VIT Vidyalankar Institute of Technology
Accredited A+ by NAAC

Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Information Technology

With Multidisciplinary Minor

Final Year Scheme & Syllabus

(R-2023)

(As per NEP 2020, with effect from the Academic Year 2025-2026)

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 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 Program Courses consisting of 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 Professional 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 professional elective courses based on industrial requirements and organizing them into tracks is a special feature of these curricula ensuring employability. The vertical Multidisciplinary Courses consists of Open Elective (OE) courses and multidisciplinary minor (MD M) courses. 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 vertical like internships/On Job Training, Community Engagement Project, Real Industry Project/ research problem. Our curriculum also introduces Social Service Internship and Internship with institutes abroad 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 to core courses, professional and open electives; our framework offers honor degree in each 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 Information Technology

Vidyalankar Institute of Technology

Chairman, Academic Council

Vidyalankar Institute of Technology

Final Year B. Tech. Information Technology **Semester: VII**

Course Structure and Assessment Guidelines

NEP-Vertical	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
PC_PCC	PCIT53T	Distributed Computing	Theory	2	15	20	40	075
	PCIT53P	Distributed Computing Lab	Practical	1	25	-	25	050
PC_PEC	PEITXXT	Programme Electives-4	Theory	2	15	20	40	075
	PEITXXP	Programme Electives-4 Lab	Practical	1	25	-	25	050
	PEITXXT	Programme Electives-5	Theory	2	15	20	40	075
	PEITXXP	Programme Electives-5 Lab	Practical	1	25	-	25	050
	PEITXXT	Programme Electives-6	Theory	2	15	20	40	075
	PEITXXP	Programme Electives-6 Lab	Practical	1	25	-	25	050
Project	PRJIT03	Project-2 (Final)	Practical	4	75	-	50	125
MDM	MDMXX#	Any MDM course	Theory+ Tutorial/ Practical	4	45	30	50	125
MDC_MDM	MDM04	Skill and Competency Development 2	Practical	1	50	-	-	050
Total Credits				**20**				
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 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 Electives-4 Courses (PEITXXT and PEITXXP)

Course Code	Course Name	Specialization Track Name#
PEIT33T	Data Analytics & Visualization	Artificial Intelligence and Machine Learning (AIML)
PEIT33P	Data Analytics & Visualization Lab	
PEIT34T	Big Data Analytics	Data science (DS)
PEIT34P	Big Data Analytics Lab	
PEIT35T	IoT and Edge Computing	Internet of Things (IoT)
PEIT35P	IoT and Edge Computing Lab	
PEIT36T	Mobile and Wireless Security	Computer Security (CSec)
PEIT36P	Mobile and Wireless Security Lab	

#For details of Specialization Certificate, refer Appendix-A

Programme Electives-5 Courses (PEITXXT and PEITXXP)

Course Code	Course Name	Specialization Track Name#
PEIT37T	Deep Learning	Artificial Intelligence and Machine Learning (AIML)
PEIT37P	Deep Learning Lab	
PEIT38T	Recommendation Systems	Data science (DS)
PEIT38P	Recommendation Systems Lab	
PEIT39T	IoT Security and Trust	Internet of Things (IoT)
PEIT39P	IoT Security and Trust Lab	
PEIT40T	Malware Analysis	Cyber Security (CSec)
PEIT40P	Malware Analysis Lab	

#For details of Specialization Certificate, refer Appendix-A

Programme Electives-6 Courses (PEITXXT and PEITXXP))

Course Code	Course Name	Specialization Track Name#
PEIT41T	Natural language processing	Artificial Intelligence and Machine Learning (AIML)
PEIT41P	Natural language processing Lab	
PEIT42T	Text, Web & Social Media Analytics	Data science (DS)
PEIT42P	Text, Web & Social Media Analytic Lab	
PEIT43T	Industrial IOT	Internet of Things (IoT)
PEIT43P	Industrial IOT Lab	
PEIT44T	Web Application Security	Computer Security (CSec)
PEIT44T	Web Application Security Lab	

#For details of Specialization Certificate, refer Appendix-A

Multidisciplinary Elective Course3 (MDMXX)

MDM 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. Information Technology **Semester: VIII**

Course Structure and Assessment Guidelines

NEP-Vertical	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	Practical	7	100	-	100	200
ELC_RM	RM01	Research Methodology	Theory	3	20	30	50	100
MDM	MDM01	Seminar	Theory	2	25	-	50	075
Total Credits				**12**				

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.

Detailed Syllabus of Final Year Semester-VII

Course Name: Distributed Computing

Course Code: PCIT53T

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: Operating systems (PCIT05T), Computer Network (PCIT06T), Cloud Computing (PCIT13T)

Pre-requisite for: -

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT53T	2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15 (~20%)	20 (~30%)	40 (~50%)	75 (100%)

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 aims to provide students with an overview of the concepts and fundamentals of distributed systems. It covers the architecture and communication mechanisms in distributed environments, enabling students to understand how distributed components collaborate. Additionally, the course explores key aspects such as concurrency, fault tolerance, and scalability, offering insights into system transparency and the challenges of distributed coordination.

Course Objectives:

- To understand the goals, characteristics, and models of distributed systems.
- To analyze communication mechanisms and protocols in distributed environments.
- To study synchronization techniques and their role in ensuring consistency in distributed systems.
- To explore resource management and process migration strategies in distributed systems.
- To examine consistency models, replication, and fault tolerance mechanisms.
- To understand the design and implementation of distributed file systems with real-world examples

Course Outcomes:

Learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Understand the goals, models, and middleware concepts in distributed systems.	Understanding
CO2	Analyze communication mechanisms such as IPC, RPC, and RMI in distributed environments.	Analysing
CO3	Apply synchronization techniques like clock synchronization, mutual exclusion, and election algorithms.	Applying
CO4	Evaluate resource allocation, load balancing, and process migration techniques.	Evaluating
CO5	Assess consistency models, replication strategies, and fault tolerance mechanisms.	Evaluating
CO6	Analyze distributed file systems with case studies like GFS and HDFS	Analysing

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Distributed Systems	**Contents:** Characterization of Distributed Systems: Issues, Goals, Distributed System Models, Hardware concepts, Software Concept. Middleware: Introduction to DCE	4
2	Communication	**Contents:** Layered Protocols, Interprocess communication (IPC): MPI, Remote Procedure Call (RPC), Parameter-passing Semantics, RPC Failures & Process resilience, Remote Method Invocation (RMI), Message Oriented Communication, Stream Oriented Communication, Group Communication & Issues	5
3	Synchronization	**Contents:** Clock Synchronization (Physical & Logical), Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm. Non Token based Algorithms: Lamport Algorithm, Ricart– Agrawala's Algorithm, Maekawa's Algorithm Token Based Algorithms: Raymond Tree Algorithm, Suzuki-Kasami's Broardcast Algorithms, Deadlock Management (Avoidance, Detection, Prevention)	9
4	Resource and Process Management	**Contents:** Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach Introduction to process management, process migration.	6
5	Consistency, Replication and Fault Tolerance	**Contents:** Introduction to consistency, Data-Centric and Client- Centric Consistency Models.	3

6	Distributed File Systems	**Contents:** Characteristics and Goals: Transparency (access, location, replication, fault tolerance, concurrency). DFS vs. Local File Systems. File Access Methods: Remote File Access, File Replication, and Caching. Case Studies: Google File System (GFS), Hadoop Distributed File System (HDFS).	3
Total			**30**

Textbooks:

1. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten Van Steen.
2. Distributed Systems: Concepts and Design by George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair.
3. Distributed Computing: Principles, Algorithms, and Systems by Ajay D. Kshemkalyani and Mukesh Singhal.
4. Distributed Operating Systems by P.K. Sinha.

Reference Books:

1. Distributed Algorithms by Nancy A. Lynch
2. Concurrent and Distributed Computing in Java by Vijay K. Garg
3. Reliable Distributed Systems: Technologies, Web Services, and Applications by Kenneth P. Birman
   Distributed and Cloud Computing: From Parallel Processing to the Internet of Things by Kai Hwang, Jack Dongarra, and Geoffrey Fox

Course Name: Distributed Computing Lab

Course Code: PCIT53P

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: Operating System Lab (PCIT05P), Computer Networks Lab (PCIT06P)

Pre-requisite for: -

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT30P	-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25 (50%)	-	25 (50%)	50 (100%)

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 lab is designed to provide students with hands-on experience in the principles and practices of distributed computing. In this lab, you will explore various aspects of distributed systems, including architecture, communication, synchronization, and fault tolerance.

Course Objectives:

- To understand basic underlying concepts of forming distributed systems.
- To learn the concept of clock Synchronization
- To learn Election Algorithm.
- To explore mutual exclusion algorithms and deadlock handling in the distributed system
- To study resource allocation and management.
- To understand the Distributed File System

Course Outcomes:

Learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Develop test and debug using Message-Oriented Communication or RPC/RMI based client-server programs.	Applying
CO2	Implement techniques for clock synchronization.	Understanding
CO3	Implement techniques for Election Algorithms.	Understanding
CO4	Demonstrate mutual exclusion algorithms and deadlock handling.	Applying
CO5	Implement techniques of resource and process management.	Understanding
CO6	Describe the concepts of distributed File Systems with some case studies.	Applying

Suggested List of Practical:

Sr No.	Suggested Topic(s)	CO's Mapped
1.	Study of NOS, DOS And Middleware	CO2, CO5, CO6
2.	Design a Distributed application using socket. Application consists of a server which takes an integer value from the client, calculates factorial and returns the result to the Client program.	CO1
3	Design a Distributed Application using RMI for remote computation	CO1
4	Implementing BERKELEY Clock Synchronization algorithm.	CO2
5.	Implementing Bully Election algorithm.	CO3
6.	Implementation of CHM for distributed deadlock detection.	CO4
7	Implementation of Ricart Agrawala algorithm for distributed Mutual Exclusion	CO4
8.	Implementation of Raymond Tree for Token based Mutual Exclusion	CO4
9	Implementing load distribution algorithm	CO5
10	Case Study of Distributed File Systems.	CO6

Note:- Above is the suggested list of Practicals and teacher can implement different problem statements using modern tools

Textbooks:

1. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten Van Steen.
2. Distributed Systems: Concepts and Design by George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair.

3. Distributed Computing: Principles, Algorithms, and Systems by Ajay D. Kshemkalyani and Mukesh Singhal.
4. Distributed Operating Systems by P.K. Sinha.

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1. Distributed Algorithms by Nancy A. Lynch
2. Concurrent and Distributed Computing in Java by Vijay K. Garg
3. Reliable Distributed Systems: Technologies, Web Services, and Applications by Kenneth P. Birman
4. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things by Kai Hwang, Jack Dongarra, and Geoffrey Fox

Professional Elective-4 Courses (PEITXXT and PEITXXP)

Course Name: Data Analytics & Visualization

Course Code: PEIT33T

Vertical/ Sub-Vertical: Professional Elective (PE)

K-S-A Mapping: Knowledge & Skill

Recommended Semester: Sem VII

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
IT33T	2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	15 (~20%)	20 (~30%)	40 (~50%)	75 (100%)

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 students to the core concepts of data analytics and visualization, emphasizing analytical thinking and insight generation. It explores the complete data lifecycle—from collection and preparation to interpretation and storytelling. Students will develop the ability to extract meaningful patterns and present data-driven narratives effectively. The course lays a strong theoretical foundation for real-world data-driven decision-making in IT contexts.

Course Objectives:

- To provide a thorough understanding of the data analytics lifecycle and its role in decision- making.
- To develop the ability to preprocess, clean, and structure data for meaningful analysis.
- To enable students to perform exploratory data analysis and interpret statistical patterns.

- To impart knowledge of visualization principles for effective communication of insights.
- To cultivate analytical and critical thinking skills for solving real-world IT problems using data.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Explain the data analytics lifecycle, types of analytics, and the foundational role of data visualization in data-driven decision-making.	Understanding
CO2	Classify data types, variables, and data quality dimensions and infer their implications for analytical processing and visualization.	Analysing
CO3	Apply concepts of data cleaning, transformation, feature engineering, sampling, and exploratory data analysis to prepare and interpret analytical datasets.	Applying
CO4	Analyse and interpret core visualization techniques and visual encodings to derive insights from univariate and multivariate data.	Analysing
CO5	Evaluate and select appropriate advanced, time-series, geospatial, and specialized visualization techniques for representing complex analytical problems and model outputs.	Evaluating
CO6	Design ethical and effective visualization-driven narratives and decision models that communicate insights clearly and support informed actions for business and IT decision-making.	Creating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Foundations of Data Analytics and Visualization	Data as a Strategic Asset, Types of Analytics, Data Analytics Lifecycle, Analytical vs Operational Thinking, Hypothesis and Uncertainty, Role of Data Visualization, Exploratory vs Explanatory Visualization, Ethical and Responsible Analytics	5	CO1
2	Data Types, Structures, and Analytical Foundations	Data Classifications, Scales and Levels of Measurement, Data Domains, Variables and Causality, Data Quality Dimensions, Dimensional Modeling Concepts, Segmentation and Cohort Analysis, Structured and Tidy Data for Visualization	5	CO2
3	Data Cleaning, Transformation,	Data Cleaning and Transformation, Handling Missing Data and Outliers, Normalization and Standardization, Feature Engineering and	5	CO3

	Feature Logic, and EDA	Construction, Dimensionality Reduction Concepts, Sampling Methods, Exploratory Data Analysis Basics		
4	Core Visualization Principles and Techniques	Data–Chart Matching, Basic Chart Types, Visual Encodings, Data-to-Ink Ratio, Grammar-of-Graphics Concepts, Customization Elements, Multivariate Visualization Concepts, Multi-Panel and Comparative Visualizations	5	CO4
5	Advanced, Time-Series, Geospatial, and Specialized DV	Multivariate and High-Dimensional Visualization, Time-Series Visualization, Geospatial Visualization Concepts, Visualization of Model and Statistical Outputs, Network and Hierarchical Visualizations, Visualization for Big Data, Interactivity Concepts	5	CO5
6	Visualization Design, Decision Modelling, and Insight Communication	Visualization for Communication, Color Theory and Accessibility, Layout and Aesthetic Principles, Narrative and Storytelling with Data, Decision Modelling Concepts, KPI-Centric Visualization, Ethics and Governance in Visual Communication	5	CO6
Total			**30**	

Textbooks:

1. J. A. Hyman et al., Data Analytics & Visualization All-in-One For Dummies, 1st ed. Hoboken, NJ, USA: Wiley, 2024.
2. C. O. Wilke, Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2019.
3. C. N. Knaflic, Storytelling with Data: A Data Visualization Guide for Business Professionals, 1st ed. Hoboken, NJ, USA: Wiley, 2015.
4. A. Kirk, Data Visualisation: A Handbook for Data Driven Design, 2nd ed. London, UK: SAGE Publications, 2019.

Reference Books:

1. T. Munzner, Visualization Analysis and Design, 1st ed. Boca Raton, FL, USA: CRC Press, 2014.
2. E. R. Tufte, The Visual Display of Quantitative Information, 2nd ed. Cheshire, CT, USA: Graphics Press, 2001.
3. S. Few, Show Me the Numbers: Designing Tables and Graphs to Enlighten, 2nd ed. Oakland, CA, USA: Analytics Press, 2012.
4. C. Ware, Information Visualization: Perception for Design, 3rd ed. Waltham, MA, USA: Morgan Kaufmann, 2013.

Online Reference Material:

- R for Data Science (online book) – Comprehensive free text on data wrangling, EDA, and visualization (grammar of graphics, tidy data), useful for conceptual understanding even if you are tool-agnostic. https://r4ds.hadley.nz

- Fundamentals of Data Visualization (C. Wilke, online version) – Free online book focused on principles of effective graphs, encodings, design, and interpretation with many examples. https://clauswilke.com/dataviz/

- Hands-On Data Visualization (online book + examples) – Open-access book covering exploratory vs explanatory plots, storytelling, dashboards, and working from spreadsheets to code and web tools. https://handsondataviz.org/

- Storytelling with Data (blog and resources) – Articles, examples, and exercises on chart choice, decluttering, color, emphasis, and narrative for business communication. https://www.storytellingwithdata.com/

- Visualising Data (Andy Kirk) – blog, resources, and tutorials – Conceptual material on chart design, interactive dashboards, case studies, and links supporting the "Data Visualisation" handbook. https://visualisingdata.com/book/

- Data Visualization Techniques – Digital Notes (academic) – Lecture-style notes for a "Data Visualization Techniques" course that cover core concepts, chart types, and evaluation, useful as supplementary theory reading.
  (PDF) https://mrcet.com/downloads/digital_notes/IT/IT_4-1_(R22A6705)%20DATA%20VISUALIZATION%20TECHNIQUES%20DIGITAL%20NOTES(2025-26).pdf

- Data Analytics & Visualization All-in-One For Dummies – companion page – Publisher's page with description and ancillary material that spans analytics lifecycle, dashboards, and multiple tools (Excel, BI tools, etc.). https://www.dummies.com/book/technology/information-technology/data-science/general-data-science/data-analytics-visualization-all-in-one-for-dummies-9781394244102/

- Curated lists of data visualization books & resources – Helpful for you and students to explore additional materials and tool-specific content (Tableau, Power BI, Python, R, etc.). Tableau book list: https://www.tableau.com/learn/articles/books-about-data-visualization Turing DV books list: https://www.turing.com/kb/must-read-data-visualization-books.

Course Name: Data Analytics and Visualization Lab

Course Code: PEIT33P

Vertical/ Sub-Vertical: Program Courses- Professional Elective

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT33P	-	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 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 laboratory course provides hands-on experience in the complete data analytics and visualization lifecycle, from problem formulation and data preparation to model building, dashboard design, and insight communication using contemporary tools such as Python, Power BI, and Tableau. Through a sequence of practical experiments, learners will work with real-world datasets to classify and clean data, engineer features, perform sampling and dimensionality reduction, conduct exploratory and inferential analyses, and detect anomalies in IT system logs. Students will design and implement interactive dashboards, build decision-tree–based churn models, create KPI-driven performance scenarios, and develop storytelling reports that translate multivariate analytical findings into actionable business insights.

Course Objectives:

- To enable learners to implement the end to end data analytics lifecycle on real world business problems, from problem definition to insight generation and reporting.
- To develop practical skills in preparing, cleaning, transforming, and sampling data, and in assessing data quality for accurate and efficient analysis.
- To train learners to perform exploratory data analysis, hypothesis testing, and anomaly detection using transactional and IT system log data.
- To provide hands on experience in designing and building interactive dashboards and dimensional models for cohort analysis and KPI monitoring using modern BI tools.
- To cultivate the ability to create effective visualizations and storytelling reports that communicate multivariate analytical insights for strategic decision making.

- To develop competence in applying decision tree–based models and KPI driven scenario modelling for tasks such as customer churn prediction and business performance optimization.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Apply the complete data analytics lifecycle to real-world business problems, from problem definition through analysis to insight generation.	Applying
CO2	Analyse and prepare datasets by classifying data types, assessing data quality, and performing cleaning, transformation, sampling, and dimensionality reduction for efficient analysis.	Analysing
CO3	Perform exploratory data analysis, hypothesis testing, and anomaly detection on business and IT system log data to uncover meaningful patterns and irregularities.	Analysing
CO4	Design and build dimensional models, cohort analyses, and interactive dashboards to support business decision-making and KPI monitoring using modern analytics tools.	Creating
CO5	Create effective visualizations and storytelling reports from multivariate data that clearly communicate business insights and support strategic decisions.	Creating
CO6	Develop and evaluate decision-tree–based models and KPI-driven scenario models for tasks such as customer churn prediction and business performance optimization.	Evaluating

Suggested List of Practical:

The laboratory work should contain any 10 experiments from the following list.

Sr No.	Suggested Experiments	CO's Mapped
1	Simulating the Analytics Lifecycle to Address a Business Problem	CO1
2	Build an Interactive Dashboard to Support Business Decisions using Power BI	CO4
3	Classify the data into structured, semi-structured, and unstructured types and identify scales of measurement. Assess data quality dimensions (accuracy, completeness, consistency, timeliness) in a real-world dataset using Python.	CO2
4	Build a Dimensional Model and Perform Cohort Analysis using Power BI	CO4
5	Enhance Model Accuracy by Cleaning and Transforming Raw Data using Python	CO2
6	Sampling and Dimensionality Reduction for Efficient Analysis using Python/Power BI	CO2

7	Uncovering Customer Behavior Patterns through EDA using Python and Power BI	CO3
8	Hypothesis Testing and Anomaly Detection in IT System Logs	CO3
9	Designing Effective Visualizations for Business Insights by developing visual dashboards to explore and explain sales performance using Power BI and Tableau	CO5
10	Create a Storytelling Report from Multivariate Data to Support Strategic Decisions	CO5
11	Predict Customer Churn Using Decision Trees and Identify Key Influencing Factors using Python	CO6
12	KPI-Based Scenario Modeling for Business Performance Optimization using Power BI	CO6

Textbooks:

1. W. McKinney, Python for Data Analysis, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.

2. G. Deckler and B. Powell, Microsoft Power BI Cookbook, 3rd ed. Birmingham, UK: Packt Publishing, 2024.

3. R. Sleeper, Practical Tableau, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2016.

4. J. VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2016.

Reference Books:

1. A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2018.

2. M. Kuhn and K. Johnson, Applied Predictive Modeling, 1st ed. New York, NY, USA: Springer, 2013.

3. W. McKinney, Python for Data Analysis, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.

4. C. O. Wilke, Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2019.

Online Reference Material:

1. Data analysis and visualization with Python (Pandas):
https://www.geeksforgeeks.org/pandas/data-analysis-visualization-python/

2. Exploratory Data Analysis (EDA) in Python — complete guide:
https://medium.com/@subhransunayak726/exploratory-data-analysis-eda-in-python-the-complete-guide-9d940cdf58d7

3. Power BI documentation (official, end-to-end):
https://learn.microsoft.com/en-us/power-bi/

4. Power BI dashboard design tips (for KPI and scenario dashboards):
https://learn.microsoft.com/en-us/power-bi/create-reports/service-dashboards-design-tips

5. Tableau training resources (dashboards and visual analytics):
https://www.purdue.edu/bicc/tools/tableau/training.php

6. Decision trees for churn and classification (scikit-learn DecisionTreeClassifier):
https://scikit-learn.org/1.7/modules/generated/sklearn.tree.DecisionTreeClassifier.html

7. Log anomaly detection tutorial (for IT system log experiment):
https://opensource.salesforce.com/logai/latest/tutorial.build_log_anomaly_detection_app.html

Course Name: Big Data Analytics

Course Code: PEIT34T

Vertical/ Sub-Vertical: PE

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PEIT26T (Data & Feature Engineering), PCIT15T (Machine Learning)

Pre-requisite for: NIL

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT34T	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.

Preamble:

This course introduces students to the foundational concepts, tools, and frameworks used in processing and analyzing big data, such as Hadoop, Spark, and NoSQL systems. Emphasis is placed on hands-on implementation and understanding of distributed computing paradigms, data storage models, data preprocessing techniques, and machine learning at scale. By integrating theory with real-world applications, the course prepares learners to design and deploy big data solutions that are efficient, robust, and impactful across domains such as finance, healthcare, social networks, and cybersecurity.

Course Objectives:

1. Understand the Big Data Platform and its Use cases
2. Provide an overview of Apache Hadoop
3. Provide HDFS Concepts and Interfacing with HDFS
4. Understand Map Reduce Jobs
5. Provide hands on Hadoop Ecosystem
6. Apply analytics on Structured, Unstructured Data.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain the motivation for big data systems and identify the main sources of Big Data in the real world.	Understanding
CO2	Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store retrieve and process Big Data for Analytics	Applying
CO3	Implement several Data Intensive tasks using the Map Reduce Paradigm	Applying
CO4	Apply several newer algorithms for Clustering Classifying and finding associations in Big Data	Applying
CO5	Design algorithms to analyze big data like streams, Web Graphs and Social Media data.	Creating
CO6	Design and implement successful Recommendation engines for enterprises.	Creating

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours	CO's Mapped
1	Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Big Data Applications	2	CO1
2	Introduction to Big Data Frameworks: Hadoop, NOSQL	Hadoop Components and Hadoop Ecosystem **Overview of** Apache Spark, Hive **What is NoSQL?** NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, **Mongo DB:** Creation and Deletion of database, insertion, deletion and updating operations	6	CO2
3	MapReduce Paradigm	**MapReduce:** The Map Tasks, Reduce Tasks, Combiners, Details of MapReduce Execution. **Algorithms Using MapReduce:** Matrix Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce,	6	CO3
4	Mining Big Data Streams	**The Stream Data Model:** A Data- Stream-Management System, Stream Queries, Issues in Stream Processing. **Counting Distinct Elements in a stream**: The Flajolet-Martin Algorithm	6	CO4

		Counting Ones in a Window: Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm.		
5	Big Data Mining Algorithms	**Frequent Pattern Mining**: Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. **Clustering Algorithms:** CURE Algorithm **Classification Algorithms:** Parallel Decision trees, Overview SVM classifiers, SVM, K-Nearest Neighbor classifications for Big Data	4	CO5
6	Big Data Applications	**Link Analysis**: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient Computation of Page Rank, , Hubs and Authorities, HITS Algorithm. **Recommendation Engines:** A Model for Recommendation Systems, Types of Recommendation, Content-Based Recommendations, Collaborative Filtering	6	CO6
Total			**30**	

Textbooks:

1. Jure Leskovec, Anand Rajaraman, Jeffrey Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge University Press.
2. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Publication.
3. Nathan Marz, James Warren, "Big Data: Principles and Best Practices of Scalable Realtime Data Systems", Manning Publications.
4. Jimmy Lin, Chris Dyer, "Data-Intensive Text Processing with MapReduce", Morgan & Claypool Publishers.

Reference Books:

1. Seema Acharya, Subhasini Chellappan, "Big Data Analytics", Wiley India Publication.
2. Bill Chambers, Matei Zaharia, "Spark: The Definitive Guide", O'Reilly Media Publication.
3. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Publication.
4. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing.
5. Alan Gates, "Programming Pig", O'Reilly Media Publication.

Online Reference Material:

1. Hadoop Tutorial - https://hadoop.apache.org/docs/current/
2. Spark Tutorial- https://spark.apache.org/documentation.html
3. Introduction to Big data - https://www.coursera.org/learn/big-data-introduction

Course Name: Big Data Analytics Lab

Course Code: PEIT34P

Vertical/ Sub-Vertical: PE

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT34P	--	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.

Preamble:

The Big Data Analytics Laboratory is designed to provide hands-on experience in handling, processing, and analyzing large-scale datasets using modern big data technologies and tools. This laboratory focuses on practical implementation of data visualization, distributed storage and processing frameworks, NoSQL databases, machine learning techniques, and streaming algorithms. Students will gain experience with technologies such as Hadoop, Spark, MongoDB, Tableau/Power BI, and recommendation systems to solve real-world big data problems.

Course Objectives

- To provide practical exposure to data visualization and analytics using Python libraries and visualization tools such as Tableau and Power BI.
- To familiarize students with distributed computing frameworks such as Hadoop and Spark for processing large-scale datasets.
- To enable students to implement big data processing techniques, including MapReduce, RDD operations, and stream mining algorithms.
- To develop practical knowledge of NoSQL databases and big data storage techniques using MongoDB.
- To implement machine learning and graph-based algorithms for classification, ranking, and recommendation systems on big data.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	**Perform** NoSQL database operations using MongoDB for managing structured and semi-structured big data.	Applying
CO2	**Apply** data visualization techniques using Python libraries, Tableau, and Power BI for analyzing suitable datasets.	Applying
CO3	**Implement** distributed data processing techniques using Hadoop commands, MapReduce, and Spark RDD transformations for large-scale data analytics.	Applying
CO4	**Analyze and implement** big data algorithms such as PageRank and DGIM for graph and stream data processing.	Analysing
CO5	**Develop** intelligent analytics solutions using classification algorithms and recommendation systems for big data applications.	Creating

Suggested List of Practical:

Sr. No.	Suggested Experiments	CO's Mapped
1	Find suitable dataset and perform data visualization using Python Libraries Tableau/PowerBI.	CO2
2	Find suitable dataset and perform data visualization using Tableau/PowerBI.	CO2
3	To study Hadoop commands.	CO3
4	To implement MapReduce task for word count application	CO3
5	To implement RDD actions and Transformations in Spark	CO3
6	To perform CRUD operations in MongoDB	CO1
7	To study and implement classification algorithms on big data	CO5
8	To implement PageRank algorithm	CO4
9	To Implement DGIM algorithm	CO4
10	To design and implement any one type of recommendation system	CO5

Textbooks:

1. Jure Leskovec, Anand Rajaraman, Jeffrey Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge University Press.
2. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Publication.
3. Nathan Marz, James Warren, "Big Data: Principles and Best Practices of Scalable Realtime Data Systems", Manning Publications.
4. Jimmy Lin, Chris Dyer, "Data-Intensive Text Processing with MapReduce", Morgan & Claypool Publishers.

Reference Books:

1. Seema Acharya, Subhasini Chellappan, "Big Data Analytics", Wiley India Publication.
2. Bill Chambers, Matei Zaharia, "Spark: The Definitive Guide", O'Reilly Media Publication.
3. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Publication.
4. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing.
5. Alan Gates, "Programming Pig", O'Reilly Media Publication.

Online Reference Material:

1. Hadoop Tutorial - https://hadoop.apache.org/docs/current/
2. Spark Tutorial - https://spark.apache.org/documentation.html
3. Introduction to Big data - https://www.coursera.org/learn/big-data-introduction

Course Name: Internet of Things and Edge Computing

Course Code: PEIT35T

Category: Professional elective - 4 (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 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.

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.

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) 2.4 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) 5.4 Data pipelines for transferring and processing sensor data in the cloud	5
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**

Textbooks:

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: Mobile & Wireless Security

Course Code: PEIT36T

Vertical/ Sub-Vertical: Professional Elective

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PEIT21T (Computer and Network Security)

Pre-requisite for: PEIT62T (Detection & Mitigation of Cyber Threats)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT36T	2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory (PEIT36T)	15 (20%)	20 (30%)	40 (50%)	75 (100%)

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*:*

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.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:

- 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:

Learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain the mobile and wireless security landscape, threats, vulnerabilities, and attack surfaces.	Understand
CO2	Analyze mobile device security mechanisms, app permissions, and threats such as rooting, malware, and phishing using tools like MobSF and Frida.	Analyze
CO3	Evaluate wireless protocols (Wi-Fi, Bluetooth, NFC, Zigbee), attacks (eavesdropping, MITM, rogue APs), and countermeasures including WPA/WPA2/WPA3 and intrusion detection systems.	Evaluate
CO4	Apply secure coding and app security principles to identify vulnerabilities in Android/iOS apps and perform static and dynamic analysis.	Apply
CO5	Examine security challenges, protocols (MQTT, CoAP), device authentication, firmware security, and threat modeling in IoT and wearable devices using tools like Shodan and IoT Inspector.	Analyze
CO6	Apply incident response methodology to mobile and wireless systems, including evidence acquisition, preservation, and analysis using Cellebrite UFED and Kali Linux tools.	Apply

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO
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)*	5	CO1
2	Mobile Device Security	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	CO2
3	Wireless Network Security	Wireless protocols: Wi-Fi, Bluetooth, NFC, and Zigbee. WPA, WPA2, WPA3: Strengths and weaknesses. Common attacks: Eavesdropping, MITM, rogue	6	CO3

		access points, replay attacks. Wireless intrusion detection and prevention systems. 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.*		
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, Services, Broadcast Receivers), Secure data storage and transmission practices in mobile apps*	6	CO4
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.*	5	CO5
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)*	2	CO6
Total			**30**	

Textbooks

1. Mobile and Wireless Network Security: Concepts and Practices – G. Singh, Springer, 2022
2. Security and Privacy in Mobile and Wireless Networks – S. Ranganathan, Wiley, 2021
3. Android Security Internals – N. Russell, No Starch Press, 2015
4. IoT Security: Advances in Authentication – J. Granjal, Springer, 2020

5. Mobile Application Security – S. Raghavan, Packt Publishing, 2021

Reference:

1. Wireless Network Security: Theories and Applications – C. Perkins, CRC Press, 2020
2. iOS and Android Security – R. Smith, Elsevier, 2021
3. Incident Response & Computer Forensics – K. Mandia, McGraw-Hill, 2018
4. Practical Mobile Forensics – R. Mahalik, Packt Publishing, 2019

Additional Reputed Materials & Tools (Online Collections)

IEEE / Research Papers:

- "Mobile Security Threats and Solutions: A Review" – IEEE Access, 2023
- "Wireless Network Security in 5G Networks" – IEEE Communications Surveys, 2022
- "IoT Device Security: Analysis and Mitigation Techniques" – IEEE Internet of Things Journal, 2021

University Lecture Notes / Online Materials:

- Stanford University – Mobile Security Course Materials –
- RPISEC – Mobile Malware Analysis Labs – GitHub Repository
- UMBC – Wireless and Mobile Security Notes – UMBC CS Department

Tools Documentation & Tutorials:

- MobSF (Mobile Security Framework)
- Frida Dynamic Analysis Tool –
- Shodan IoT Security Tools
- IoT Inspector
- Cellebrite UFED

Course Name: Mobile and Wireless Security Lab

Course Code: PEIT36P

Vertical/ Sub-Vertical: Professional Elective

Mapping: Knowledge & Skill

Pre-requisite required: PEIT21P (CNS)

Pre-requisite for: IT62P (Detection & Mitigation of Cyber Threats)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT36P	-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical (PEIT36P)	25 (50%)	-	25 (50%)	50 (100%)

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 laboratory provides hands-on exposure to mobile, wireless, and IoT security concepts. Students will perform static and dynamic mobile app analysis, wireless network assessment, IoT device analysis, and incident response tasks using industry-standard tools. Emphasis is on practical skills, ethical handling of devices, and structured reporting.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:

- Develop practical skills in mobile and wireless security assessment.
- Apply static and dynamic analysis techniques to identify vulnerabilities.
- Analyze and secure wireless networks and IoT devices.
- Execute incident response procedures for mobile and wireless systems.

Course Outcomes:

Learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain mobile and wireless security concepts and threats	Understand
CO2	Perform static and dynamic analysis of mobile applications	Apply
CO3	Analyze wireless network vulnerabilities and IoT device security	Analyze
CO4	Use security tools (MobSF, Frida, Wireshark, Aircrack-ng, Shodan) effectively	Apply
CO5	Execute incident response procedures for mobile and wireless devices	Apply
CO6	Evaluate security breaches and propose mitigation strategies	Evaluate

Suggested List of Practicals:

Sr No.	Suggested Topic(s)	CO
1.	Explain mobile and wireless security concepts and threats	CO1
2.	Setting Up a Mobile and Wireless Security Lab	CO1
3.	Conduct dynamic analysis of a mobile app using Frida	CO4
4.	Wireless Network Penetration Testing	CO4
5.	Explore Android/iOS security features and app permissions	CO1, CO2
6.	Monitor IoT traffic and analyze security vulnerabilities with IoT Inspector	CO5
7.	Analyze Bluetooth/NFC communication security	CO3
8.	Conduct mobile incident response: evidence acquisition using Cellebrite UFED	CO6
9.	Identify mobile threats: malware, phishing, rooting/jailbreaking	CO2
10.	Capture and analyze Wi-Fi traffic using Wireshark	CO3
11.	Perform WPA/WPA2/WPA3 security testing using Air cracking	CO3
12.	Wireless incident response using Kali Linux tools	CO6

Textbooks

1. Mobile and Wireless Network Security: Concepts and Practices – G. Singh, Springer, 2022
2. Security and Privacy in Mobile and Wireless Networks – S. Ranganathan, Wiley, 2021
3. Android Security Internals – N. Russell, No Starch Press, 2015
4. IoT Security: Advances in Authentication – J. Granjal, Springer, 2020
5. Mobile Application Security – S. Raghavan, Packt Publishing, 2021

Reference Books

1. Wireless Network Security: Theories and Applications – C. Perkins, CRC Press, 2020
2. iOS and Android Security – R. Smith, Elsevier, 2021
3. Incident Response & Computer Forensics – K. Mandia, McGraw-Hill, 2018
4. Practical Mobile Forensics – R. Mahalik, Packt Publishing, 2019

Video Tutorials & Online References

- MobSF: https://mobsf.github.io/
- Frida: https://frida.re/docs/
- Shodan: https://www.shodan.io/
- IoT Inspector: https://www.iot-inspector.com/
- Cellebrite UFED: https://www.cellebrite.com/en/home/

Professional Elective-5 Courses (PEITXXT and PEITXXP)

Course Name: Deep Learning

Course Code: PEIT37T

Vertical/ Sub-Vertical: Professional Elective

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PCIT15 (Machine Learning), PEIT25 (Soft Computing)

Pre-requisite for: PEIT41 (Natural Language Processing)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT37T	2	--	2	--

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory (PEIT37T)	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.

Preamble:

Deep Learning explores the design, principles, and theoretical foundations of multi-layered neural networks used to model complex patterns in data. This course covers core architectures such as feedforward networks, CNNs, RNNs, and generative models, along with essential concepts like optimization, regularization, and representation learning. By the end, students will gain a strong conceptual understanding of deep learning and be prepared to analyze, design, and interpret deep models across a range of AI applications.

Course Objectives:

1. Understand the mathematical foundations and core algorithms of deep learning.
2. Study the architectures and working principles of neural network models.
3. Analyze deep learning models based on performance and computational efficiency.
4. Understand optimization, regularization, and representation learning techniques in model training.
5. To understand advanced deep learning architectures and generative models for intelligent representation learning, sequence processing, and decision-making applications in AI systems.
6. Develop and Deploy deep learning solutions using industry-standard tools and frameworks.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain the fundamental concepts, architectures, and mathematical foundations of deep learning models.	Understand (L2)
CO2	Apply preprocessing, optimization, and regularization techniques for training deep learning models.	Apply (L3)
CO3	Develop and implement Artificial Neural Networks (ANNs) and Convolutional Neural Networks (CNNs) for real-world applications.	Apply (L3)
CO4	Design sequence-based models using RNN, LSTM, and Transformer architecture for NLP and time-series applications.	Create (L6)
CO5	Design and evaluate advanced deep learning models such as Transformers, Autoencoders, GANs, and basic Reinforcement Learning techniques for mod AI applications.	Create (L6)
CO6	Build and deploy deep learning solutions using modern frameworks and industry-standard tools.	Create (L6)

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours	CO Mapping
1	Foundations of Deep Learning	Introduction to AI, Machine Learning, and Deep Learning Biological neuron vs artificial neuron, Perceptron, Multilayer Perceptron (MLP) ,Activation functions (ReLU, Sigmoid, Tanh, Softmax) , Loss functions and optimization basics ,Gradient Descent (Batch, Mini-batch, Stochastic)	2	CO1
2	Neural Network Training & Optimization	Backpropagation algorithm , Weight initialization techniques, Overfitting and underfitting, Regularization (L1, L2, Dropout, Early stopping), Optimization algorithms (SGD, Momentum, RMSProp, Adam), Hyperparameter tuning strategies	4	CO2
3	Convolutional Neural Networks (CNNs)	Introduction to CNNs and image data, Convolution operation and filters, Pooling layers (Max, Average), CNN architectures: LeNet, AlexNet, VGG, ResNet, Transfer learning and fine-tuning Applications: Image classification, object detection basics	6	CO3

4	Recurrent Neural Networks (RNNs) & Sequence Models	Sequence modeling concepts, Vanilla RNN and limitations (vanishing gradients), LSTM and GRU architectures, Bidirectional RNNs Applications: NLP basics, speech recognition, time series forecasting	6	CO4
5	Advanced Deep Learning Architectures	Attention mechanism and Transformers, Natural Language Processing with BERT, GPT basics, Autoencoders (Vanilla, Denoising) Generative Adversarial Networks (GANs) Introduction to Reinforcement Learning (basic concepts only)	6	CO5
6	Tools, Deployment & Industry Applications	Deep Learning frameworks: TensorFlow, PyTorch, Model evaluation metrics (Accuracy, Precision, Recall, F1-score), Model deployment basics (APIs, cloud, edge devices) Introduction to MLOps Ethics in AI and bias Case studies: Agriculture, Healthcare, autonomous vehicles, recommendation systems	6	CO6
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.Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer.
2.Understanding Deep Learning – Simon J. D. Prince, MIT Press.
3.Dive into Deep Learning – Aston Zhang et al., Cambridge University Press.
4.Learning Deep Learning – Magnus Ekman, Addison-Wesley / NVIDIA.
5.Designing Machine Learning Systems – Chip Huyen, O'Reilly Media

Links

1. DeepLearning.AI Courses
2. Stanford CS231n (CNN for Visual Recognition)
3. Stanford CS224n (NLP with Deep Learning)
4. Kaggle Learn - Dive into Deep Learning (Interactive Book)

Course Name: Deep Learning Lab

Course Code: PEIT37P

Vertical/ Sub-Vertical: Professional Elective

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PCIT15T (Machine Learning), PEIT25T (Soft Computing)

Pre-requisite for: PEIT41T (Natural Language Processing)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT37P	--	2	--	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical (PEIT37P)	25 (50%)	-	25 (50%)	50 (100%)

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:

Deep Learning explores the design, principles, and theoretical foundations of multi-layered neural networks used to model complex patterns in data. This course covers core architectures such as feedforward networks, CNNs, RNNs, and generative models, along with essential concepts like optimization, regularization, and representation learning. By the end, students will gain a strong conceptual understanding of deep learning and be prepared to analyze, design, and interpret deep models across a range of AI applications.

Course Objectives:

- To develop skills in data preprocessing, feature engineering, and reusable pipeline creation for deep learning applications.
- To implement and train deep learning models such as ANN, CNN, RNN, and LSTM using modern frameworks and datasets.
- To analyze and improve model performance using optimization, regularization, and hyperparameter tuning techniques.
- To apply advanced deep learning methods including transfer learning, NLP, and time-series forecasting for solving real-world problems.
- To deploy deep learning models using APIs, web interfaces, containerization, and basic MLOps practices.
- To evaluate deep learning models using performance metrics, explainability methods, and responsible AI principles.

Course Outcomes:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Develop reusable data preprocessing pipelines including data cleaning, feature engineering, and dataset preparation for deep learning applications.	Understand (L2)
CO2	Build, train, and evaluate deep learning models such as ANN, CNN, RNN, and LSTM using industry-standard frameworks.	Apply (L3)
CO3	Analyze and optimize deep learning models using hyperparameter tuning, regularization, pruning, and quantization techniques.	Apply (L3)
CO4	Implement advanced deep learning approaches including transfer learning, NLP pipelines, and time-series forecasting for real-world applications.	Create (L6)
CO5	Deploy deep learning models using REST APIs, web interfaces, containerization, and basic MLOps practices.	Create (L6)
CO6	Evaluate model performance, interpretability, fairness, and ethical considerations using appropriate metrics and explainability techniques.	Create (L6)

Suggested List of Practicals:

The laboratory work should contain any 10 experiments from the following list and one project which will cover all units.

Sr No	Module	Suggested List	CO Mapping
1.	Foundations of Deep Learning	Experiment 1: Data Pipeline & Preprocessing Objective Build a reusable data pipeline (industry practice). Dataset Titanic Dataset Industry Tasks Data cleaning, missing value handling Feature engineering Train-test-validation split Pipeline creation using functions/classes Outcome Clean, reusable dataset pipeline Git-tracked project structure	CO1
2.	Neural networks	Experiment 2: Baseline Model + Experiment Tracking Objective Establish baseline + track experiments. Dataset MNIST Industry Tasks Train baseline ANN	CO2, CO3

		Track experiments (manual logs or MLflow intro) Compare hyperparameters Outcome Reproducible experiments Versioned results	
3.	Convolution Neural Networks	CNN with Real-World Constraints Objective Handle real-world image problems. Dataset CIFAR-10 Industry Tasks Data augmentation Handle class imbalance Performance tuning Outcome Robust CNN model Better generalization	CO2, CO3
4.	Transfer learning with CNN	Transfer Learning (Production Use Case) Objective Use pretrained models like industry systems. Dataset Dogs vs Cats dataset Industry Tasks Use pretrained ResNet/VGG Fine-tuning vs feature extraction Performance benchmarking Outcome Production-ready model approach Faster training cycles	CO2, CO4
5.	RNN and Sequence models	NLP Pipeline with RNN/LSTM Objective Build end-to-end NLP system. Dataset IMDB Reviews Dataset Industry Tasks Text preprocessing (tokenization, padding) Embedding layers Model evaluation using precision/recall Outcome Deployable NLP pipeline Business metrics understanding	CO2, CO4
6.		Time Series Forecasting (Business Use Case) Objective Forecast real-world trends. Dataset Airline Passenger Dataset Industry Tasks Feature engineering (lag features)	CO2, CO4

		Train LSTM Evaluate using RMSE Outcome Business-ready forecasting model	
7.	Optimization	Model Optimization Objective Optimize models for deployment. Dataset Use previous trained models Industry Tasks Quantization Pruning Measure latency vs accuracy Outcome Lightweight deployable model	CO3
8.	Deployment and training	Model Deployment (API + UI) Objective Deploy model like a real product. Dataset Any trained model Industry Tasks Build REST API using Flask Create UI using Streamlit Test API endpoints Outcome Working ML application	CO5
9.	Tools and deployment	MLOps Basics Objective Introduce production ML lifecycle. Tools Git Docker Industry Tasks Version control Containerize model CI/CD basics Outcome Production workflow understanding	CO5
10.	Model Evaluation	Responsible AI & Model Evaluation Objective Evaluate models beyond accuracy. Dataset Any dataset Industry Tasks Confusion matrix Precision, Recall, F1-score Bias detection Model explainability (basic SHAP/LIME intro) Outcome Ethical and interpretable AI	CO6

11.	Industry Applications projects	Applied Project (Industry-Level) Requirements End-to-end pipeline (data → model → deployment) Use Git + Docker Include UI + API Project Ideas (Samples , List will be provided during Lab sessions) Smart surveillance (CNN) AI chatbot (NLP) Predictive maintenance system Recommendation engine Industry Evaluation Rubric Code quality (modularity, Git usage) – 20% Model performance – 20% Deployment (API/UI) – 20% Documentation (README, reports) – 20% Innovation – 20% Outcome : What Makes This Industry-Ready Focus on end-to-end systems, not just training Exposure to MLOps + deployment Real datasets and constraints Emphasis on optimization & explainability	CO1 TO CO6

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. Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer.
2. Understanding Deep Learning – Simon J. D. Prince, MIT Press.
3. Dive into Deep Learning – Aston Zhang et al., Cambridge University Press.
4. Learning Deep Learning – Magnus Ekman, Addison-Wesley / NVIDIA.
5. Designing Machine Learning Systems – Chip Huyen, O'Reilly Media

Links:

1. DeepLearning.AI Courses
2. Stanford CS231n (CNN for Visual Recognition)
3. Stanford CS224n (NLP with Deep Learning)
4. Google Colab
5. Kaggle Learn
6. Dive into Deep Learning (Interactive Book)

Course Name: Recommendation System

Course Code: PEIT38T

Vertical/ Sub-Vertical:

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PEIT21T (Artificial Intelligence), PEIT15T (Machine Learning)

Pre-requisite for: NIL

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
IT38T	2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	15 (~20%)	20 (~30%)	40 (~50%)	75 (100%)

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:

Recommendation systems have emerged as essential tools to deliver personalized suggestions, enhancing user experience and decision-making. By analyzing user behavior, preferences, and contextual data, these systems intelligently filter and present relevant options. This project focuses on developing an effective Recommendation System that adapts to user needs, improves engagement, and supports smarter, data-driven decisions.

Course Objectives:

- To provide a foundation of recommender systems concepts
- To expose to a variety of recommender systems algorithms
- To provide a knowledge on the different evaluation methods of Recommender Systems
- To build up the capability to develop a recommender system solution

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Explain the fundamental concepts, architecture, and types of recommender systems, including personalized and non-personalized approaches.	Understand
CO2	Apply collaborative filtering techniques, similarity measures, and user-based/item-based recommendation methods to generate recommendations.	Apply
CO3	Analyze content-based recommender system components, including item profiles, user profiles, content similarity, and knowledge-based recommendation approaches.	Analyze
CO4	Evaluate neighborhood-based recommendation methods and compare user-based, item-based, and hybrid recommendation strategies.	Evaluate
CO5	Design context-aware recommender systems by incorporating contextual, trust, and additional information into recommendation models.	Create
CO6	Assess recommender system performance using evaluation metrics such as RMSE, MAE, correlation, utility-based measures, and ROC.	Evaluate

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to Recommender Systems	What is Recommendation engine, Need for recommender systems, Framework of recommendation systems, Personalized vs. Non-Personalized, Semi/Segment - Personalized, Privacy, users data and trustworthiness.	5	CO1
2	Collaborative filtering-based Recommender System	Understanding ratings and rating data, User-based nearest-neighbor recommendation: Similarity Function, User-Based Algorithms Item-based nearest neighbor recommendation: Similarity Function, Item-Based Algorithms, Further model-based and preprocessing-based approaches, Comparing User-Based and Item-Based recommendations, data drift and concept drift	5	CO2
3	Content-based Recommender System	Architecture of Content-based Systems, Advantages and Drawbacks of Content-based Filtering, Content representation and content similarity, Item profiles, discovering features of data, obtaining item features	5	CO3

		from tags, representing item profiles, Learning User Profiles and Filtering, Similarity-based retrieval, Classification algorithms, Knowledge base recommendation: Knowledge representation and reasoning, constraint-based recommenders, Case based recommenders.		
4	Neighborhood-based Recommendation Methods	Advantages of Neighborhood Approaches, Neighborhood-based Recommendation, User-based Rating Prediction, User-based Classification Regression Vs Classification, Item-based Recommendation, User-based Vs Item based Recommendation, Rating Normalization, Similarity Weight Computation, Neighborhood Selection	5	CO4
5	Context-Aware Recommender Systems	Trust Context in Recommender Systems, Modeling Contextual Information in Recommender Systems. Paradigms for Incorporating Context in Recommender Systems: Contextual Pre- Filtering, Contextual Post-Filtering, Contextual Modeling, Combining Multiple Approaches, Additional Issues in Context-Aware Recommender Systems.	5	CO5
6	Evaluating Recommender system	Evaluation Paradigms, General Goals of Evaluation Design, Design Issues in Offline Recommender Evaluation, Case Study of the Netflix Prize Data Set, Segmenting the Ratings for Training and Testing, Hold-Out, Cross-Validation Accuracy Metrics Evaluation: RMSE versus MAE, Impact of the Long Tail, Evaluating Ranking via Correlation, Evaluating Ranking via Utility, Evaluating Ranking via Receiver Operating Characteristic.	5	CO6
Total			**30**	

Textbooks:

1. C. C. Aggarwal, *Recommender Systems: The Textbook*, 1st ed. Cham, Switzerland: Springer, 2016.
2. R. Jannach, M. Zanker, A. Felfernig, and G. Friedrich, *Recommender Systems: An Introduction*, 2nd ed. Cambridge, UK: Cambridge University Press, 2018.
3. F. Ricci, L. Rokach, and B. Shapira, Eds., *Recommender Systems Handbook*, 3rd ed. New York, NY, USA: Springer, 2022.
4. D. Jannach and M. Zanker, *Personalized and Context-Aware Recommender Systems*, 1st ed. Cham, Switzerland: Springer, 2020.
5. J. Bobadilla, F. Ortega, A. Hernando, and A. Gutiérrez, *Recommender Systems in Action*, 1st ed. Cham, Switzerland: Springer, 2021.

6. G. Adomavicius and A. Tuzhilin, "Context-Aware Recommender Systems," in *Recommender Systems Handbook*, 2nd ed. Boston, MA, USA: Springer, 2015.

Reference Books:

1. F. Ricci, L. Rokach, and B. Shapira, Eds., Recommender Systems Handbook, 3rd ed. New York, NY, USA: Springer, 2022.
2. C. C. Aggarwal, Recommender Systems: The Textbook, 1st ed. Cham, Switzerland: Springer, 2016.
3. R. Jannach, M. Zanker, A. Felfernig, and G. Friedrich, Recommender Systems: An Introduction, 2nd ed. Cambridge, UK: Cambridge University Press, 2018.
4. D. Jannach and M. Zanker, Personalized and Context-Aware Recommender Systems, 1st ed. Cham, Switzerland: Springer, 2020.
5. J. Bobadilla, F. Ortega, A. Hernando, and A. Gutiérrez, Recommender Systems in Action, 1st ed. Cham, Switzerland: Springer, 2021.
6. G. Adomavicius and A. Tuzhilin, "Context-Aware Recommender Systems," in Recommender Systems Handbook, 2nd ed. Boston, MA, USA: Springer, 2015.

Online Reference Material:

1. Google for Developers, "Introduction to Recommendation Systems."
   Available: https://developers.google.com/machine-learning/recommendation.

2. Coursera, "Recommender Systems," Sungkyunkwan University.
   Available: https://www.coursera.org/learn/recommender-systems-ml.

3. Stanford InfoLab, "Recommendation Systems." Available: http://infolab.stanford.edu/~ullman/mmds/ch9.pdf.

4. GitHub, "An introduction to recommendation systems in Python."
   Available: https://github.com/topspinj/recommender-tutorial.

5. GitHub, "A List of Recommender Systems and Resources."
   Available: https://github.com/grahamjenson/list_of_recommender_systems.

6. Medium, "Recommender System Hands-on Tutorials."
   Available: https://medium.com/@aman.jain.004/recommender-system-hands-on-tutorials-38b8da37e268.

7. LinkedIn Learning, "Recommendation Systems: A Practical Hands-On Introduction."
   Available: https://www.linkedin.com/learning/recommendation-systems-a-practical-hands-on-introduction.

8. Google Developers, "Recommendation Systems." Available: https://developers.google.com/machine-learning/recommendation.

Course Name: Recommendation systems Lab

Course Code: PEIT38P

Vertical/ Sub-Vertical: Program Courses- Professional Elective

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT38P	-	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 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 lab gives hands-on experience in designing, implementing, and evaluating recommender systems using collaborative, content-based, neighborhood, and context-aware approaches. Students will build user- and item-based recommenders, implement rating-prediction methods, and construct content and knowledge-based models. Emphasis is placed on feature extraction, similarity computation, and user/item profiling to produce personalized suggestions. Labs include experiments on contextualization and neighborhood selection to improve recommendation quality. Finally, students will evaluate systems using metrics such as RMSE, MAE, correlation, and ROC, and compare different approaches for real-world datasets.

Course Objectives:

- To introduce students to the fundamental concepts, architecture, and applications of recommender systems.
- To develop an understanding of collaborative filtering techniques and similarity-based recommendation methods.
- To enable students to design content-based and knowledge-based recommender systems.
- To familiarize students with neighborhood-based, user-based, and item-based recommendation approaches.
- To provide knowledge of context-aware recommendation and the use of contextual information in recommender systems.
- To train students in evaluating recommender systems using appropriate metrics and validation methods.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Understand the basic architecture, types, and workflow of recommender systems through hands-on experiments.	Understand
CO2	Apply collaborative filtering techniques to generate recommendations using user-based and item-based methods.	Apply
CO3	Implement content-based and knowledge-based recommendation methods using item features, user profiles, and rules.	Apply
CO4	Analyze neighborhood-based recommendation methods and compare similarity measures and rating prediction approaches.	Analyze
CO5	Design context-aware recommendation experiments by incorporating contextual and trust-related information.	Create
CO6	Evaluate recommender system performance using validation methods and metrics such as RMSE, MAE, correlation, and ROC.	Evaluate

Suggested List of Practical:

The laboratory work should contain any 10 experiments from the following list.

Sr No.	Suggested Experiments	CO's Mapped
1	Study the basic architecture and workflow of a recommender system.	CO1
2	Analyze different types of recommender systems: personalized, non-personalized, semi-personalized.	CO1
3	Implement user-based collaborative filtering using a similarity measure.	CO2
4	Implement item-based collaborative filtering and compare it with user-based filtering.	CO2
5	Perform rating prediction using user-based and item-based nearest-neighbor methods.	CO4
6	Build a content-based recommender system using item features and user profiles.	CO3
7	Apply similarity-based retrieval for recommending items using content profiles.	CO3
8	Implement a knowledge-based recommender system using rules or constraints.	CO3
9	Study neighborhood-based recommendation methods and compute similarity weights.	CO4
10	Implement context-aware recommendation using contextual information.	CO5
11	Evaluate a recommender system using train-test split and cross-validation.	CO6

12	Compare recommender system performance using RMSE, MAE, correlation, and ROC-based measures.	CO6

Textbooks:

1. C. C. Aggarwal, *Recommender Systems: The Textbook*, 1st ed. Cham, Switzerland: Springer, 2016.
2. F. Ricci, L. Rokach, and B. Shapira, Eds., *Recommender Systems Handbook*, 3rd ed. New York, NY, USA: Springer, 2022.
3. R. Jannach, M. Zanker, A. Felfernig, and G. Friedrich, *Recommender Systems: An Introduction*, 2nd ed. Cambridge, UK: Cambridge University Press, 2018.
4. J. Bobadilla, F. Ortega, A. Hernando, and A. Gutiérrez, *Recommender Systems in Action*, 1st ed. Cham, Switzerland: Springer, 2021.
5. D. Jannach and M. Zanker, *Personalized and Context-Aware Recommender Systems*, 1st ed. Cham, Switzerland: Springer, 2020.
6. G. Adomavicius and A. Tuzhilin, "Context-Aware Recommender Systems," in *Recommender Systems Handbook*, 2nd ed. Boston, MA, USA: Springer, 2015.

Reference Books:

1. F. Ricci, L. Rokach, and B. Shapira, Eds., *Recommender Systems Handbook*, 3rd ed. New York, NY, USA: Springer, 2022.
2. C. C. Aggarwal, *Recommender Systems: The Textbook*, 1st ed. Cham, Switzerland: Springer, 2016.
3. R. Jannach, M. Zanker, A. Felfernig, and G. Friedrich, *Recommender Systems: An Introduction*, 2nd ed. Cambridge, UK: Cambridge University Press, 2018.
4. J. Bobadilla, F. Ortega, A. Hernando, and A. Gutiérrez, *Recommender Systems in Action*, 1st ed. Cham, Switzerland: Springer, 2021.
5. D. Jannach and M. Zanker, *Personalized and Context-Aware Recommender Systems*, 1st ed. Cham, Switzerland: Springer, 2020.
6. G. Adomavicius and A. Tuzhilin, "Context-Aware Recommender Systems," in *Recommender Systems Handbook*, 2nd ed. Boston, MA, USA: Springer, 2015.

Online Reference Material:

1. Google for Developers, "Recommendation Systems."
   Available: https://developers.google.com/machine-learning/recommendation.
2. Coursera, "Recommender Systems" courses and certificates.
   Available: https://www.coursera.org/courses?query=recommender+systems.
3. Codecademy, "Learn Recommender Systems." Available: https://www.codecademy.com/learn/learn-recommender-systems.

4. Stanford InfoLab, "Recommendation Systems."
   Available: http://infolab.stanford.edu/~ullman/mmds/ch9.pdf.

5. GitHub, "An introduction to recommendation systems in Python."
   Available: https://github.com/topspinj/recommender-tutorial.

6. GitHub, "A List of Recommender Systems and Resources."
   Available: https://github.com/grahamjenson/list_of_recommender_systems.

7. LearnOpenCV, "Mastering Recommendation System: A Complete Guide."
   Available: https://learnopencv.com/recommendation-system/.

8. LinkedIn Learning, "Recommendation Systems: A Practical Hands-On Introduction."
   Available: https://www.linkedin.com/learning/recommendation-systems-a-practical-hands-on-introduction

Course Name: Internet of Things Security and Trust

Course Code: PEIT39T

Category: Professional elective - 5 (IoT Track)

Pre-requisites: C Programming, Object Oriented Programming**,** Microprocessor and Microcontroller

Course Scheme:

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

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory (PEIT39T)	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.

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.

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.

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**

Textbooks:

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:

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

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

Course Code: PEIT39P

Category: Professional Elective- 5 (IoT Track)

Pre-requisites: C Programming**,** Object Oriented Programming, Microprocessor and microcontroller

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	25

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.

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.

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:

"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: PEIT40T

Vertical/ Sub-Vertical: PE

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PEIT28T (SSEH) & PEIT32T (DF)

Pre-requisite for: IT62T (Decentralized and Blockchain Technologies)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT40T	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.

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.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:

- 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:

Learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain malware fundamentals, lifecycle, delivery mechanisms, and real-world malware trends.	Understand
CO2	Analyze malware behavior, infection vectors, persistence, escalation, and IOCs.	Analyze
CO3	Perform static malware analysis using PE structure, hashing, strings, and disassembly tools.	Apply
CO4	Conduct dynamic malware analysis using sandboxing, behavioral monitoring, and network analysis tools	Apply
CO5	Examine reverse engineering methods and anti-analysis techniques using debugging tools.	Analyze
CO6	Apply automated malware analysis, classification, signature creation, and reporting techniques.	Apply

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO
1	Introduction to Malware	Definition, types, history, and trends of malware Malware lifecycle and delivery mechanisms Real-world case studies	5	CO1
2	Malware Behavior and Infection Vectors	Persistence mechanisms, privilege escalation Fileless malware, macro malware, polymorphism Indicators of Compromise (IOCs)	6	CO2
3	Static Malware Analysis	PE file structure, hashing, strings extraction Disassembly using IDA Free/Ghidra Assembly code basics	6	CO3
4	Dynamic Malware Analysis	Sandboxing, system call monitoring Behavioral analysis using Process Monitor, ProcMon Network behavior using Wireshark	6	CO4
5	Reverse Engineering & Anti-Analysis Techniques	Anti-debugging and anti-VM techniques Unpacking and decryption Debugging with x64dbg/OllyDbg	5	CO5
6	Automated Malware Analysis & Reporting	Cuckoo Sandbox and Any.Run usage Classification and signature creation Threat Intelligence Platforms Malware reporting and IOCs	2	*CO6*
Total			**30**	

Textbooks

1. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software by Michael Sikorski & Andrew Honig — A foundational book for static and dynamic malware analysis methods.

2. Practical Reverse Engineering by Bruce Dang, Alexandre Gazet & Elias Bachaalany — Deep dive into reverse engineering fundamentals and architectures.

3. Reversing: Secrets of Reverse Engineering by Eldad Eilam — Classic reference on software reverse engineering techniques.

4. Malware Analyst's Cookbook and DVD: Tools and Techniques for Fighting Malicious Code – Practical recipes and tool-based techniques.

5. Learning Malware Analysis by Monnappa K A — Good beginner-friendly resource with conceptual insights.

6. Rootkits and Bootkits: Reversing Modern Malware and Next Generation Threats – Advanced coverage of stealth malware.

7. The IDA Pro Book by Chris Eagle — Reference on using the IDA disassembler (helpful for advanced analysis).

8. Windows Internals by Mark E. Russinovich et al. — Useful for understanding core OS structures malware interacts with.

Reference & Research Papers

1. Memory Forensics Techniques for Automated Detection and Analysis of Go Malware – A recent paper on advanced memory forensics techniques in malware analysis (ArXiv).

2. AI Assisted Malware Analysis: A Course for Next Generation Cybersecurity Workforce – Discusses integrating AI/ML techniques into malware analysis workflows.

3. Survey of Machine Learning Techniques for Malware Analysis – Overview of ML approaches used in automated malware detection and analysis.

4. Evading Malware Analysis Using Reverse Execution – A study on methods malware uses to avoid being analyzed.

Additional Reputed Materials & Tools (Online Collections)

- Malware Analysis Tools & Resources (GitHub repo)
- Official Ghidra Documentation & NSA Training
- Malware Traffic Analysis Tutorials & Case Studies

Course Name: Malware Analysis Lab

Course Code: PEIT40P

Vertical/ Sub-Vertical: PE

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PEIT28P (SSEH) & PEIT32T (DF)

Pre-requisite for: IT62P (Decentralised and Blockchain Technologies)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
IT36P	--	2	--	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical (IT36P)	25 (50%)	---	25 (50%)	50 (100%)

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 laboratory course provides hands-on experience in analyzing malware using both static and dynamic techniques. Students will gain practical skills in reverse engineering, sandboxing, network traffic analysis, debugging, and automated malware analysis tools. The lab emphasizes forensic rigor, tool usage, and ethical practices.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:

- Understand different types of malware and infection vectors.
- Apply static and dynamic malware analysis techniques.
- Develop skills in reverse engineering and debugging.
- Use automated malware analysis tools and generate structured reports.

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Identify malware types, lifecycle, and delivery mechanisms	Understand
CO2	Analyze malware behavior and infection vectors including persistence and privilege escalation	Analyze
CO3	Apply static analysis techniques such as PE structure analysis, hashing, string extraction, and disassembly	Apply
CO4	Conduct dynamic analysis using sandboxing, process monitoring, and network traffic	Apply
CO5	Examine anti-analysis techniques and perform reverse engineering with debugging tools.	Analyze
CO6	Apply automated malware analysis tools to classify malware and generate actionable reports.	Apply

Suggested List of Practical's:

Sr No.	Suggested Topic(s)	CO
1.	Identify and classify malware samples based on type and delivery mechanism	CO1
2.	Analyze persistence and privilege escalation mechanisms in malware	CO2
3.	Extract PE file structure, compute hashes, and extract strings from malware	CO3
4.	Capture network traffic from malware execution and analyze using Wireshark	CO4
5.	Unpack and decrypt malware to analyze payload	CO5
6.	Compare automated analysis results with manual dynamic/static analysis	CO4, CO6
7.	Analyze real-world malware case study and summarize mitigation steps	CO1, CO2
8.	Generate malware classification report and identify IOCs	CO6
9.	Debug malware with x64dbg to bypass anti-debugging techniques	CO5
10.	Execute malware in sandbox and monitor system calls using ProcMon	CO4
11.	Perform disassembly using IDA Free/Ghidra and interpret assembly instructions	CO3

Textbooks

1. Practical Malware Analysis – Michael Sikorski & Andrew Honig
2. Practical Reverse Engineering – Bruce Dang, Alexandre Gazet, Elias Bachaalany
3. Reversing: Secrets of Reverse Engineering – Eldad Eilam
4. The IDA Pro Book – Chris Eagle

Reference Books

1. Malware Analyst's Cookbook and DVD – Michael Hale Ligh et al.
2. Learning Malware Analysis – Monnappa K A
3. Windows Internals – Mark E. Russinovich et al.
4. Rootkits and Bootkits – Alex Matrosov, Eugene Rodionov

Video Tutorials & Online References

- Malware Analysis Tutorials (YouTube – MalwareTech)
- Ghidra Reverse Engineering Guide – NSA Ghidra Tutorials
- Wireshark Network Traffic Analysis

Professional Elective-6 Courses (PEITXXT and PEITXXP)

Course Name: Natural Language Processing

Course Code: PEIT41T

Vertical/ Sub-Vertical: Professional Elective

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PCIT09 (Automata Theory), PEIT29T (Probabilistic Graphical Model), PEIT37T (Deep Learning)

Pre-requisite for: HMIT09T (Generative AI models)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT41T	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.

Preamble:

Natural Language Processing (NLP) is an interdisciplinary field that combines Artificial Intelligence, Machine Learning, and Linguistics to enable computers to process, analyze, and generate human language effectively. With the rapid growth of digital text and speech data, NLP plays a vital role in developing intelligent systems such as chatbots, machine translation, sentiment analysis, and question-answering systems. This course provides a comprehensive introduction to the fundamental concepts and advanced techniques in NLP, including language modelling, parsing, semantics, discourse analysis, word embeddings, and neural language models.

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:

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

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
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.	6	CO1, CO2, CO5
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; Top Down Parser: Early Parser, Predictive Parser	5	CO1, CO2, CO3, CO5

3	Semantics, and Discourse	Semantics: Introduction, meaning representation; Lexical Semantics; Corpus study; Knowledge Graphs & 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	5	CO1, CO2, CO3, CO4
4	Word Representations and Embedding Models	Word2Vec, CBOW and Skip-Gram Models, One word learning architecture, Forward pass for Word2Vec, Matrix Operations, Lec 07: Word Representation: Word2Vec & fastText, Word Representation: GloVe, Tokenization Strategies	6	CO1, CO2, CO3, CO5
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	CO1, CO2, CO3, CO5
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	3	CO1, CO2, CO5, CO6
Total			**30**	

Textbooks:

1. Daniel Jurafsky and James H Martin, *Speech and Language Processing*, 3rd ed., 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*, 1st ed., OReilly Media, 2009.
4. Daniel and James H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*, 2nd Edition, Prentice Hall of India, 2008.

Reference Books:

1. Tanveer Siddiqui and U.S. Tiwary, *Natural Language Processing and Information Retrieval*, Oxford University Press, 2008.
2. Alexander Clark, Chris Fox and Shalom Lappin, *The Handbook of Computational Linguistics and Natural Language Processing*, John Wiley & Sons, 2012.
3. James Allen, *Natural Language Understanding*, 8th ed., Pearson Publication, 2012.

Online Reference Material:

1. Prof. Pawan Goyal, Natural Language Processing, IIT Kharagpur, NPTEL, 2026. [Online]. Available: https://nptel.ac.in/courses/106105158
2. Prof. Ramaseshan R, Applied Natural Language Processing, Chennai Mathematical Institute, NPTEL, 2020. [Online]. Available: https://nptel.ac.in/courses/106106211
3. Eddy Shyu, Łukasz Kaiser, Younes Bensouda Mourri, Natural Language Processing, Specialization, DeepLearning.AI, Coursera, 2023. [Online]. Available: https://www.coursera.org/specializations/natural-language-processing
4. Prof. Pawan Goyal, Deep Learning for Natural Language Processing, IIT Kharagpur, NPTEL, 2026. [Online]. Available: https://nptel.ac.in/courses/108105572

Course Name: Natural Language Processing Lab

Course Code: PEIT41P

Vertical/ Sub-Vertical: Program Courses_Professional Elective

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT41P	-	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 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:

The Natural Language Processing (NLP) Laboratory course provides practical exposure to computational techniques used for processing and analyzing human language. The course covers implementation of text preprocessing, language modelling, parsing, semantic analysis, and neural NLP models using modern tools and frameworks. Learners will develop hands-on skills in building intelligent applications such as sentiment analysis, machine translation, and chatbot systems. The laboratory also emphasizes multilingual and regional language processing for solving real-world NLP problems.

Course Objectives:

- To provide practical understanding of fundamental NLP techniques such as tokenization, stemming, parsing, and semantic analysis.
- To develop the ability to implement statistical and neural language models for text processing and sequence prediction tasks.
- To enable learners to apply machine learning and deep learning approaches for solving real-world NLP problems.
- To familiarize learners with modern NLP tools, libraries, and frameworks for building intelligent language processing applications.
- To develop skills in designing and evaluating NLP systems such as sentiment analysis, machine translation, and question answering systems.
- To encourage experimentation with multilingual and regional language datasets for developing inclusive and scalable NLP solutions.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Implement text preprocessing and linguistic analysis techniques such as tokenization, stemming, POS tagging, and parsing.	Apply
CO2	Develop and evaluate statistical language models and feature extraction techniques for NLP applications.	Create & Evaluate
CO3	Apply semantic analysis and discourse processing methods including word sense disambiguation and anaphora resolution.	Apply
CO4	Build word embedding and neural language models using architectures such as Word2Vec, RNN, LSTM, and GRU.	Create
CO5	Design and implement NLP applications such as sentiment analysis, machine translation, text summarization, and chatbot systems.	Create
CO6	Analyze and evaluate the performance of NLP systems using appropriate metrics and real-world multilingual datasets.	Analyze & Evaluate

Suggested List of Practical:

The laboratory work should contain any 10 experiments from the following list.

Sr No.	Suggested Experiments	CO's Mapped
1.	Text Preprocessing using NLP Libraries (Tokenization, stop-word removal, stemming, and lemmatization) for English and a selected Indian regional language (e.g., Hindi or Tamil).	CO1
2.	Implement a language model to predict the next word using Trigram with Laplace smoothing.	CO2
3.	POS Tagging using rule-based, statistical approaches. Also, implement Bidirectional LSTM-based POS tagger.	CO1, CO4
4.	Syntax Parsing using CFG/PCFG/CYK.	CO1, CO3
5.	Build a Word Sense Disambiguation (WSD) tool using dictionary-based and machine learning approaches. Word Sense Disambiguation using Contextual Embeddings.	CO3
6.	Develop an Anaphora Resolver using Hobbs' Algorithm for English narratives.	CO3
7.	Train Word2Vec (CBOW and Skip-Gram) models on a regional language corpus.	CO4
8.	Build and train an RNN-based language model to generate simple sentences from a dataset.	CO4
9.	Create a Seq2Seq translation model with attention for English to regional language (e.g., English to Hindi).	CO4, CO5

10.	Design a sentiment analysis system in a regional language using RNN/LSTM.	CO5
11.	Develop a Transformer-based Text Classification System using BERT	CO4, CO5
12.	Implement a Question Answering System using Retrieval-Augmented Generation (RAG)	CO5, CO6

Textbooks:

1. Daniel Jurafsky and James H Martin, *Speech and Language Processing*, 3rd ed., 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*, 1st ed., OReilly Media, 2009.
4. Daniel and James H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*, 2nd Edition, Prentice Hall of India, 2008.

Reference Books:

1. Tanveer Siddiqui and U.S. Tiwary, *Natural Language Processing and Information Retrieval*, Oxford University Press, 2008.
2. Alexander Clark, Chris Fox and Shalom Lappin, *The Handbook of Computational Linguistics and Natural Language Processing*, John Wiley & Sons, 2012.
3. James Allen, *Natural Language Understanding*, 8th ed., Pearson Publication, 2012.

Online Reference Material:

1. Prof. Pawan Goyal, Natural Language Processing, IIT Kharagpur, NPTEL, 2026. [Online]. Available: https://nptel.ac.in/courses/106105158
2. Prof. Ramaseshan R, Applied Natural Language Processing, Chennai Mathematical Institute, NPTEL, 2020. [Online]. Available: https://nptel.ac.in/courses/106106211
3. Eddy Shyu, Łukasz Kaiser, Younes Bensouda Mourri, Natural Language Processing, Specialization, DeepLearning.AI, Coursera, 2023. [Online]. Available: https://www.coursera.org/specializations/natural-language-processing
4. Prof. Pawan Goyal, Deep Learning for Natural Language Processing, IIT Kharagpur, NPTEL, 2026. [Online]. Available: https://nptel.ac.in/courses/108105572

Course Name: Text, Web & Social Media Analytics

Course Code: PEIT41T

Vertical/ Sub-Vertical: Professional Elective

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: Basic Programming, Data Structures and Algorithms, Statistics and Probability

Pre-requisite for: Basic Programming, Data Structures and Algorithms, Statistics and Probability

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT41T	2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15 (~20%)	20 (~30%)	40 (~50%)	75 (100%)

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 on Text, Web & Social Media Analytics introduces the fundamental techniques and tools for analyzing unstructured textual data from web and social media sources. Students will learn methods in text mining, natural language processing, sentiment analysis, and web analytics, combined with practical applications using real-world datasets. The course aims to develop skills necessary for extracting actionable insights and making data-driven decisions in diverse fields.

Course Objectives:

- To introduce the foundational concepts and techniques of text mining, including information extraction, text representation, clustering, and classification.
- To develop analytical skills for mining structured and unstructured data from web and social media platforms, focusing on user behavior, influence, and recommendation systems.
- To enable students to perform sentiment analysis and opinion mining using supervised and unsupervised learning methods, and to detect and handle opinion spam effectively.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Understand the core concepts, terminologies, and real-world applications of text mining, web mining, and social media analytics.	Understand
CO2	Apply text preprocessing and representation techniques (e.g., tokenization, vectorization, N-grams) to prepare unstructured data for analysis.	Apply
CO3	Implement appropriate clustering, classification, and modeling algorithms (e.g., K-means, Decision Trees, CRFs) for extracting patterns from text and web data.	Apply/ Analyze
CO4	Analyze web usage data to identify user behavior patterns using data modeling, clustering, and session analysis techniques.	Analyze
CO5	Evaluate social network structures, user influence, and recommendation strategies by mining and interpreting social media data.	Evaluate
CO6	Develop opinion and sentiment mining systems using supervised and unsupervised learning methods, and detect spam and abnormal behaviors in online content.	Create/Evaluate

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to Databases and Data Models	Introduction to Text Mining: Introduction, Algorithms for Text Mining: Topic Modelling, Sentiment analysis, Future Directions Information Extraction from Text: Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction Text Representation: tokenization, stemming & Lemmatization, stop words, NER, N- gram modelling, Vectorization	2	CO1
2	Clustering and Classification	Text Clustering: Feature Selection and Transformation Methods, distance-based Clustering Algorithms, Word and Phrase based Clustering, Probabilistic document Clustering Text Classification: Feature Selection, Decision tree Classifiers, Rule- based Classifiers, Probabilistic based Classifiers, Proximity based Classifiers. Text Modelling: Bayesian Networks, Hidden Markovian Models, Markov random Fields, Conditional Random Fields	5	CO2, CO3
3	Web-Minning	Introduction to Web-Mining: Web Structure mining, web content mining and web usage mining, Inverted indices and Compression, Latent Semantic Indexing, Web Search	5	CO3, CO4

		Meta Search: Search Engine and types of search engine, Using Similarity Scores, Rank Positions Web Spamming: Content Spamming, Link Spamming, hiding Techniques, and Combating Spam		
4	Web Usage Mining	Data Collection and Pre-processing, Sources and types of Data, Data Modelling, Session and Visitor Analysis, Cluster Analysis and Visitor segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigational Patterns, Classification and Prediction based on Web User Transactions.	6	CO4, CO5
5	Social Media Mining	Introduction, Challenges, Types of social Network Graphs Mining Social Media: Influence and Homophily, Behaviour Analytics, Recommendation in Social Media: Challenges, Classical recommendation Algorithms, Recommendation using Social Context, Evaluating recommendations.	5	CO5, CO6
6	Opinion Mining and Spam Detection	The problem of opinion mining, Document Sentiment Classification: Supervised, Unsupervised, Opinion Lexicon Expansion: Dictionary based, Corpus based, Opinion Spam Detection: Supervised Learning, Abnormal Behaviours, Group Spam Detection.	2	CO6
Total			**30**	

Textbooks:

1. H. Jiawei and M. Kamber, *Data Mining: Concepts and Techniques*, 4th ed. Burlington, MA, USA: Morgan Kaufmann, 2023.

2. C. C. Aggarwal, *Data Mining: The Textbook*, 2nd ed. Cham, Switzerland: Springer, 2020.

3. B. Liu, *Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data*, 2nd ed. Cham, Switzerland: Springer, 2011.

4. R. Zafarani, M. A. Abbasi, and H. Liu, *Social Media Mining: An Introduction*, 1st ed. Cambridge, UK: Cambridge University Press, 2014.

5. G. Paliouras, M. D. D. A. L. H. et al., *Text Mining: Classification, Clustering, and Applications*, 1st ed. Boca Raton, FL, USA: CRC Press, 2012.

6. M. Srivastava and S. T. P. Ramesh, *Opinion Mining and Sentiment Analysis*, 1st ed. Cham, Switzerland: Springer, 2018.

Reference Books:

1. A. Z. Broder, *Mining the Web: Discovering Knowledge from Hypertext Data*, 1st ed. San Francisco, CA, USA: Morgan Kaufmann, 2001.

2. J. Han, M. Kamber, and J. Pei, *Data Mining: Concepts and Techniques*, 3rd ed. Waltham, MA, USA: Morgan Kaufmann, 2011.

3. M. Berry and G. Linoff, *Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management*, 3rd ed. Indianapolis, IN, USA: Wiley, 2011.

Online Reference Material:

1. Coursera, "Data Mining Specialization." Available: https://www.coursera.org/specializations/data-mining.

2. GeeksforGeeks, "Data Mining Tutorial." Available: https://www.geeksforgeeks.org/data-science/data-mining/.

3. University of Illinois, "CS 412 Introduction to Data Mining."
   Available: https://ws.engr.illinois.edu/sitemanager/getfile.asp?id=511.

4. Purdue Engineering, "Intro to Data Mining." Available: https://engineering.purdue.edu/online/courses/data-mining.

5. Data Science Dojo, "Data Mining Fundamentals Course." Available: https://datasciencedojo.com/free-courses/data-mining-fundamentals/.

6. Simplilearn, "Free Data Mining Course with Certificate." Available: https://www.simplilearn.com/free-introduction-to-data-mining-course-skillup.

7. IntechOpen, "Data Mining - Methods, Applications and Systems."
   Available: https://www.intechopen.com/books/9961.

8. Alison, "Free Online Data Mining Courses." Available: https://alison.com/tag/data-mining.

Course Name: Text, web & Social Media Analytics lab

Course Code: IT41P

Vertical/ Sub-Vertical: Program Courses- Professional Elective

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
IT41P	-	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 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 laboratory course provides hands-on experience in text mining, web mining, social media mining, sentiment analysis, and opinion mining. Students will learn to preprocess text, extract information, build classification and clustering models, and analyze web and social data. The experiments also cover search ranking, web spam detection, user behavior analysis, and social network patterns. Overall, the lab helps students apply data mining techniques to real-world problems and develop practical analytical skills.

Course Objectives:

- To provide hands-on understanding of text preprocessing, representation, and information extraction techniques.
- To enable students to apply classification, clustering, and topic modeling methods on text and web data.
- To develop the ability to analyze web content, web usage, and search engine behavior using mining techniques.
- To familiarize students with social media analysis, influence detection, and recommendation methods.
- To train students in sentiment classification, opinion mining, and spam detection for real-world applications.

Course Outcomes:

Learner will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Apply text preprocessing and representation techniques for preparing unstructured text data for analysis.	Apply
CO2	Perform named entity recognition, topic modeling, classification, and clustering on text data.	Analyze / Apply
CO3	Analyze web content, web search results, and web spam using mining and ranking techniques.	Analyze
CO4	Examine web usage patterns, session behavior, and visitor analysis for predicting user intent.	Analyze / Evaluate
CO5	Analyze social network structure, influence, and homophily in social media data.	Analyze / Evaluate
CO6	Develop sentiment classification and opinion spam detection solutions for online reviews and social content.	Create / Evaluate

Suggested List of Practical:

The laboratory work should contain any 10 experiments from the following list.

Sr No.	Suggested Experiments	CO's Mapped
1	Text Preprocessing and Representation	CO1
2	Named Entity Recognition and Topic Modelling	CO2
3	News Article Categorization using Text Classification	CO2
4	Clustering Customer Feedback for Service Improvement	CO2
5	Implement a Mini Search Engine with Ranking and Similarity Scoring	CO3
6	Detecting Web Spam in Search Results	CO3
7	Session and Visitor Behavior Analysis for an E-Commerce Website	CO4
8	Predicting Purchase Intent Based on Web Usage Patterns	CO4
9	Analyzing Influence and Homophily in a Twitter Network	CO5
10	Building a Social Media Recommendation System	CO5
11	Sentiment Classification of Product Reviews	CO6
12	Opinion Spam Detection in Online Reviews	CO6

Textbooks:

1. J. Han, M. Kamber, and J. Pei, *Data Mining: Concepts and Techniques*, 3rd ed. Waltham, MA, USA: Morgan Kaufmann, 2011.
2. C. C. Aggarwal, *Data Mining: The Textbook*, 2nd ed. Cham, Switzerland: Springer, 2020.
3. B. Liu, *Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data*, 2nd ed. Cham, Switzerland: Springer, 2011.
4. R. Zafarani, M. A. Abbasi, and H. Liu, *Social Media Mining: An Introduction*, 1st ed. Cambridge, UK: Cambridge University Press, 2014.

Reference Books:

1. A. Z. Broder, *Mining the Web: Discovering Knowledge from Hypertext Data*, 1st ed. San Francisco, CA, USA: Morgan Kaufmann, 2001.
2. M. Berry and G. Linoff, *Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management*, 3rd ed. Indianapolis, IN, USA: Wiley, 2011.
3. M. Srivastava and S. T. P. Ramesh, *Opinion Mining and Sentiment Analysis*, 1st ed. Cham, Switzerland: Springer, 2018.
4. D. Jurafsky and J. H. Martin, *Speech and Language Processing*, 3rd ed. draft, 2024.
5. S. Bird, E. Klein, and E. Loper, *Natural Language Processing with Python*, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2009.
6. C. D. Manning, P. Raghavan, and H. Schütze, *Introduction to Information Retrieval*, 1st ed. Cambridge, UK: Cambridge University Press, 2008.

Online Reference Material:

1. IBM, "What Is Text Mining?" Available: https://www.ibm.com/think/topics/text-mining.
2. Coursera, "Text Mining and Analytics." Available: https://www.coursera.org/learn/text-mining.
3. University of Illinois, "Introduction to Data Mining" notes.
   Available: https://ws.engr.illinois.edu/sitemanager/getfile.asp?id=511.
4. GeeksforGeeks, "Web Mining." Available: https://www.geeksforgeeks.org/machine-learning/web-mining/.
5. RDataMining, "Free Data Mining Tools." Available: https://www.rdatamining.com/resources/free-data-mining-tools.
6. American University, "Tools for Text Mining and Social Media Research."
   Available: https://subjectguides.library.american.edu/c.php?g=1348585&p=9994508.
7. Kaggle, "Learn." Available: https://www.kaggle.com/learn.
8. GitHub, "awesome-nlp." Available: https://github.com/keon/awesome-nlp.

Course Name: Industrial Internet of Things (IIoT)

Course Code: PEIT43T

Category: Professional elective – 7 (IoT Track)

Pre-requisites: Modern Sensor Technology for IoT**,** Principles of IoT

Course Scheme:

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

Assessment Guidelines:

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

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.

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.

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.

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. 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.	4
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) Lab

Course Code: PEIT43P

Category: Professional elective – 7 (IoT Track)\

Pre-requisites: Modern Sensor Technology for IoT**,** Principles of IoT

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical (PEIT43P)	25	-	25	050

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.

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

Suggested List of Practical:

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.

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.

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.

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.

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.

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.

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.

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.

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 Piby Colin Wong
2. Hands-On Industrial Internet of Things by Richard Radoczki

Course Name: Web Application Security

Course Code: PEIT44T

Vertical/ Sub-Vertical: PE

K-S-A Mapping: Knowledge & Skill

Pre-requisite required:(PEIT28T) System Security & Ethical hacking

Pre-requisite for: (PEIT62T) Detection & Mitigation of Cyber Threats

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT44T	2	2	2	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory (PEIT44T)	15 (20%)	20 (30%)	40 (50%)	75 (100%)

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 focuses on identifying, analyzing, 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.

Course Objectives*:*

- To reveal the underlying in 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:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Identify the vulnerabilities in the web applications	Understanding
CO2	Identify the various types of threats and mitigation measures of web applications.	Understanding
CO3	Apply the security principles in developing a reliable web application.	Applying
CO4	Use industry standard tools for web application security	Applying
CO5	Create detailed reports on findings, mitigation's , and secure design	Creating
CO6	Understand the case studies of the industry for security	Analyze

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Overview of Web Applications	Introduction history of web applications interface ad 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	CO1
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	CO2
3	Web Application Vulnerabilities	Understanding vulnerabilities in traditional client server application 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	CO3

4	Tools for Security Testing	Burp Suite, ZAP Proxy, Nikto, WFuzz, HTTP interceptors, crawling, fuzzing, authentication testing	6	CO4
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	CO5
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	CO6
Total			**30**	

Textbooks:

1. Web Application Security (2nd Edition), Andrew Hoffman, 2nd Edition, O'Reilly Media, 2024.
2. The Web Application Hacker's Handbook, Dafydd Stuttard and Marcus Pinto, 2nd Edition, Wiley Publishing, 2011.
3. The Tangled Web: A Guide to Securing Modern Web Applications, Michal Zalewski, 1st Edition, No Starch Press, 2011.
4. Web Security for Developers, Malcolm McDonald, 1st Edition, No Starch Press, 2019.

Reference Books:

1. Web Security Testing Cookbook, Paco Hope and Ben Walther, 1st Edition, O'Reilly Media, 2008.
2. Mobile Application Hacker's Handbook, Dominic Chell et al., 1st Edition, Wiley Publishing, 2015.
3. Android Security Internals, Nikolay Elenkov, 1st Edition, No Starch Press, 2014.
4. OWASP Foundation, Open Worldwide Application Security Project, Available at: OWASP Foundation

Online Reference Material:

1. OWASP Foundation, Open Worldwide Application Security Project, Available at: OWASP Foundation
2. OWASP Web Security Testing Guide, OWASP Foundation, Available at: OWASP WSTG
3. PortSwigger Web Security Academy, PortSwigger Ltd., Available at: PortSwigger Web Security Academy
4. OWASP Top 10 Project, OWASP Foundation, Available at: OWASP Top 10

Course Name: Web Application Security Lab

Course Code: PEIT44P

Vertical/ Sub-Vertical: PE

Mapping: Knowledge & Skill

Pre-requisite required: (PEIT28T) system Security & Ethical Hacking

Pre-requisite for: PEIT62T (Detection & Mitigation of Cyber Threats)

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT44P	2	2	2	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25 (50%)	-	25 (50%)	50 (100%)

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 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.

Course Objectives:

- To reveal the underlying in 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:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Identify the vulnerabilities in the web applications	Understanding
CO2	Identify the various types of threats and mitigation measures of web applications.	Understanding
CO3	Apply the security principles in developing a reliable web application.	Applying
CO4	Use industry standard tools for web application security	Applying
CO5	Create detailed reports on findings, mitigations, and secure design	Creating

Suggested List of Practical:

Sr No.	Experiment Titles	CO Map
1	Analyse of different laws and standards of cyber security	CO1
2	Case study for SDLC with different threats	CO2
3	For a problem statement design Exercise on Threat Modelling	CO3
4	Study of SAST(Static Application Security Testing) tools (Open Source like GitHub, Gitlab and so on).	CO4
5	For a project Use ZAP/Burp Proxy to test web applications	CO5,
6	Registration Page data Validation	CO2
7	SQL injection vulnerabilities allows login page to bypass(DVWA or Juice Shop)	CO3
8	Paper Review Cross Site Scripting (XSS) vulnerability lab	CO4
9	Case study OS Command Vulnerability Lab	CO5
10	Online Password attack,Prepare a Security Assessment Report	CO4
11	Session Management for Web Application	CO5
12	Sesssion on web analysisis and report generation	CO5

Textbooks:

1. Web Application Security (2nd Edition), Andrew Hoffman, 2nd Edition, O'Reilly Media, 2024.
2. The Web Application Hacker's Handbook, Dafydd Stuttard and Marcus Pinto, 2nd Edition, Wiley Publishing, 2011.
3. The Tangled Web: A Guide to Securing Modern Web Applications, Michal Zalewski, 1st Edition, No Starch Press, 2011.
4. Web Security for Developers, Malcolm McDonald, 1st Edition, No Starch Press,

2019.

Reference Books:

1. Web Security Testing Cookbook, Paco Hope and Ben Walther, 1st Edition, O'Reilly Media, 2008.
2. Mobile Application Hacker's Handbook, Dominic Chell et al., 1st Edition, Wiley Publishing, 2015.
3. Android Security Internals, Nikolay Elenkov, 1st Edition, No Starch Press, 2014.
4. OWASP Foundation, Open Worldwide Application Security Project, Available at: OWASP Foundation

Online Reference Material:

1. OWASP Foundation, Open Worldwide Application Security Project, Available at: OWASP Foundation
2. OWASP Web Security Testing Guide, OWASP Foundation, Available at: OWASP WSTG
3. PortSwigger Web Security Academy, PortSwigger Ltd., Available at: PortSwigger Web Security Academy
4. OWASP Top 10 Project, OWASP Foundation, Available at: OWASP Top 10

Detailed Syllabus of Multidisciplinary Minor Subjects

Track: Bioinformatics

Course Name: Machine Learning Applications in Bioinformatics

Course Code: MDMBI03

Vertical/ Sub-Vertical: MDM

K-S-A Mapping: Knowledge and Skills

Pre-requisite required: MDMBI01 (Introduction to Bioinformatics), PCIT15T (Machine Learning)

Pre-requisite for: NIL

Recommended Semester: 7

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	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.

Course 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, Protein folding and structure prediction. Application like Biomedical image analysis.	8	CO5
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

Track: Innovation, Entrepreneurial and Venture Development

Course Title: Innovation Management and Scaling Startups

Course Code: MDMIE03

NEP Vertical_Basket: MDC_MDM

Pre-requisites: NIL

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Tutorial
MDMIE03	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.

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.

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.

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.

Track: Business Development, Marketing and Finance

Course Name: Strategic Marketing and Business Planning

Course Code: MDMBD03

Category: Minor Degree Course (MDM)

Pre-requisites: Introduction to Business Development and Marketing Principles, Financial Basics for Engineers and Technopreneurs.

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Tutorial
MDMBD03	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.

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.

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	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	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	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**

Textbooks:

1. Marketing for Entrepreneurs- Frederick Crane, Sage Publications

Reference Books:

1. How to Build a Startup - Udacity Free Course

Track: Robotics

Course Name: Intelligent Mobile Robotics

Course Code: MDMRB03

Category: Multidisciplinary Minor (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 (BMMDM1T)

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Total
03	--	03

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Practical	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 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 Outcome:

The students will be able to:

CO1: Explain the fundamentals of mobile robots, locomotion mechanisms, and kinematic principles including wheel constraints, maneuverability, and motion control of mobile robotic systems. **(Modules 1 & 2)**

CO2: Describe the principles of robot perception, sensor systems, uncertainty representation, and feature extraction techniques used in mobile robots. **(Module 3)**

CO3: Apply localization and mapping techniques including probabilistic localization, belief representation, and map representation for determining robot position in an environment. **(Module 4)**

CO4: Analyze localization-based navigation methods and autonomous map-building techniques for mobile robot navigation. **(Modules 4 & 5)**

CO5: Design path planning and obstacle avoidance strategies for autonomous mobile robots using planning and reacting approaches. **(Module 5)**

CO6: Evaluate navigation architectures, decomposition techniques, and modern autonomous navigation systems used in intelligent mobile robots. **(Module 6)**

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;	07

Module No.	Module Name	Module Contents	No. of Hours
		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.	
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.