get understanding of firmware security aspects.
- To gain knowledge of common attack vectors.

Course Outcomes:

Student will be able to:
CO1: Identify metrics for providing security in IoT system.
CO2: Implement techniques for handling IoT Vulnerabilities and Threats.
CO3: Perform testing of IoT systems.
CO4: Use tools and frameworks for providing security to IoT applications.
CO5: Design efficient secure firmware for IoT applications.
CO6: Implement mechanism to handle different types of attacks in IoT application.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	25

Suggested List of Practical:

All practical will be project based with focus on following concepts

1. Identification and implementation of standard metrics for providing security.
2. Handle different types of threats and vulnerabilities in IoT application.
3. Perform security testing of IoT application.
4. Identify and explore different tools for monitoring and providing security to IoT applications.
5. Design secure firmware for IoT application.
6. Handle different types of attacks in IoT application.

Text Books:

1. "Securing the Internet of Things", Shancang Li, Li Da Xu, Syngress, Elsevier, 2017.
2. "Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", Edited by Fei Hu, CRC Press, 2016.
3. "IoT Security Guide", DSCI, August 2022.

Reference Books:

1. "Practical Internet of Things Security", Brian Russell Drew Van Duren, Packt Publishing, 2016

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***
3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction. ***Student will lose the marks if he or she remains absent for the Laboratory Practical Session.***

Course Name: Malware Analysis

Course Code: PECE15T

Category: PC_PEC (PE5 of CSec Track)

Preamble:

The course "Malware Analysis" is designed to equip students with the theoretical knowledge and practical skills required to detect, analyze, and respond to malicious software threats. With the increasing complexity and frequency of cyberattacks, understanding the techniques used by attackers and reverse engineering malware is crucial for cyber defense professionals.

Pre-requisites:

PECE08 (System Security and Ethical Hacking) and PECE21 (Digital Forensics)

Course Objectives:

After completing this course, you will be able to learn:

- Introduce the fundamentals of malware and its impact on computing systems.
- Enable students to perform static and dynamic analysis of malware.
- Equip students with the knowledge to use forensic and reverse engineering tools.
- Familiarize students with malware detection, classification, and reporting techniques.
- Develop hands-on skills to safely analyze malware in controlled environments.

Course Outcomes:
Learner will be able to learn:

CO1: Describe various types of malware, their behavior, and infection mechanisms.
CO2: Apply static and dynamic malware analysis techniques to extract and interpret behavior and artifacts.
CO3: Use tools for reverse engineering and demonstrate understanding of anti-analysis techniques.
CO4: Utilize automated analysis tools and synthesize malware analysis reports including IOCs.
CO5: Analyze and evaluate real-world malware samples using forensic approaches and document the findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a

panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Malware	Definition, types, history, and trends of malware Malware lifecycle and delivery mechanisms Real-world case studies	5
2	Malware Behavior and Infection Vectors	Persistence mechanisms, privilege escalation Fileless malware, macro malware, polymorphism Indicators of Compromise (IOCs)	6
3	Static Malware Analysis	PE file structure, hashing, strings extraction Disassembly using IDA Free/Ghidra Assembly code basics	7
4	Dynamic Malware Analysis	Sandboxing, system call monitoring Behavioral analysis using Process Monitor, ProcMon Network behavior using Wireshark	7
5	Reverse Engineering & Anti-Analysis Techniques	Anti-debugging and anti-VM techniques Unpacking and decryption Debugging with x64dbg/OllyDb	5
6	Automated Malware Analysis & Reporting	Cuckoo Sandbox and Any.Run usage Classification and signature creation Threat Intelligence Platforms Malware reporting and IOCs	2
Total			**30**

Textbooks:

1. Practical Malware Analysis by Michael Sikorski and Andrew Honig
2. The IDA Pro Book by Chris Eagle
3. Malware Analyst's Cookbook and DVD by Ligh et al.

Reference books:

1. The Art of Memory Forensics by Ligh, Case, Levy, Walters
2. Rootkits: Subverting the Windows Kernel by Greg Hoglund
3. Online Resources: VirusTotal, Hybrid Analysis, Any.Run, Cuckoo Sandbox Documentation

Course Name: Malware Analysis Lab

Course Code: PECE15P

Category: PC_PEC (PE5 of CSec Track)

Preamble:

The course "Malware Analysis" is designed to equip students with the theoretical knowledge and practical skills required to detect, analyze, and respond to malicious software threats. With the increasing complexity and frequency of cyberattacks, understanding the techniques used by attackers and reverse engineering malware is crucial for cyber defense professionals.

Pre-requisites:

PECE08 (System Security and Ethical Hacking) and PECE21 (Digital Forensics)

Course Objectives:

After completing this course, you will be able to learn:

- Introduce the fundamentals of malware and its impact on computing systems.
- Enable students to perform static and dynamic analysis of malware.
- Equip students with the knowledge to use forensic and reverse engineering tools.
- Familiarize students with malware detection, classification, and reporting techniques.
- Develop hands-on skills to safely analyze malware in controlled environments.

Course Outcomes:

Learner will be able to learn:

CO1: Describe various types of malware, their behavior, and infection mechanisms.
CO2: Apply static and dynamic malware analysis techniques to extract and interpret behavior and artifacts.
CO3: Use tools for reverse engineering and demonstrate understanding of anti-analysis techniques.
CO4: Utilize automated analysis tools and synthesize malware analysis reports including IOCs.
CO5: Analyze and evaluate real-world malware samples using forensic approaches and document the findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	2

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a

panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr. No.	Suggested Topic(s)
1	Perform string analysis and examine PE file headers.
2	Observe malware behavior using system monitoring tools.
3	Monitor and analyze malware's network behavior.
4	Analyze malware using an automated sandbox environment.
5	Disassemble malware and interpret logic.
6	Final Project: Perform end-to-end malware analysis and documentation.
7	Study and present a real-world case study where blockchain is used with cognitive applications.

Textbooks:

1. Practical Malware Analysis by Michael Sikorski and Andrew Honig

2. The IDA Pro Book by Chris Eagle

3. Malware Analyst's Cookbook and DVD by Ligh et al.

Reference books:

1. The Art of Memory Forensics by Ligh, Case, Levy, Walters

2. Rootkits: Subverting the Windows Kernel by Greg Hoglund

3. Online Resources: VirusTotal, Hybrid Analysis, Any.Run, Cuckoo Sandbox Documentation

Course Name: Deep Learning

Course Code: PECE13T

Category: PC_PEC (PE6 of AIML Track)

Preamble:

Deep Learning has emerged as a transformative technology powering advancements in artificial intelligence, from computer vision and natural language processing to healthcare and autonomous systems. This course provides a comprehensive introduction to the foundational concepts, architectures, and applications of deep neural networks. Students will gain hands-on experience with modern frameworks (e.g., TensorFlow/PyTorch) and learn to design, train, and evaluate models for real-world problems.

Pre-requisites:

- Proficiency in Python programming.
- Familiarity with linear algebra, calculus, and probability.
- Basic knowledge of machine learning (supervised/unsupervised learning).

Course Objectives:

After completing this course, you will be able to learn:

- Understand the mathematical and computational principles behind deep learning.
- Implement and experiment with key architectures (CNNs, RNNs, Transformers, etc.).
- Develop skills in data preprocessing, model optimization, and hyperparameter tuning.
- Apply deep learning techniques to tasks like image classification, sequence modeling, and generative AI.
- Critically analyze the ethical and societal implications of deployed systems.

Course Outcomes:

Learner will be able to learn:

CO1: Explain fundamental concepts of neural networks (perceptrons, MLPs, activation functions) and analyze their representation power
CO2: Implement feedforward networks using gradient-based optimization and derive backpropagation mathematically.
CO3: Design autoencoders and apply regularization techniques to mitigate overfitting in deep networks.
CO4: Optimize deep architecture using advanced techniques (batch norm, attention, word embeddings).
CO5: Develop CNN/RNN models for vision and sequence tasks and diagnose vanishing gradient problems.
CO6: Build generative models (VAEs, GANs, transformers) and critique their ethical implications.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Deep Learning	History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons	2
2	Neural Network Training Fundamentals	Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, FeedForward Neural Networks, Backpropagation	4
3	Autoencoders & Regularization	Autoencoders and relation to PCA, Regularization in autoencoders, Sparse autoencoders, Contractive autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout	6
4	Advanced Architectures & Representations	Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Learning Vectorial Representations Of Words, Encoder Decoder Models, Attention Mechanism, Attention over image	6
5	Advancement of CNNs and RNNs	Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs	6
6	Generative Deep Learning	Variational Autoencoders (VAEs): Latent space, reparameterization trick, Applications in image generation, Transformer-based Gen Models: GPT architecture (decoder-only), Self-attention for text generation, Autoregressive Models: PixelRNN, WaveNet, Token-based generation (e.g., char-RNNs)	6
Total			**30**

Textbooks:

1. Deep Learning, Goodfellow, Ian, author, Cambridge, Massachusetts: The MIT Press
2. Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, Springer
3. Pattern Recognition and Machine Learning, Christopher Bishop, Springer

Reference books:

1. Artificial Intelligence: A Modern Approach, Russell & Norvig, 4th Edition, Pearson
2. Machine Learning: A Probabilistic Perspective, Kevin Murphy, MIT Press
3. Speech and Language Processing, Jurafsky & Martin, Pearson

Course Name: Deep Learning Lab

Course Code: PECE13P

Category: PC_PEC (PE6 of AIML Track)

Preamble:

This hands-on lab complements the theoretical foundations of deep learning by providing practical experience in designing, training, and evaluating neural networks. Through coding exercises, projects, and experiments, students will gain proficiency in modern frameworks (e.g., TensorFlow/PyTorch) and learn to solve real-world problems using state-of-the-art architectures.

Pre-requisites:

- Basic Python programming.
- Familiarity with linear algebra and calculus (gradients).
- Core deep learning concepts

Course Objectives:

After completing this course, you will be able to learn:

- Implement Core Neural Network Components.
- Develop End-to-End Deep Learning Pipelines
- Optimize Models with Advanced Techniques
- Generate and Evaluate Synthetic Data.

Course Outcomes:

Learner will be able to learn:

CO1: Implement Neural Networks from Scratch
CO2: Build and Deploy CNN/RNN Models.
CO3: Debug and Improve Model Performance.
CO4: Generate Data with Generative Models.
CO5: Evaluate Ethical and Technical Trade-offs.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	2

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr. No.	Suggested Topic(s)
1	Train a single-layer perceptron to perform binary classification (e.g., AND/OR gates) using Python and NumPy.
2	Develop an MLP using PyTorch/TensorFlow to classify handwritten digits (MNIST dataset).
3	Plot the loss landscape for a simple model and compare convergence rates of SGD, Momentum, and Adam optimizers.
4	Experiment with dropout, L2 regularization, and early stopping to improve model generalization on a noisy dataset.
5	Design a CNN (e.g., LeNet or custom architecture) to classify images from the CIFAR-10 dataset.
6	Fine-tune a pre-trained CNN (e.g., ResNet, VGG) on a custom dataset using PyTorch/TensorFlow.
7	Train an LSTM/GRU model to predict stock prices or perform sentiment analysis on text data.
8	Build and train a denoising autoencoder to reconstruct corrupted images (e.g., noisy MNIST digits).
9	Train a DCGAN to generate synthetic images (e.g., faces or handwritten digits) and evaluate output quality.
10	Implement a transformer-based model (e.g., simplified GPT or seq2seq with attention) for language translation tasks.

Textbooks:

1. Deep Learning with Python – François Chollet
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron
3. PyTorch Pocket Reference" – Joe Papa

Reference books:

1. Deep Learning for Computer Vision with Python – Adrian Rosebrock
2. Natural Language Processing with PyTorch – Delip Rao & Brian McMahan
3. Generative Deep Learning – David Foster

Course Name: Recommendation System

Course Code: PECE18T

Category: PC_PEC (PE6 of DS Track)

Preamble:

In the digital age, recommendation engines have become an integral part of personalized user experiences across various domains such as e-commerce, entertainment, education, and social media. This course introduces students to the fundamental concepts, methodologies, and algorithms used in designing and implementing recommendation systems. It explores collaborative filtering, content-based filtering, hybrid models, and the use of machine learning and deep learning techniques in personalization. Through theoretical foundations and practical applications, the course equips learners with the skills to analyse user behaviour, handle large-scale data, and build intelligent systems that deliver relevant and meaningful recommendations. The goal is to prepare students to design robust, scalable, and ethically responsible recommendation engines that enhance user satisfaction and engagement.

Pre-requisites:

PCCE13 (Machine Learning), PECE01 (Soft Computing)

Course Objectives:

- To introduce the core concepts and techniques used in recommendation systems.
- To explore different recommendation algorithms, including collaborative filtering, content-based filtering, and hybrid approaches.
- To understand how deep learning and AI techniques enhance recommendations.
- To apply recommendation techniques to real-world datasets.
- To evaluate and optimize recommendation models using appropriate metrics.

Course Outcomes:

Learner will be able to:
CO1: Understand the principles and applications of recommendation systems.
CO2: Implement different recommendation techniques and compare their effectiveness.
CO3: Design and develop a recommendation system using machine learning models.
CO4: Evaluate the performance of recommendation systems using standard metrics.
CO5: Apply recommendation techniques to domains such as e-commerce, media, and healthcare.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Recommendation Systems	Definition and Types of recommendation systems Business value of Recommender System A conceptual framework for understanding recommender system Real World Applications, Challenges in building recommendation systems	4
2	Data for recommendation: Explicit Vs Implicit data collection	Scales of measurement, Statistical and machine learning foundations for recommender system, Data preprocessing	4
3	Collaborative Filtering	Collaborative filtering approaches: Memory based and model based, Memory based collaborative filtering foundations: Distance and similarity measures User based collaborative filtering, Item based collaborative filtering, Model based collaborative filtering foundations: matrix factorization, UV decomposition, Singular value decomposition Model based collaborative filtering techniques: SVD, SVD++ etc	6
4	Content based recommender System	Feature engineering: Feature extraction, feature selection, dimensionality reduction 4.2 Content-based recommended system examples with few supervised machine learning techniques	6
5	Evaluation of recommended systems	Online and offline evaluation, metrics such as RMSE, AME, Good Item MAE, Good predicted item MAE, Precision, Recall, F1 Measure, NDCG, Average Reciprocal Rank	6
6	Case Studies & Applications	Overview of other types of recommended systems such as trust based, social network based, and context aware systems, Case Studies (E.g.: Netflix, Flipkart)	4
Total			**30**

Textbooks:

1. Recommender Systems: An Introduction, Dietmar Jannach, Markus Zanker, Alexander Felfernig, Gerhard Friedrich,Cambridge University Press,First edition
2. Recommender Systems Handbook Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor,Springer, second edition
3. Hands-On Recommendation Systems with Python, Rounak Banik, Packt Publishing,First edition

Reference Books:

1. Practical Recommender Systems, Kim Falk, Manning Publications
2. Recommendation Engines, Michael Schrage, MIT Press
3. Deep Learning for Recommender Systems, Charu Aggarwal, Springer

Course Name: Recommendation Systems Lab

Course Code: PECE18P

Category: PC_PEC (PE6 of DS Track)

Preamble:

The Recommendation Systems Laboratory is designed to provide hands-on experience in implementing and evaluating various recommendation algorithms. Students will work with real-world datasets and apply machine learning, deep learning, and hybrid approaches to build personalized recommendation systems. The course ensures that students gain practical exposure to industry-standard tools and libraries used for recommendation model development.

Pre-requisites:

PCCE13 (Machine Learning), PECE01 (Soft Computing)

Lab Objectives:

- Provide hands-on experience in implementing different recommendation algorithms.
- Develop skills in working with real-world datasets for building recommendation models.
- Learn to evaluate and optimize the performance of recommendation systems.
- Apply deep learning techniques for recommendation models.
- Explore industry use cases and ethical considerations in recommendation systems.

Lab Outcomes:

Learner will be able to:
LO1: Understand and explore different types of recommendation systems.
LO2: Apply various recommendation algorithms using Python libraries.
LO3: Analyze the performance of recommendation models using evaluation metrics.
LO4: Evaluate and compare different recommendation techniques based on efficiency and accuracy.
LO5: Develop a complete recommendation system for a real-world application.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment

methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Introduction to Recommendation Systems
2	Content-Based Filtering
3	User-Based Collaborative Filtering
4	Item-Based Collaborative Filtering
5	Matrix Factorization using SVD
6	Hybrid Recommendation System
7	Implementing Recommendation Models using Surprise Library
8	Machine Learning for Recommendations
9	Evaluating Recommendation Systems
10	Project: Building a real-life application-based Recommendation System

Textbooks:

1. Recommender Systems: An Introduction, Dietmar Jannach, Markus Zanker, Alexander Felfernig, Gerhard Friedrich,Cambridge University Press,First edition
2. Recommender Systems Handbook Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor,Springer, second edition
3. Hands-On Recommendation Systems with Python, Rounak Banik, Packt Publishing,First edition

Reference Books:

1. Practical Recommender Systems, Kim Falk, Manning Publications
2. Recommendation Engines, Michael Schrage, MIT Press
3. Deep Learning for Recommender Systems, Charu Aggarwal, Springer

Course Name: Industrial Internet of Things (IIoT)

Course Code: PECE20T

Category: PC_PEC (PE6 of IoT Track)

Preamble:
This course introduces students to IIoT complexity on a scale previously unseen in the software industry. Software architecture must accommodate these heterogeneous domains and competencies and handle the increasing levels of complexity. The IIoT generates large amounts of data that is subsequently stored, analysed, archived and eventually fed back into the product life cycle.

Pre-requisites:

- Modern Sensor Technology for IoT
- Principles of IoT

Course Objectives:
- To understand the concepts of Industry 4.0 and IIoT.
- To learn the reference architecture of IIoT
- To learn industrial data acquisition and transmission
- To learn the IIoT key technologies.
- To learn securities in IIoT.
- To learn application areas in IIoT.

Course Outcomes:

Student will be able to:
CO1: Understand the fundamentals of Industry 4.0 and IIoT.
CO2: Understand different types of architectures required in the IIoT applications.
CO3: Apply knowledge of data acquisition and transmission techniques required in IIoT.
CO4: Understand Key technologies required in the implementation of IIoT model.
CO5: Create a security system for IIoT application.
CO6: Design prototype model of IIoT system.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction	Overview of Industry 4.0 and Industrial Internet of Things, Industrial Internet, Design requirements of Industry 4.0, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Basics, IIOT and Industry 4.0, Industrial Internet Systems, Industrial Sensing, Industrial Processes, IIOT Challenges – Identifying Things within the internet, Discovering Things and the Data they possess, Managing massive amount of data, Navigating Connectivity Outages, IIOT Edge - Leveraging the Power of Cloud Computing, Communicating with Devices on the Edge, Determining a Request/Response Model	4
2	IIOT Reference Architecture	The IIC Industrial Internet Reference Architecture - Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints. The Three-Tier Topology, Key Functional Characteristics of Connectivity. Software Architectural Style for the Industrial Internet of Things. Challenges of Software Engineering in IIoT, Principles for Software Architecture design in IIoT, The Principled Decomposition, and The Architectural Style.	5
3	IIoT data acquisition and transmission	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	6
4	Key Technologies in IIoT	Off-Site Technologies: Cloud Computing in IIOT Fog Computing: Principles, Architectures, and Applications. On-Site Technologies: Big Data and Advanced Analytics	5
5	IIoT securities	Securing the Industrial Internet- Security in Manufacturing, PLCs and DCS, Securing the OT (Operation Technology), Network, System Level: Potential Security Issues, Identity Access Management. Internet of Things (IoT) Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security. The IoT Security Lifecycle	6
6	IIoT Applications	Develop New Business Models : Adopt Smart Architectures and Technologies, Sensor-Driven Computing, Industrial Analytics, Intelligent Machine Applications, Transform the Workforce.	4

Module no	Module name	Content	No of Hours
		Inventory Management and Quality Control: Introduction, Inventory Management and IIOT, Quality Control Case Studies: Manufacturing Industry, Automotive Industry and Mining Industry, Healthcare Applications in Industries, Challenges associated with Healthcare	
Total			**30**

Textbooks:

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

Reference Books:

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

Course Name: Industrial Internet of Things (IIoT) Laboratory

Course Code: PECE20P

Category: PC_PEC (PE6 of IoT Track)

Preamble:

The IIoT Lab is a hands-on learning environment where you will gain practical experience in designing, developing, and deploying IIoT solutions. By the end of this lab, students will have a strong foundation in IIoT concepts and be prepared to apply your knowledge to real-world industrial applications.

Pre-requisites:

Modern Sensor Technology for IoT and Principles of IoT

Course Objectives:

- Familiarize students with the fundamentals of Industrial IoT (IIoT)
- Understand the core concepts of IIoT, including sensors, actuators, communication protocols, and data analytics
- Gain insights into the applications of IIoT in various industries
- Develop the skills necessary to design and implement IIoT solutions

Course Outcomes:

Student will be able to:

CO1: Learn IIoT and its key components

CO2: Study and interface the different types of sensors and actuators used in IIoT applications

CO3: Analyze the various communication protocols used in IIoT

CO4: Analyze and interpret data collected from IIoT devices

CO5: Design and implement simple IIoT solutions

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	050

Suggested List of Practical:

1) **Familiarization with Development Boards:** This experiment will get students familiar with popular development boards like Arduino Uno or Raspberry Pi. Students will learn how to set up the board, install the necessary software, and write simple programs to control LEDs, read sensor data, and control actuators.
2) **Sensor Interfacing**: This experiment will introduce students to various sensors used in IIoT applications, such as temperature sensors, humidity sensors, light sensors, and pressure sensors. Students will learn how to interface these sensors with the development board and read the sensor data.
3) **Actuator Control:** This experiment will introduce students to actuators used in IIoT applications, such as relays, motors, and solenoids. Students will learn how to control these actuators using the development board based on sensor readings or user input.
4) **Data Visualization**: This experiment will teach students how to visualize the data collected from sensors. Students will use software tools to plot the data on graphs and charts, allowing for easier monitoring and analysis.
5) **Communication Protocols:** This experiment will cover various communication protocols used in IIoT, such as Modbus, Profibus, and MQTT. Students will learn how to configure these protocols for communication between devices and the cloud platform.
6) **Cloud Integration**: This experiment will introduce students to cloud platforms for IIoT applications. Students will learn how to connect their IIoT devices to the cloud platform, send sensor data to the cloud, and receive commands from the cloud.
7) **Remote Monitoring and Control:** This experiment will build on the previous experiments by creating a system where students can remotely monitor sensor data and control actuators over the internet.
8) **Data Analytics:** This experiment will introduce students to basic data analytics techniques used in IIoT applications. Students will learn how to analyze sensor data to identify trends, patterns, and anomalies.
9) Robotics arms and Industry 4.0 Setup

Textbooks:

1. Industrial Automation with the Internet of Things by Andreas Georgakopoulos and Peter Slyepen
2. Designing the Industrial Internet of Things by Adrian McEwen and Hakim El-Darwich

Reference Books:

1. Internet of Things (IoT) Prototyping with Arduino and Raspberry Pi by Colin Wong
2. Hands-On Industrial Internet of Things by Richard Radoczki

Course Name: Mobile & Wireless Security

Course Code: PECE16T

Category: PC_PEC (PE6 of CSec Track)

Preamble:

The rapid proliferation of mobile devices and wireless networks has introduced unique security challenges. This course focuses on understanding threats, vulnerabilities, and defenses specific to mobile platforms and wireless communication. Students will learn about attack vectors, security protocols, and mitigation strategies, with an emphasis on practical tools for securing mobile and wireless systems.

Pre-requisites:

PECE04T (Computer and Network Security)

Course Objectives:

- Understand the architecture and security challenges of mobile and wireless systems.
- Explore vulnerabilities and attack methods in mobile devices and wireless networks.
- Familiarize students with tools used for penetration testing and securing mobile and wireless platforms.
- Study security protocols and frameworks used in wireless communications.
- Develop strategies to protect against malware, phishing, and other mobile-based attacks.

Course Outcomes:

Learner will be able to:
CO1: Analyze and identify threats in mobile and wireless systems
CO2: Perform security assessments using industry-standard tools.
CO3: Understand and implement wireless security protocols.
CO4: Mitigate risks associated with mobile applications and platforms
CO5: Demonstrate knowledge of securing IoT devices and wireless communications

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment

methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Mobile & Wireless Security	Overview of mobile and wireless security landscape. Threats and vulnerabilities in mobile platforms. Introduction to mobile and wireless attack surfaces. Self-Learning Topics: Evolution of mobile communication technologies (2G to 5G), Mobile operating systems (Android, iOS) security features, Wireless communication standards and protocols (Wi-Fi, Bluetooth, LTE)	4
2	Mobile Device Security	Mobile operating systems (Android and iOS): Security architecture and features. Mobile device management (MDM) and policies. Securing mobile apps: Code 6 analysis, permissions, and data storage. Threats: Rooting/jailbreaking, malware, phishing. Tools Covered: MobSF (Mobile Security Framework): For mobile app security assessment. Frida: For runtime analysis of mobile applications. Self-Learning Topics: Android and iOS app security models , Best practices for secure mobile app development, Overview of OWASP Mobile Top 10 vulnerabilities, Static and dynamic mobile app analysis techniques, Case studies on real-world mobile security breaches, Introduction to mobile threat defense (MTD) solutions.	6
3	Wireless Network Security	Wireless protocols: Wi-Fi, Bluetooth, NFC, and Zigbee. WPA, WPA2, WPA3: Strengths and weaknesses. Common attacks: Eavesdropping, MITM, rogue access points, replay attacks. Wireless intrusion detection and prevention systems. Tools Covered: Aircrack-ng: For Wi-Fi penetration testing. Wireshark: For traffic capture and network analysis. Self Learning topics: Differences between personal and enterprise wireless security configurations, IEEE 802.11 standards and security extensions, Real-world case studies of wireless network breaches.	6
4	Mobile Application Security	To understand the principles of secure mobile application development, perform static and dynamic analysis, and identify vulnerabilities using industry-standard tools and frameworks. Self-Learning Topics: Mobile app development lifecycle and security checkpoints, Android app components and security implications (Activities,	4

		Services, Broadcast Receivers), Secure data storage and transmission practices in mobile apps	
5	IoT and Wearable Device Security	Security challenges in IoT and wearable devices. Protocols used in IoT communication (MQTT, CoAP). Securing IoT devices and gateways. Case studies: IoT attacks and their mitigation. Tools Covered: Shodan: For IoT device discovery and analysis. IoT Inspector: For IoT traffic analysis. Self-Learning Topics: Security implications of constrained devices and networks, Device authentication and firmware security in IoT, Threat modeling for IoT systems.	6
6	Mobile and Wireless Incident Handling	Steps in mobile and wireless incident response. Analyzing and preserving evidence from mobile and wireless systems. Case studies: Mobile malware and wireless network breaches. Tools Covered: Cellebrite UFED: For mobile device forensic investigation. Kali Linux Wireless Tools: For wireless incident analysis. Self-Learning Topics: Legal and ethical aspects of digital forensics, Chain of custody and evidence handling procedures, Mobile device acquisition techniques (logical, physical, and file system extraction)	4

Textbooks:

1. Mobile Application Security Himanshu Dwivedi, Chris Clark, David Thiel McGraw-Hill
2. Wireless and Mobile Device Security Jim Doherty Jones & Bartlett Learning

Reference Books:

1. The Mobile Application Hacker's Handbook Dominic Chell, Tyrone Erasmus, Shaun Colley, Ollie Whitehouse Wiley
2. Network Security Essentials: Applications and Standards William Stallings Pearson

Course Name: Mobile & Wireless Security Lab

Course Code: PECE16P

Category: PC_PEC (PE6 of CSec Track)

Preamble:

The rapid proliferation of mobile devices and wireless networks has introduced unique security challenges. This course focuses on understanding threats, vulnerabilities, and defenses specific to mobile platforms and wireless communication. Students will learn about attack vectors, security protocols, and mitigation strategies, with an emphasis on practical tools for securing mobile and wireless systems.

Pre-requisites:

PECE04P (Computer and Network Security Lab)

Course Objectives:

- Understand the architecture and security challenges of mobile and wireless systems.
- Explore vulnerabilities and attack methods in mobile devices and wireless networks.
- Familiarize students with tools used for penetration testing and securing mobile and wireless platforms.
- Study security protocols and frameworks used in wireless communications.
- Develop strategies to protect against malware, phishing, and other mobile-based attacks.

Course Outcomes:

Learner will be able to:
CO1: Analyze and identify threats in mobile and wireless systems
CO2: Perform security assessments using industry-standard tools.
CO3: Understand and implement wireless security protocols.
CO4: Mitigate risks associated with mobile applications and platforms
CO5: Demonstrate knowledge of securing IoT devices and wireless communications

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment

methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical:

Sr No.	Title of Practical
1	Setting Up a Mobile and Wireless Security Lab
2	Mobile Application Security Testing
3	Reverse Engineering Android Applications
4	Wireless Network Penetration Testing
5	Rogue Access Point and Evil Twin Attack Simulation
6	IoT Device Security Analysis
7	Bluetooth Security Testing

Textbooks:

- Mobile Application Security Himanshu Dwivedi, Chris Clark, David Thiel McGraw-Hill
- Wireless and Mobile Device Security Jim Doherty Jones & Bartlett Learning

Reference Books:

- The Mobile Application Hacker's Handbook Dominic Chell, Tyrone Erasmus, Shaun Colley, Ollie Whitehouse Wiley
- Network Security Essentials: Applications and Standards William Stallings Pearson

Course Title: Skill and Competency Development 2

Course Code: MDM02

Vertical/Sub-Vertical: MDC_MDM

K-S-A Mapping: Skill

Pre-requisite required: Basic communication skills, fundamental numerical ability, and awareness of campus placement process.
Pre-requisite for: Placement preparedness, internship readiness, professional interviews, and workplace communication
Course Level:5
Recommended Semester: 7

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
	2		1

Preamble:

The Skill Competency Development 2 course is designed as a placement-oriented professional development course for Semester 7 undergraduate students. The course focuses on preparing learners for campus recruitment through personality building, CV building, mock interviews, company-specific training, aptitude paper solving, technical and HR interview practice, and pre-placement preparation.
The course aims to enhance students' confidence, self-presentation, communication ability, professional attitude, and interview readiness. It provides structured exposure to company-specific recruitment requirements such as online assessments, written tests, coding or aptitude rounds, group discussions, mock sessions, and campus recruitment interactions.
By integrating personality development, resume preparation, interview practice, paper-solving sessions, and company-specific placement training, this course prepares learners to participate effectively in campus placement drives and professional selection processes.

Course Objectives:

- Develop students' personality, confidence, grooming, professional behaviour, workplace etiquette, email etiquette, telephone etiquette, and self-presentation skills required for campus placement.
- Train students to prepare a professional CV/resume, career objective, LinkedIn profile, self-introduction, and professional portfolio suitable for campus recruitment.
- Prepare students for HR interviews, technical interviews, behavioural interviews, mock interviews, and group discussions through structured practice and feedback.
- Prepare students for fundamental technical concepts and their relevance in problem solving
- Provide the insight about the various problem solving approaches, highlighting the important technical test and technical interview questions from placement point of view.
- Provide company-specific placement preparation through mock aptitude tests, technical test series, coding/written test practice, previous company paper solving, and campus drive readiness.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Demonstrate improved personality traits, grooming, confidence, professional behaviour, email etiquette, telephone etiquette, body language, and workplace etiquette required for campus placement	Remember
CO2	Prepare a professional CV/resume, career objective, LinkedIn profile summary, self-introduction, and portfolio presentation suitable for company recruitment processes.	Understand
CO3	Participate effectively in mock interviews, HR interviews, technical interviews, behavioural interviews, and group discussions by applying appropriate communication, presentation, and interview etiquette.	Apply
CO4	Analyze the different technical concepts and their relevance for soling the various optimization problems.	Analyze
CO5	Analyze the effectiveness of good problem-solving approaches and consider the important technical questions from placement point of view.	Analyze
CO6	Solve company-specific aptitude, reasoning, verbal, coding, written, and technical test papers using suitable strategies, accuracy, and time-management techniques for campus recruitment	Analyze

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	50	-	-	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Personality Building and Professional Behaviour	1. Self-Awareness and Personality Development 2. Confidence Building and Personal Effectiveness 3. Professional Appearance and Grooming 4. Communication Skills and Professional Etiquette 5. Career Readiness and Professional Conduct	4
2	CV Building and Professional Profile Development	1. Introduction to CV / Resume and Career Documentation 2. Resume Structure, Resume Writing and Optimization Techniques 3. ATS-friendly resume basics.	2
3	Mock GD, Interview and Interview Readiness.	1. Interview Types and Selection Process Overview 2. Technical and Behavioural Interview Skills, dos and don'ts during interview. 3. Group Discussion and Mock Interview Practice	4
4.	Revisiting Technical Topics	1. Revision of Data Structure Topics 2. Revision of Algorithms and Complexity 3. Revision of Algorithm Design and Optimization Problems	4
5	Revision of Problem-Solving Approach	1. Revision of Problem-Solving Approaches 2. Revision of Important Technical Test Questions 3. Revision of Important Technical Interview Questions	4
6	Company-Specific Mock Aptitude and Technical Test series.	1. Company Recruitment Process and Eligibility Understanding 2. Aptitude and Technical Assessment Preparation, mock test practise 3. Practice Sessions and Performance Enhancement 4. Pre-Placement Preparation and Communication Skills 5. Placement Day Readiness and Professional Conduct	12
		Total	**30**

Textbooks:

1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", Revised Edition, S. Chand Publishing, 2018.
2. R.S. Aggarwal, "A Modern Approach to Verbal and Non-Verbal Reasoning", Revised Edition, S. Chand Publishing, 2018.
3. Norman Lewis, "Word Power Made Easy", Revised Edition, Goyal Publishers, 2014.
4. S.P. Bakshi, "Objective General English", 4th Edition, Arihant Publications, 2017.

Reference Books:

1. Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT", 9th Edition, McGraw Hill Education, 2018.
2. Arun Sharma, "How to Prepare for Logical Reasoning for the CAT", McGraw Hill Education, 2018.
3. Meenakshi Raman and Sangeeta Sharma, "Technical Communication: Principles and Practice", Oxford University Press, 2015.
4. Dale Carnegie, "How to Win Friends and Influence People", Simon & Schuster, Revised Edition.
5. Stephen R. Covey, "The 7 Habits of Highly Effective People", Simon & Schuster.

Related/ Equivalent MOOC and Associated Certification:

1. NPTEL, "Developing Soft Skills and Personality", SWAYAM–NPTEL, IIT Kanpur, with NPTEL Certification.
2. Coursera, "Improving Communication Skills", University of Pennsylvania, with Coursera Certification.
3. Coursera, "Successful Interviewing", University of Maryland, with Coursera Certification.
4. LinkedIn Learning, "Learning Personal Effectiveness", LinkedIn Learning Platform, with LinkedIn Certification.
5. LinkedIn Learning, "Resume Makeover" or "Writing a Resume", LinkedIn Learning Platform, with LinkedIn Certification.
6. Infosys Springboard / TCS iON / NASSCOM FutureSkills, placement readiness or professional communication certification courses, as approved by the course faculty.

Course Title: Machine Learning Applications in Bioinformatics

Course Code: MDMBI03

Vertical/Sub-Vertical: MDC_MDM

Pre-requisite required: MDMBI01 (Introduction to Bioinformatics), PCCE13T (Machine Learning)

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Practical
MDMBI03	3	1	4	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Preamble:

This course introduces the integration of Machine Learning techniques with Bioinformatics for analyzing complex biological data. It covers fundamental concepts of bioinformatics, biological datasets, and essential machine learning methods including supervised, unsupervised, and deep learning approaches. The course emphasizes data preprocessing, pattern recognition, and predictive modeling in genomics, proteomics, and other omics data. It also highlights real-world applications in healthcare such as disease prediction, drug discovery, and precision medicine. The subject aims to equip students with analytical and computational skills required for modern biological and biomedical research.

Objectives:

- To introduce the fundamental concepts of bioinformatics and machine learning for biological data analysis.
- To enable students to apply data preprocessing, feature selection, and representation techniques on biological datasets.
- To develop the ability to apply supervised and unsupervised learning algorithms for solving bioinformatics problems.
- To provide understanding of deep learning methods and their applications in genomics, proteomics, and healthcare analytics.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Explain the fundamental concepts of bioinformatics and machine learning techniques.	Remember

CO2	Describe biological data preprocessing, feature selection, and data representation methods.	Understand
CO3	Apply supervised learning algorithms for classification and prediction in bioinformatics.	Apply
CO4	Apply clustering and pattern recognition techniques on biological datasets.	Apply
CO5	Analyze deep learning models used in sequence and structure analysis.	Analyze
CO6	Analyze machine learning applications in healthcare and bioinformatics domains.	Analyze

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to Bioinformatics and Machine Learning	Overview of bioinformatics, Biological datasets, Challenges in biological data analysis, Introduction to Artificial Intelligence and Machine Learning, Applications of ML in bioinformatics and healthcare	6	CO1
2	Data Preprocessing and Biological Data Representation	Biological data representation, Data cleaning and preprocessing, Handling missing biological data, Feature engineering and feature selection, Data normalization and scaling, Data visualization techniques, Applications such as disease prediction based on gene expression data.	7	CO2
3	Supervised Learning Techniques in Bioinformatics	Introduction to supervised learning, Regression techniques, Classification algorithms - K-Nearest Neighbours (KNN), Decision Trees, Random Forest, Support Vector Machines (SVM), Model evaluation metrics, Cross-validation and model optimization. Application such as Protein function prediction	9	CO3
4	Unsupervised Learning and Pattern Recognition	Introduction to unsupervised learning, Clustering methods - K-Means clustering, Hierarchical clustering, DBSCAN, Dimensionality reduction, Pattern recognition in omics data, Association analysis in biological datasets, Application like Protein-Protein Interactions etc.	7	CO4
5	Deep Learning Applications in Bioinformatics	Introduction to deep learning, Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Transformers and attention mechanisms,	8	CO5

		Protein folding and structure prediction. Application like Biomedical image analysis.		
6	Advanced Machine Learning Applications in Bioinformatics	Ensemble learning techniques, Explainable AI (XAI) in healthcare, Machine learning in genomics and precision medicine, Drug discovery and virtual screening, Biomedical signal and image analysis, AI-driven disease diagnosis, Ethical issues and bias in biomedical AI, Emerging trends in AI for bioinformatics	8	CO6
		Total	**45**	

Textbooks:

1. P. Baldi and S. Brunak, *Bioinformatics: The Machine Learning Approach*, 2nd ed. Cambridge, MA, USA: MIT Press, 2001.

2. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016. Hardcover edition available.

3. M. Lesk, *Introduction to Bioinformatics*, 5th ed. Oxford, UK: Oxford University Press, 2019.

Reference Books:

1. C. M. Bishop, *Pattern Recognition and Machine Learning*. New York, NY, USA: Springer, 2006. Hardcover edition widely available.

2. T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2nd ed. New York, NY, USA: Springer, 2009. Hardcover edition available.

3. S. J. D. Prince, *Understanding Deep Learning*. Cambridge, MA, USA: MIT Press, 2023. Hardcover edition available.

Online Reference Material:

1. Coursera – Bioinformatics Specialization (UC San Diego) - https://www.coursera.org/specializations/bioinformatics

2. Scikit-learn Official Documentation - https://scikit-learn.org/stable/user_guide.html

3. DeepLearning.AI Courses - https://www.deeplearning.ai/courses/

4. EMBL-EBI Training Portal - https://www.ebi.ac.uk/training/?utm_source=chatgpt.com

Course Title: Innovation Management and Scaling Startups

Course Code: MDMIE03

Category: MDC_MDM

Preamble:

This course is designed to help students understand how startups and innovation-driven organisations move beyond the early idea and planning stage into product-market fit, growth, scale, and long-term sustainability. Building on the concepts introduced in Foundations of Innovation and Entrepreneurship and Startup Planning and Development, the course focuses on managing innovation, developing scalable products, building growth strategies, creating partnerships, using emerging technologies responsibly, and preparing ventures for expansion.

The course combines global innovation frameworks with practical startup scaling methods used by founders, product teams, investors, and innovation leaders. Students will explore how organisations manage innovation portfolios, use agile and AI-enabled product development practices, measure growth through startup metrics, scale operations and teams, build strategic partnerships, and address responsible innovation, sustainability, data privacy, and AI governance.

The teaching approach is case-based and application-oriented, with emphasis on real-world examples, technology-led ventures, group activities, startup growth analysis, and scale-up strategy development.

Pre-requisites: NIL

Course Objectives:

- To introduce students to innovation management and startup scale-up strategies.
- To develop understanding of product-market fit, product development, and growth metrics.
- To expose students to AI-enabled innovation, digital business models, partnerships, and global scaling.
- To build awareness of responsible innovation, sustainability, data privacy, and governance in scaling ventures.
- To enable students to prepare a practical scale-up strategy for a technology-driven startup.

Course Outcomes:

Students will be able to:

CO1: Formulate innovation strategies for technology-driven ventures and growing organisations.

CO2: Apply product development, agile, and AI-assisted innovation methods for scalable solutions.

CO3: Analyse product-market fit, growth metrics, business model scalability, and scale-up strategies.

CO4: Evaluate partnerships, funding, responsible AI, sustainability, and governance issues in scaling startups.

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Tutorial
MDMIE01	3	1	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Innovation Strategy and Management	Meaning and types of innovation. Incremental, disruptive, architectural, and business model innovation. Innovation lifecycle and innovation portfolio. Open innovation, co-creation, and ecosystem-based innovation. Building a culture of innovation in growing organisations. Managing innovation in early-stage, growth-stage, and established organisations.	**8**
2	Product-Market Fit and AI-Enabled Product Development	Product-market fit and customer feedback loops. Product roadmap and feature prioritisation. Agile and Scrum fundamentals. Rapid prototyping and testing. No-code and low-code tools for prototyping. AI-assisted ideation, design, user research, content creation, code generation, and product workflows. Build versus buy decisions for digital and AI-enabled products.	**10**
3	Growth Strategy and Scaling Metrics	Startup growth models and growth loops. North Star Metric, KPIs, and OKRs. Customer acquisition, activation, retention, referral, and revenue. Growth experiments and data-driven decision-making. AI-assisted analytics, personalisation, and marketing automation. Scaling operations, customer support, teams, and organisational processes. Common scale-up challenges and failure patterns.	**10**

4	Funding, Partnerships and Global Scale-Up	Growth-stage funding and investor readiness. Basics of valuation, cap table awareness, and funding rounds. Strategic partnerships, alliances, platform thinking, and distribution partnerships. Role of incubators, accelerators, corporates, government bodies, and startup ecosystems. Internationalisation of startups, market entry models, and cross-border scaling challenges. Mergers, acquisitions, and acqui-hire concepts at an introductory level.	**8**
5	Responsible Innovation and Sustainable Entrepreneurship	Responsible innovation and ethical scaling. Responsible AI, data privacy, cybersecurity awareness, transparency, fairness, and accountability in digital products. ESG basics and triple bottom line. Social entrepreneurship and impact-driven business models. Impact measurement. Founder resilience, team well-being, and sustainable work culture during scale-up. Long-term resilience and governance in scaling ventures.	**9**
Total			**45**

Tutorials:

- Case study analysis of Indian and global scaling startups.
- Innovation audit of an existing product, startup, or organisation.
- Product-market fit analysis using customer personas and feedback loops.
- Prototype testing workshop using no-code, low-code, or AI-assisted tools.
- Growth metrics worksheet using KPIs, OKRs, funnel metrics, retention, and revenue logic.
- AI-assisted startup scaling exercise for market research, product ideas, customer communication, and growth planning.
- Investor and partnership role-play discussion.
- Responsible AI, privacy, sustainability, and ethical scaling discussion.
- Group activity: preparing a scale-up strategy for a selected startup idea.

Textbooks:

1. Clayton M. Christensen, The Innovator's Dilemma, Harvard Business Review Press.
2. Peter F. Drucker, Innovation and Entrepreneurship, HarperBusiness.
3. Sean Ellis and Morgan Brown, Hacking Growth, Currency.
4. Geoffrey A. Moore, Crossing the Chasm, HarperBusiness.

5. Eric Ries, The Startup Way, Currency

Reference Reading:

1. Reid Hoffman and Chris Yeh, Blitzscaling, Currency.
2. Alexander Osterwalder and Yves Pigneur, Business Model Generation, Wiley.
3. Steve Blank and Bob Dorf, The Startup Owner's Manual, K&S Ranch.
4. OECD/Eurostat, Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation. https://doi.org/10.1787/9789264304604-en
5. NIST, Artificial Intelligence Risk Management Framework (AI RMF 1.0). https://www.nist.gov/itl/ai-risk-management-framework
6. World Economic Forum, Future of Jobs Report 2025. https://www.weforum.org/publications/the-future-of-jobs-report-2025/
7. Selected case studies and reports from Y Combinator Startup Library, Harvard Business Review, MIT Technology Review, NASSCOM, and Startup India.

Course Name: Strategic Marketing and Business Planning

Course Code: MDMBD03

Category: MDC_MDM

Preamble:
The objective of this course is to advance the student's knowledge in planning and managing a business in the tech sector with an emphasis on marketing strategy, branding, and market expansion.

Pre-requisites:
Introduction to Business Development and Marketing Principles (MDMBD01), Financial Basics for Engineers and Technopreneurs (MDMBD02)

Course Objectives:

- Create effective marketing and branding strategies for engineering products.
- Explore B2B and B2C models.
- Learn to write a business plan.
- Evaluate market entry and scale-up strategies.

Course Outcomes:

Student will be able to:
CO1: Draft a business plan with marketing, operations and financial sections.
CO2: Create a brand positioning strategy for a tech product.
CO3: Compare different go-to-market models and digital strategies.
CO4: Design a simple customer acquisition funnel

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory + Tutorial	Practical
3	1	4	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Strategic Marketing	Market analysis techniques, segmentation and targeting, positioning strategy, BCG Matrix, SWOT analysis.	9
2	Branding and Identity	Elements of branding, creating brand equity, storytelling, brand positioning strategy for tech startups.	7
3	Market Entry Strategy	Domestic vs international markets, pricing models, product launch strategy, sales forecasting.	7
4	Business Planning	Components of a business plan including executive summary, marketing plan, operations, HR, and financial plan.	10
5	Customer Acquisition	Customer acquisition cost (CAC), sales funnels, CRM basics, online and offline channel strategy.	6
6	Technology Markets	Market behavior and innovation diffusion in electronics and telecommunication sectors. Case studies.	6
		Total	**45**

Suggested list of Tutorial:

1. Strategic analysis of a local brand (2 hrs)
2. Develop a mock business plan (2 hrs) 3
3. Brand storytelling and pitch creation (2 hrs)
4. Marketing channel mapping (2 hrs)
5. Business simulation case review (2 hrs)
6. Business pitch drill (3 hrs)
7. Analysis of brand elements of any start up tech brand of choice/ Plan for international market entry of a tech brand (2 hrs)

Textbooks:

1. Marketing for Entrepreneurs- Frederick Crane, Sage Publications

Reference Books:

1. How to Build a Startup - Udacity Free Course

Course Name: Intelligent Mobile Robotics

Course Code: MDMRB03

Vertical_Sub-Vertical: MDC_MDM

Preamble:

This course introduces the fundamentals of mobile robotics with an emphasis on navigation and path planning. Students learn how mobile robots perceive their environment, localize themselves, and plan safe and efficient paths using classical and optimization-based algorithms such as Bug methods, A*, Potential Fields, and Gradient Descent.

Course Objectives:

- To understand the kinematics, sensing, and perception principles governing mobile robot motion and environment interaction.
- To apply localization, mapping, and classical path planning algorithms for autonomous navigation.
- To design and evaluate optimization-based and intelligent path planning strategies for smooth and collision-free robot motion.

Pre-requisites:

Fundamentals of Robotics and Control (MDMRB01)

Course Outcome:

Students will be able to:

CO1: Explain the fundamentals of mobile robots, locomotion mechanisms, and kinematic principles including wheel constraints, manoeuvrability, and motion control of mobile robotic systems.
CO2: Describe the principles of robot perception, sensor systems, uncertainty representation, and feature extraction techniques used in mobile robots.
CO3: Apply localization and mapping techniques including probabilistic localization, belief representation, and map representation for determining robot position in an environment
CO4: Analyze localization-based navigation methods and autonomous map-building techniques for mobile robot navigation.
CO5: Design path planning and obstacle avoidance strategies for autonomous mobile robots using planning and reacting approaches.
CO6: Evaluate navigation architectures, decomposition techniques, and modern autonomous navigation systems used in intelligent mobile robots

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	2	3	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction and Locomotion	Introduction to mobile robots; overview of mobile robotics; key issues in locomotion; legged mobile robots; leg configurations and stability; examples of legged locomotion; wheeled mobile robots; wheeled locomotion design space; case studies of wheeled mobile robots.	07
02	Mobile Robot Kinematics	Kinematic models and constraints; representation of robot position; forward kinematic models; wheel kinematic constraints; robot kinematic constraints; examples of robot kinematic models; mobile robot manoeuvrability; degree of mobility and steerability; robot workspace; holonomic robots; path and trajectory considerations; motion control — open loop and feedback control.	08
03	Perception	Sensors for mobile robots; sensor classification and performance; wheel and motor sensors; heading sensors; ground-based beacons; active ranging; motion and speed sensors; vision-based sensors; representing uncertainty; statistical representation; error propagation; feature extraction using range and visual data.	07
04	Mobile Robot Localization	Introduction to localization; challenges of localization — noise and aliasing; sensor noise; sensor aliasing; effector noise; odometric error models; localization-based navigation; belief representation; map representation; probabilistic map-based localization; Markov localization; Kalman filter localization; landmark-based navigation; positioning beacon systems; route-based localization.	08
05	Autonomous Mapping and Navigation	Autonomous map building; stochastic map technique; other mapping techniques; introduction to planning and navigation; competences for navigation — planning and reacting; path planning; obstacle avoidance techniques.	08
06	Navigation Architectures	Navigation architectures; modularity for code reuse and sharing; control localization; techniques for decomposition; case studies of tiered robot architectures; introduction to modern navigation systems and autonomous mobile robots.	08
Total			**45**

Suggested List of Value-Added Home Assignments

1. Design and simulate a wheeled mobile robot capable of autonomous navigation and obstacle avoidance in an indoor environment using ultrasonic or LiDAR sensors.
2. Develop a vision-based mobile robot system for object detection and sorting using a camera and a basic machine learning or image processing technique.
3. Implement a mobile robot simulation that performs path planning and navigation for automated material handling in a warehouse environment.
4. Design a voice-controlled mobile robot using speech recognition tools to execute commands such as movement, navigation, or environmental monitoring.
5. Build a prototype or simulation of a surveillance mobile robot capable of detecting motion or intrusions and generating alerts through a monitoring interface.
6. Simulate a multi-robot system for cooperative exploration and mapping of an unknown environment using onboard sensors and communication between robots.

Problem-Based Experiments (PBL List)

1. Study different types of mobile robots and compare legged and wheeled locomotion using suitable case studies or simulations.
2. Analyze the stability and maneuverability of legged mobile robots for different leg configurations.
3. Simulate wheeled mobile robots and study the effect of wheel arrangements on robot motion.
4. Develop a kinematic model for a differential drive robot and simulate its movement for different velocity inputs.
5. Analyze wheel kinematic constraints and robot kinematic constraints for mobile robotic systems.
6. Study the maneuverability of holonomic and non-holonomic robots using simulation tools.
7. Implement open-loop and feedback motion control for trajectory tracking of a mobile robot.
8. Interface and simulate wheel encoders, ultrasonic sensors, LiDAR, and vision sensors for mobile robots.
9. Analyze the performance characteristics of different sensors used in mobile robots.
10. Represent uncertainty in sensor measurements and study error propagation using simulated sensor data.
11. Perform feature extraction using range data or vision-based sensor inputs for object identification.
12. Implement dead reckoning localization using odometry data and analyze localization errors.
13. Apply Kalman filter localization for improving robot pose estimation using sensor fusion.
14. Implement particle filter or Markov localization techniques in a known environment.
15. Develop and compare different map representation methods for mobile robot navigation.
16. Simulate landmark-based and beacon-based localization methods for autonomous robots.
17. Implement autonomous map building using basic SLAM or stochastic mapping techniques.
18. Develop path planning algorithms for mobile robot navigation in obstacle-filled environments.
19. Implement obstacle avoidance techniques for autonomous mobile robots using sensor inputs.
20. Study modular navigation architectures and simulate autonomous navigation of a mobile robot in ROS or a virtual environment.

Recommended Online Courses:

1. Computer Vision Specialization (by University of Buffalo) https://www.coursera.org/specializations/computer-vision
2. NPTEL: Wheeled Mobile Robots, IITM IIT Palakkad. nptel.ac.in/courses/112106298
3. Computer Vision, https://www.udacity.com/course/computer-vision-nanodegree--nd891
4. OpenCVBootcamp https://opencv.org/university/free-opencv-course/?utm_source=google&utm_medium=cpc&utm_campaign=WW_tut_OBC&utm_term=best%20opencv%20tutorial&gad_source=1&gad_campaignid=21004628838&gbraid=0AAAACbv-xhUM70mKirK31LiktTRipo8G&gclid=Cj0KCQjw9O_BBhCUARIsAHQMjS7VA3JEdz8KONvGanFNC7KAqSt2HModiDtp5hB_PJKX_oKTK80pNxQaAlcVEALw_wcB

Reference Books / Articles

1. Siegwart, Roland, Illah R. Nourbakhsh, and Davide Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2nd Edition, 2011.
2. Choset, Howie, Kevin M. Lynch, Seth Hutchinson et al., Principles of Robot Motion: Theory, Algorithms, and Implementations, MIT Press, 1st Edition, 2005.
3. Russell, Stuart J., and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education, 3rd Edition, 2010.
4. Craig, John J., Introduction to Robotics: Mechanics and Control, Pearson Education, 3rd Edition, 2009.
5. Wooldridge, Michael, An Introduction to MultiAgent Systems, Wiley, 2nd Edition, 2009.
6. Grover, Vikram, Mastering UiPath Studio: A Beginner's Guide to Robotic Process Automation, BPB Publications, 1st Edition, 2021.

Detailed Syllabus of Final Year Semester-VIII

Course Name: Research Methodology

Course Code: RM01

Category: ELC_RM

Preamble:

This course offers "An overview of research methodology including basic concepts employed in quantitative and qualitative research methods. Includes computer applications for research.

Pre-requisites: Nil

Course Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcome:

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction and Basic Research Concepts	Introduction and Basic Research Concepts 1.1 Research – Definition: Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	10
2	Types of Research	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	8
3	Research Design and Sample Design	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	9
4	Research Methodology	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	8
5	Ethics in Research	Ethics in Research Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.	5
6	ICT Tools for Research	ICT Tools for Research: Role of computers in research, maintenance of data using software such as Mendeley, Endnote, Tabulation and graphical presentation of research data and software tools.	5

Module No.	Module Name	Content	No of Hours
		Web search: Introduction to Internet, use of Internet and www, using search engines and advanced search tools.	
Total			**45**

Textbooks:

1 Donald Cooper and PS Schindler (2009) Business Research Methods, 9th edition, Tata McGraw Hill.
2 Kothari C. R Research Methodology
3 Uma Sekaran (2010) Research Methods for Business, 4th edition, Wiley.
4 Ranjit Kumar (2009) Research Methodology, 2nd edition, Pearson Education
5 Naresh Malhotra and S Dash (2009) Marketing Research, 5th edition, Pearson Prentice Hall.
6 Michael V. P Research Methodology.
7 Fred N. Kerlinger: Foundations of Behavioral Research.

Reference books

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

Course Name: Cyber Law

Course Code: OEC02

Category: MDC_OE

Preamble:

This course explores the evolving landscape of cyber law and security, equipping students with legal frameworks and technology insights necessary to navigate the challenges posed by digital crimes. It emphasizes both technical and legal aspects of cybersecurity, with a focus on Information Technology Act, 2000 (ITA 2000) and the amendments in the Information Technology Amendment Act, 2008 (ITAA 2008).

Pre-requisites: Nil

Course Objectives:

- To introduce students to the legal framework governing cyber activities, with a focus on ITA 2000 and ITAA 2008.
- To understand the technical foundations of cybersecurity and the role of various security mechanisms in preventing cyber threats.
- To explore different types of cybercrimes and the processes involved in investigating and addressing them.
- To examine the legal aspects of e-commerce, e-governance, and the use of electronic signatures in Indian law.
- To analyze the importance of privacy, data protection, and how international laws influence Indian regulations.
- To provide a global perspective on cyber law and international conventions, addressing challenges like intellectual property and cyber warfare.

Course Outcomes:

Student will be able to:
CO1: Explain the key provisions of ITA 2000 and ITAA 2008 and their impact on various legal domains.
CO2: Gain practical knowledge of cybersecurity tools and techniques such as encryption, firewalls, and digital signatures.
CO3: Identify different types of cybercrimes and apply forensic techniques to investigate digital crimes.
CO4: Assess the legal implications of e-commerce, e-governance, and electronic contracts in India.
CO5: Analyze privacy and data protection laws in India and evaluate them from an international perspective.
CO6: Understand global cyber law frameworks and how international treaties impact the regulation of cyberspace in India.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction to Cyber Law and IT Act	Evolution and necessity of ITA 2000 Overview of ITA 2000 and ITAA 2008: Key provisions, authorities, and penalties Amendments to Indian Penal Code, Evidence Act, and other laws Case studies on jurisdiction under cyber law	6
2	Cyber Security Framework	Definition and importance of cybersecurity Overview of threats: hacking, malware, phishing, and cyberterrorism Basic security mechanisms: firewalls, encryption, PKI, and digital signatures Role of CERT-IN and other agencies in India	7
3	Cyber Crimes and Investigation	Types of cybercrimes: data theft, identity theft, cyberstalking, cyberbullying, and online fraud Investigation procedures for cybercrimes Seizure of digital evidence and forensic procedures Digital forensics: tools and anti-forensics measures	8
4	E-Commerce, E-Governance, and Cyber Law	E-commerce regulations under ITA 2000 and ITAA 2008 Validity of electronic signatures and contracts in Indian law E-Governance and issues in e-taxation Cyber Tribunal and appellate processes	8
5	Privacy, Data Protection, and Emerging Trends	Sensitive Personal Data or Information (SPDI) under Indian law International perspectives on data protection and privacy (GDPR, HIPAA) Impact of cloud computing and data localization Case studies on privacy violations and legal recourse	8
6	International Cyber Law and Legal Framework	UNCITRAL model law and international conventions on cybercrime Intellectual property rights in cyberspace: trademarks, patents, and copyright Cyber warfare, digital sovereignty, and human rights Cyber law practices in other jurisdictions (US, EU, China)	8
Total			**45**

Textbooks:

1. "Cyber Law & Cyber Crimes" by Advocate Prashant Mali, Snow White Publications, Mumbai.
2. "Information Technology Law and Practice" by Vakul Sharma, Universal Law Publishing Co. Pvt. Ltd.
3. "The Indian Cyber Law" by Suresh T. Vishwanathan, Bharat Law House, New Delhi.

Reference Books:

1. "Digital Evidence and Computer Crime" by Eoghan Casey, Academic Press.
2. "Cyber Law in India" by Farooq Ahmad, Pioneer Books.
3. "Computer Forensics: Principles and Practices" by Linda Volonino et al., Pearson Prentice-Hall, 2007.

Course Name: Project Management

Course Code: OEC03

Category: MDC_OE

Preamble:

This course discusses tools that any organization can use to improve its ability to plan, implement, and control its activities as well as the ways in which it utilizes its people and resources.

Pre-requisites: Nil

Course Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcomes:

Student will be able to:
CO1. Apply selection criteria and select an appropriate project from different options.
CO2. Write work breakdown structure for a project and develop a schedule based on it.
CO3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
CO4. Use Earned value technique and determine & predict status of the project.
CO5. Capture lessons learned during project phases and document them for future reference

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Project Management Foundation	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	6
2	Initiating Projects	How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter, Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	8
3	Project Planning and Scheduling	Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS)	8
4	Planning Projects	Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	8
5	Executing Projects, Monitoring and Controlling Projects and Project Contracting	Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. Project Contracting: Project procurement management, contracting and outsourcing	8
6	Project Leadership and Ethics Closing the Project	Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lesson	7

Module no	Module name	Content	No of Hours
		learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study	
Total			**45**

Reference Books:

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

Course Name: Product Life Cycle Management

Course Code: OEC04

Category: MDC_OE

Preamble:

This course aims to give students an overview of product Life Cycle Management (PLM) which is a strategic approach to managing the entire lifecycle of a product, from its inception through design, manufacturing, deployment, and disposal. This course gives student insights on various aspects such as PLM Strategies, Product design, Product Data Management, Virtual Product Development Tools, Integration of Environmental Aspects in Product Design, Life Cycle Assessment and Life Cycle Cost Analysis.

Pre-requisites:

Nil

Course Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Developmen

Course Outcomes:

Students will be able to:

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology

based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Product Lifecycle Management and PLM Strategies	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
2	Product Design	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering. and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	10
3	Product Data Management (PDM)	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
4	Virtual Product Development Tools	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case Studies	07
5	Integration of Environmental Aspects in Product	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for	06

Module No.	Module Name	Content	No of Hours
	Design	Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of- Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
6	Life Cycle Assessment and Life Cycle Cost Analysis	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06
Total			**45**

Textbooks:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229

Reference Books:

1. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
2. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Name: Sustainability Management

Course Code: OEC05

Category: MDC_OE

Preamble:

To provide learners with a comprehensive understanding of sustainability principles, strategies, and management practices that enable organizations to operate responsibly while achieving long-term success.

Pre-requisites:

NIL

Course Objectives:

- To provide a comprehensive understanding of sustainability concepts and their importance in global and organizational contexts.
- To equip participants with the tools and frameworks to develop and implement effective sustainability strategies.
- To foster the ability to analyze environmental, social, and economic impacts and propose practical solutions.
- To empower learners to lead and manage sustainable practices through innovation, technology, and ethical decision-making.

Course Outcomes:

Learner will be able to:

CO1: Understand the Core Principles of Sustainability: Comprehend the key environmental, social, and economic dimensions of sustainability

CO2: Analyze Environmental Impacts: Evaluate organizational and societal environmental footprints and recommend sustainable practices.

CO3: Develop Strategies for Social and Economic Sustainability: Formulate strategies that address social equity, community engagement, and economic resilience.

CO4: Implement Sustainability Practices: Design and implement sustainability strategies within an organizational context, including reporting and stakeholder management.

CO5: Leverage Technology and Innovation: Utilize emerging technologies to enhance sustainability outcomes.

CO6: Lead and Manage Change: Apply leadership and change management principles to foster a sustainability-focused culture.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment

methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Sustainability	Overview of Sustainability: Definition, history, and importance. Sustainable Development Goals (SDGs): UN's 2030 Agenda and its impact on global development. Three Pillars of Sustainability: Environmental, social, and economic dimensions. Current Challenges: Climate change, resource depletion, inequality, and global initiatives.	5
2	Environmental Sustainability	Understanding Environmental Impact: Carbon footprint, waste management, and biodiversity. Energy Management: Renewable energy sources, energy efficiency, and innovations in energy systems. Circular Economy: Concepts, examples, and transitioning to closed-loop systems. Sustainable Resource Management: Water, minerals, and sustainable agriculture.	8
3	Social Sustainability	Social Equity and Inclusion: Addressing diversity, equity, and inclusion in organizations. Community Engagement: Building partnerships and contributing to societal development. Labor Practices: Ethical employment practices, health, and safety. Corporate Social Responsibility (CSR): Importance, frameworks, and success stories.	7
4	Economic Sustainability	Sustainable Business Practices: Triple bottom line approach. Green Finance: ESG investing, green bonds, and carbon pricing. Sustainable Innovation: Developing products and services that align with sustainability goals. Regulatory Frameworks: Policies and standards for sustainable business operations.	5

Module No.	Module Name	Content	No of Hours
5	Sustainability Strategy & Implementation	Developing a Sustainability Strategy: Key steps and tools. Stakeholder Engagement: Identifying and collaborating with key stakeholders. Sustainability Reporting: Standards (GRI, SASB), metrics, and case studies. Measuring Impact: Life cycle assessment (LCA), carbon accounting, and sustainability indicators.	8
6	Technology and Innovation for Sustainability	Digital Transformation: Role of AI, IoT, and big data in achieving sustainability. Green Technologies: Innovations in clean energy, transportation, and waste management. Smart Cities: Integration of sustainable technologies in urban planning. Role of Blockchain: Transparency and traceability in sustainability practices.	6
7	Leadership and Change Management in Sustainability	Sustainability Leadership: Characteristics and examples of successful leaders. Driving Organizational Change: Overcoming resistance and fostering a sustainability culture. Ethical Decision Making: Frameworks for responsible leadership. Global Case Studies: Examining successful implementations of sustainability initiatives.	6
Total			**45**

Textbooks:

1. "Sustainability Principles and Practice" by Margaret Robertson.
2. "The Triple Bottom Line" by Andrew Savitz.
3. "The Business Guide to Sustainability" by Darcy Hitchcock and Marsha Willard.

Reference Books:

1. "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart.
2. "Sustainability: A Systems Approach" by Tony Clayton and Nicholas Radcliffe.

Course: Renewable Energy Management

Course Code: OEC06

Category: MDC_OE

Preamble:

Renewable Energy Management focuses on the development, implementation, and management of renewable energy projects. This course aims to equip students with the knowledge and skills required to effectively manage renewable energy resources, assess their impact, and implement sustainable energy solutions. The curriculum covers various renewable energy technologies, their applications, and the economic, environmental, and policy aspects of renewable energy systems.

Pre-requisites:
Nil

Course Outcomes:

- Understand the principles and technologies of various renewable energy sources.
- Analyse the economic, environmental, and social impacts of renewable energy projects.
  Evaluate and design renewable energy systems for specific applications.
- Develop strategies for the integration and management of renewable energy in the energy mix.
- Understand the policies, regulations, and incentives related to renewable energy.
- Gain practical skills in renewable energy project planning, implementation, and management.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head of Learning	ISA	MSE	Project	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Mod No.	Module Name	Content	No. of hrs.
1	Introduction to Renewable Energy	• Overview of global and national energy scenarios • Importance and benefits of renewable energy • Types of renewable energy sources: solar, wind, biomass, hydro, a geothermal • Comparison between renewable and non-renewable energy • Current trends and future prospects in renewable energy	7
2	Solar Thermal Energy	• Principles of solar thermal energy conversion • Solar collectors: flat plate, evacuated tube, and concentrating collectors • Solar thermal applications: water heating, space heating, and industrial processes • Solar thermal power plants: parabolic troughs, solar towers, and dish Stirling systems • Economic and environmental aspects of solar thermal energy	6
3	Solar Photovoltaics	• Principles of photovoltaic energy conversion • Types of photovoltaic cells: monocrystalline, polycrystalline, and thin film • Design and components of photovoltaic systems: modules, inverters, and batteries • Performance analysis of PV systems: efficiency, shading, and temperature effects • Grid integration and energy storage for PV systems	6
4	Wind Energy	• Fundamentals of wind energy conversion • Wind turbine types, components, and operation • Wind farm design and site selection • Environmental and social impacts of wind energy projects • Economic analysis and policy considerations for wind energy	6
5	Biomass, Hydro and Geothermal Energy	**Biomass & Bio Energy** • Biomass resources and conversion technologies • Bioenergy production: biogas, biofuels, and biomass power generation • Waste-to-energy systems • Environmental and economic aspects of bioenergy • Policies and incentives for bioenergy development **Hydro Energy** • Principles of hydro power generation • Small-scale and large-scale hydro power plants **Geothermal Energy** • Geothermal energy resources and extraction methods • Applications and challenges of geothermal energy • Environmental and economic considerations for hydro and geothermal energy	9
6	Renewable Energy and Management Policy	• Energy management principles and practices • Renewable energy project planning and management • Integration of renewable energy into the grid • Policies, regulations, and incentives for renewable energy • Case studies of successful renewable energy projects	11
		Total	45

Textbooks:

1. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
2. "Renewable Energy Systems: The Earthscan Expert Guide to Renewable Energy Technologies for Home and Business" by David Thorpe
3. "Energy Management Handbook" by Wayne C. Turner and Steve Doty

Reference Books:

1. "Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman
2. "Wind Energy Explained: Theory, Design and Application" by James F. Manwell, Jon G. McGowan, and Anthony L. Rogers
3. "Biomass to Renewable Energy Processes" by Jay Cheng
4. "Hydropower: Renewable Energy for a Sustainable Future" by Dirk Aschenbach
5. "Geothermal Energy: Renewable Energy and the Environment" by William E. Glassley
6. "Renewable Energy Policy and Politics: A Handbook for Decision-Making" by Volker M. Quaschning

Course Name: Digital Public Infrastructure

Course Code: OEC16

Category: MDC_OE

K-S-A Mapping: Knowledge

Pre-requisite required: Nil

Pre-requisite for: Digital Public Infrastructure

Recommended Semester: VII

Course Scheme:

Contact Hours	Credits Assigned
Workshop/Group-Based Learning	Workshop/Group-Based Learning
3	3

Assessment guidelines: (No final or Mid-term Exams, your performance will be evaluated based on your group activities, Final Capstone Projects, Etc,)

Continuous Evaluation	Total
100	100

Suggested Classroom Teaching Pedagogy/Methodology

Teaching Digital Public Infrastructure (DPI) requires an engaging, real-world-oriented approach that goes beyond traditional lectures. At the core of this methodology is workshop-based and group learning, where students actively explore real-life DPI use cases such as Aadhaar, UPI, and ONDC. Thematic workshops and group assignments allow students to ideate and present solutions to real-world challenges while encouraging peer-to-peer learning, collaboration, and critical thinking. Case study discussions further deepen understanding by analyzing the impact of DPI from various stakeholder perspectives—such as government, citizens, startups, and NGOs—enabling students to appreciate both the technical and societal dimensions of DPI.

To bring practical insights into the classroom, sessions with industry experts and DPI practitioners can be organized, exposing students to current trends and implementation challenges. These interactions inspire students and bridge the gap between theory and application. Additionally, capstone projects and DPI-focused hackathons offer students an opportunity to apply their learning through hands-on solution-building, enhancing their technical, analytical, and innovation skills. This blended pedagogy fosters a deeper understanding of DPI and prepares students to contribute meaningfully to India's digital future.

Preamble:

India is at the forefront of the global digital transformation through its pioneering efforts in Digital Public Infrastructure (DPI), including innovations like Aadhaar, UPI, and ONDC. This course aims to introduce students to the core concepts, frameworks, and real-world impact of DPI, enabling them to understand its role in governance, commerce, and public service delivery. Designed with a practical and interdisciplinary approach, the course fosters critical thinking, collaboration, and innovation. It also prepares students for emerging career opportunities in the rapidly evolving digital ecosystem.

Course Objectives:

1. To understand the architecture, principles, and components of Digital Public Infrastructure (DPI), with a focus on scalability, interoperability, and privacy.
2. To analyse key DPI components, including decentralized identity management, real-time payment systems, consent-driven data sharing, and open digital marketplaces.
3. To evaluate the societal impact of DPI through case studies like Aadhaar, UPI, Digipin, and ONDC, focusing on financial inclusion, governance, and digital equity.
4. To explore global DPI initiatives, governance frameworks, and ethical considerations, including data privacy laws, open standards, and zero-knowledge proofs.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Recall the core principles, components, and global examples of Digital Public Infrastructure (DPI).	Remembering
CO2	Explain the characteristics and societal impacts of DPI systems, including scalability, interoperability, and privacy.	Understanding
CO3	Apply DPI concepts to analyse case studies like Aadhaar, UPI, and ONDC for their role in financial inclusion and governance.	Applying
CO4	Analyse the effectiveness of DPI governance frameworks, such as data privacy laws and open standards, in diverse global contexts.	Analysing
CO5	Evaluate the ethical challenges and technological innovations, such as zero-knowledge proofs and AI, in DPI implementations.	Evaluating
CO6	Design a conceptual DPI framework for a specific societal challenge, integrating components like digital identity and payment systems.	Creating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Digital Public Infrastructure	DPI definition, need, and role in digital economies. Core Principles of India Stack: Open standards, modularity, inclusion, scalability, and interoperability. Overview of India Stack Components: Aadhaar, UPI, Digi Locker, e-Sign, and DEPA. Use Cases of India Stack: Governance (e.g., Direct Benefit Transfers), payments, e-commerce, and data sharing. Cloud Infrastructure for DPI: Role of AWS, GCP, and Azure in scalability and security. Challenges and Considerations: Data privacy, digital divide, regulatory compliance, scalability, and cybersecurity. Future of India Stack and DPI: Global expansion, new components, AI integration, and economic impact.	8
2	Key Components of DPI	Decentralized Identity Management (DID): Use of blockchain for secure identity verification. Digital Identity: Aadhaar as a case study. Payment Systems: UPI and its impact on financial inclusion. Real-time Payment Systems: Exploring frameworks beyond UPI, including FedNow (USA), PIX (Brazil), and Faster Payments Service (FPS) (UK). Data Empowerment: Consent-driven data sharing through DEPA. Open Marketplaces: Overview of ONDC and its potential for e-commerce.	8
3	Societal Impacts of DPI	Financial inclusion through UPI. Transforming governance with digital identity. Ethical challenges: Privacy, inclusion, and data security. DPI's role in cross-border digital infrastructure: Adoption of India's DPI model by different countries (e.g., Brazil's PIX, Africa's DPI projects). DPI as a foundation for innovation and startups: Economics of various components of DPI.	7
4	DPI Governance and Policy	Overview of data privacy laws: General Data Protection Regulation (GDPR), Indian Data Protection Bill, and UNDP DPI Playbook. Principles of Open Banking: UK's Open Banking, Europe's PSD2, and comparisons with UPI & ONDC. Principles of open standards vs. proprietary systems. Zero-Knowledge Proofs (ZKP) in DPI: Privacy-enhancing cryptographic techniques for data sharing without revealing identity. Ensuring inclusion and addressing biases.	8

5	Open-Source DPI, Global Initiatives, and Sustainable Development	Open Source DPI: Principles and implementation of open-source frameworks in DPI ecosystems. Data Privacy in DPI: Ensuring secure and ethical data handling in open-source systems. Continuous Information on DPI: Mechanisms for ongoing updates and advancements in DPI frameworks. Global DPI Initiatives: Estonia's X-Road, Singapore's GovTech, and India Stack. DPI and Sustainable Development Goals (SDGs): Supporting financial inclusion, governance, and digital equity. Characteristics of DPI: Scalability, interoperability, and privacy as defining features.	7
6	Case Studies and Applications of DPI	Aadhaar: Digital identity enabling government schemes. UPI: Democratizing digital payments. ONDC: Decentralized digital marketplaces. Smart Contracts & DPI: Ethereum-based contracts for automating governance and payments. International Examples: Estonia's X-Road and Singapore's GovTech. AI in DPI: Applications of artificial intelligence in enhancing DPI efficiency, security, and personalization. Verifiable Identity Systems, Ayushman Bharat Health Account, National Common Mobility Card (NCMC) with Mumbai Case Study. National Public Learning Online Platform (NPTEL- SWAYAM)	7
Total			**45**

Appendix-A

Guidelines for Programme Elective Courses and Specialization Certificate

Programme Elective courses are designed to meet industrial requirements. All learners must opt for 6 Programme Elective courses (both Theory and Practical component) as a part of requirement for B.Tech. degree.

Specialization Certificate is introduced in order to build competency of learners in the chosen domain. Department of Computer Engineering offers the following specialization tracks:

1. Artificial Intelligence and Machine Learning (AIML)
2. Data Science (DS)
3. Internet of Things (IoT)
4. Computer Security (CSec)

Learners can take courses from any track. **However, if learners complete all Programme Elective Courses from the same chosen track, they will be eligible to receive a Specialization Certificate from the Institute.**

Learners who choose Programme Elective courses from different specialisation tracks will not be eligible for a Specialization Certificate.

It should be noted that there are no additional credit requirements for these specialisations.

AIML track: Courses to be chosen for specialization in Artificial Intelligence and Machine Learning

Semester	Course Code	Course Name
V	PECE02T	Data Warehousing and Data Mining
V	PECE02P	Data Warehousing and Data Mining Lab
VI	PECE01T	Soft Computing
VI	PECE01P	Soft Computing Lab
VI	PECE10	Probabilistic and Graphical Model
VII	PECE05T	Natural language processing
VII	PECE05P	Natural language processing Lab
VII	PECE09T	Advance Machine Learning
VII	PECE09P	Advance Machine Learning Lab
VII	PECE13T	Deep learning
VII	PECE13P	Deep learning Lab

DS track: Courses to be chosen for specialization in Data Science

Semester	Course Code	Course Name
V	PECE02T	Data Warehousing and Data Mining
V	PECE02P	Data Warehousing and Data Mining Lab
VI	PECE06T	Advanced Databases
VI	PECE06P	Advanced Databases Lab
VI	PECE10	Probabilistic and Graphical Model
VII	PECE07T	Text, Web & Social Media Analytics
VII	PECE07P	Text, Web & Social Media Analytics Lab

Semester	Course Code	Course Name
VII	PECE14T	Big Data Analytics
VII	PECE14P	Big Data Analytics Lab
VII	PECE18T	Recommendation System
VII	PECE18P	Recommendation System Lab

IoT track: Courses to be chosen for specialization in Internet of Things

Semester	Course Code	Course Name
V	PECE03T	Modern Sensors for Internet of Things
V	PECE03P	Modern Sensors for Internet of Things Lab
VI	PECE11T	Embedded Systems Design and Tiny OS
VI	PECE11P	Embedded Systems Design and Tiny OS Lab
VI	PECE22T	Principles of Internet of Things
VI	PECE22P	Principles of Internet of Things Lab
VII	PECE17T	IoT & Edge Computing
VII	PECE17P	IoT & Edge Computing Lab
VII	PECE19T	IoT Security & Trust
VII	PECE19P	IoT Security & Trust Lab
VII	PECE20T	Industrial IoT
VII	PECE20P	Industrial IoT Lab

CSec track: Courses to be chosen for specialization in Computer Security

Semester	Course Code	Course Name
V	PECE04T	Computer and Network Security
V	PECE04P	Computer and Network Security Lab
VI	PECE08T	System Security and Ethical Hacking
VI	PECE08P	System Security and Ethical Hacking Lab
VI	PECE21T	Digital Forensics
VI	PECE21P	Digital Forensics Lab
VII	PECE12T	Web Application Security
VII	PECE12P	Web Application Security Lab
VII	PECE15T	Malware Analysis
VII	PECE15P	Malware Analysis Lab
VII	PECE16T	Mobile and Wireless Security
VII	PECE16P	Mobile and Wireless Security Lab

Appendix-B

Guidelines for Multidisciplinary Elective Courses

In alignment with the NEP objectives and the evolving demands of the engineering profession, the introduction of a Multidisciplinary Minor courses within the Undergraduate Engineering Programme aims to foster academic breadth, innovation, and cross-domain competency. These guidelines are formulated to support the structured integration of multidisciplinary elective courses, enabling students to pursue focused study in areas beyond their core engineering discipline.

Department of Computer Engineering offers the following Multidisciplinary Minor Titles for B.Tech. Computer Engineering students:

1. Bioinformatics (BI)
2. Innovation, Entrepreneurial and Venture Development (IE)
3. Business Development, Marketing and Finance (BD)
4. Robotics (RB)

Bioinformatics (BI):

Semester	Course Code	Course Name
V	MDMBI01	Introduction to Bioinformatics
VI	MDMBI02	Algorithms and Data Structures in Bioinformatics
VII	MDMBI03	Machine Learning Applications in Bioinformatics

Innovation, Entrepreneurial and Venture Development (IE):

Semester	Course Code	Course Name
V	MDMIE01	Foundations of Innovation and Entrepreneurship
VI	MDMIE02	Startup Planning and Development
VII	MDMIE03	Innovation Management and Scaling Startups

Business Development, Marketing and Finance (BD):

Semester	Course Code	Course Name
V	MDMBD01	Introduction to Business Development and Marketing Principles
VI	MDMBD02	Financial Basics for Engineers and Technopreneurs
VII	MDMBD03	Strategic Marketing and Business Planning

Robotics (RB):

Semester	Course Code	Course Name
V	MDMRB01	Fundamentals of Robotics and Control
VI	MDMRB02	Machine Vision and Robotic Perception
VII	MDMRB03	Intelligent Mobile Robotics