Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Information Technology

With Multidisciplinary Minor

Sem V Scheme & Syllabus (R-2024)

(As per NEP 2020, with effect from the Academic Year 2024-25)

Preamble

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

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

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

Details of implementation:

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

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

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

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

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

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

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

Chairman, Board of Studies
Department of Information Technology
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

VERTICAL BASED CREDIT ALLOTMENT

Sr. No.	Verticals	Baskets	Credits
I	BSC/ ESC	Basic Science (BS)	15
II		Engineering Science (ES)	12
III	Program Courses	Programme Core Course (PCC)	44
IV		Programme Elective Course (PEC)	20
V	Multidisciplinary Courses	Multidisciplinary Minor (MDM)	14
VI		Open Elective (OE)	08
VII	Skill Courses	Vocational and Skill Enhancement Course (VSEC)	08
VIII	Humanities Social Science and Management (HSSM)	Ability Enhancement Course (AEC)	04
IX		Entrepreneurship/ Economics/ Management Course (EEMC)	03
X		Indian Knowledge System (IKS)	02
XI		Value Education Course (VEC)	05
XII	Experiential Learning Courses	Research Methodology (RM)	03
XIII		Comm. Engg. Project (CEP)/ Field Project (FP)	02
XIV		Project	07
XV		Internship/ OJT	12
XVI	Liberal Learning Courses	Co-Curricular Courses (CC)	04
Total			**163**

Learner is expected to complete requirement of 163 credits (with minimum credits under each vertical and/or bucket as mentioned above) for B.Tech. degree in Information Technology with Multidisciplinary Minor.

Additionally, learners can choose to avail

i) B.Tech. in Information Technology – Honors and Multidisciplinary Minor or

ii) B.Tech. in Information Technology - Honours with Research and Multidisciplinary Minor or

iii) B.Tech. in Computer Engineering with Double Minors (Multidisciplinary and Specialization Minor) degree

Definition of Credit

Duration	Credit
1 Hr. Lecture (L) per week	1
1 Hr. Tutorial (T) per week	1
1 Hr. Practical (P) per week	0.5

by completing requirements of additional 18 credits, which will be over and above the 163 credits required for "B.Tech. with Multidisciplinary Minor" degree. Details of additional 18 credits are stated in Honours/ Honours by Research/ Double Minor Degree Document applicable for R-2024 curriculum.

Third Year B. Tech. Information Technology **Preferred Semester: V**

Course Structure and Assessment Guidelines

Vertical_ Subvertical	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
PC_PCC	PCIT10T	Data warehousing & Mining	Theory	2	15	20	40	075
PC_PCC	PCIT10P	Data warehousing & Mining Lab	Practical	1	25	-	25	050
PC_PCC	PCIT15T	Machine Learning	Theory	2	15	20	40	075
PC_PCC	PCIT15P	Machine Learning Lab	Practical	1	25	-	25	050
PC_PCC	PCIT12T	Software Engineering with WDL	Theory	2	15	20	40	075
PC_PCC	PCIT12P	Software Engineering with WDL Lab	Practical	1	25	-	25	050
PC_PCC	PCIT03T	Computer Graphics	Theory	2	15	20	40	075
PC_PCC	PCIT03P	Computer Graphics Lab	Practical	1	25	-	25	050
MDC_MDM	MDMXX[#]	MDM Course3 of chosen Title	As per course	4	45	30	50	125
HSSM_VEC	VECXX	Any HSSM_VEC course	Theory	2	15	20	40	075
MDC_OE	OEC15	Professional Competency Development 2	Practical	1	50	-	-	050
PC_PEC	PEITXX[*]	Programme Electives-1	Theory	2	15	20	40	075
	PEITXX[*]	Programme Electives-1 Lab	Practical	1	25	-	25	050
PC_PEC	PRJIT05	Specialization-Based Project	Practical	2	25	-	50	075
Total Credits				**24**				
Course credits completed during the previous inter-semester break will appear in this semester's marksheet								
MDC_OE	OEC01	Collaborative Inter-Institute Studies	As per course	4	125	-	-	125

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

*Selection based on the subset of courses made available by the Institute for the semester.
#Selection based on the MDM Title chosen by the student.

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.

Guidelines for Programme Electives Courses and Specialization Certificate – Refer Appendix-A

Learners are required to go through the Appendix-A carefully before selecting the Programme Electives courses. Detailed guidelines regarding Programme Electives courses, specialization tracks and courses relevant to each track are given in Appendix-A.

Programme Electives-1 Courses (PEITXXT and PEITXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEIT21T	Artificial Intelligence	Theory	2	15	20	40	075
	PEIT21P	Artificial Intelligence Lab	Practical	1	25	-	25	050
Data Science (DS)	PEIT22T	Advanced Database Management System	Theory	2	15	20	40	075
	PEIT22P	Advanced Database Management System Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PEIT23T	Modern Sensors for IoT	Theory	2	15	20	40	075
	PEIT23P	Modern Sensors for IoT Lab	Practical	1	25	-	25	050
Computer Security (CSec)	PEIT24T	Computer & Network Security	Theory	2	15	20	40	075
	PEIT24P	Computer & Network Security Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

List of Value Education Courses (VECXX)

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
VEC02	E-waste and Environmental Management	Theory	2	15	20	40	075
VEC03	Universal Human Values	Theory	2	25	-	50	075
VEC04	Responsibility towards sustainable environment	Theory	2	25	-	50	075
VEC05	Four Pillars of Democratic Nation	Theory	2	25	-	50	075

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

Guidelines for Award of Honours / Honours by Research / Double Minor (Multidisciplinary and Specialization) Degree

Before the end of Semester 5, learners are required to go through the Honours/ Honours by Research/ Specialization Minor Degree Programme document carefully to opt for Honours/ Honours by Research/ Double Minor Degree. Learners willing to opt for Honours/ Honours by Research/ Specialization Minor degree programme are required to satisfy the eligibility criteria stated in the document.

Course Name: Data Warehousing & Mining

Course Code: PCIT10T

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge and Skills

Pre-requisite required: PCIT07T (Database Management Systems)

Pre-requisite for: Data Analytics and Visualization, Big data Analytics

Recommended Semester: 5

Course Scheme:

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

Assessment guidelines:

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

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

Preamble:

In today's data-driven world, organizations rely heavily on data warehousing and data mining techniques to extract meaningful insights from large volumes of data. This course aims to provide learners with a comprehensive understanding of the foundational principles of data warehousing and basic concepts of data mining. Through theoretical exploration, participants will gain insights into the design, implementation, and administration of data warehouses, as well as the fundamental techniques and applications of data mining.

Course Objectives:

- Develop knowledge of dimensional modeling and design data warehouse schemas such as star, snowflake, fact constellation, fact less fact, and aggregate fact tables.

- Understand the fundamental concepts, architecture, and evolution of data warehouses, data marts, and data mining systems.
- Explain ETL processes, OLAP operations, and data lake architecture for efficient data storage, processing, and analytical decision-making.
- Apply data exploration, visualization, and preprocessing techniques to prepare datasets for data mining.
- Analyze classification, regression, and clustering techniques for solving real-world data mining problems.
- Evaluate frequent pattern mining and association rule mining techniques for discovering useful patterns and supporting business decisions.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Design data warehouse schemas using dimensional (star, snowflake) and describe the ETL (Extract, Transform, Load) process involved in building and maintaining a data warehouse.	Applying
CO2	Recall and explain the fundamental concepts, architecture, and components of data warehouses, data marts, data lakes, and data mining systems.	Understanding
CO3	Perform data preprocessing, OLAP operations, data exploration, visualization, and preprocessing techniques to prepare datasets for analysis.	Applying
CO4	Analyze classification and regression techniques such as decision tree, Naïve Bayes, simple linear regression, and multiple linear regression for predictive data mining.	Analyzing
CO5	Analyze clustering techniques such as K-Means, agglomerative clustering, and divisive clustering for grouping similar data objects.	Analyzing
CO6	Evaluate frequent pattern mining and association rule mining techniques such as Apriori, candidate generation, pattern growth, and vertical data format for decision-making.	Evaluating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to data warehouse and ETL Process	Introduction to Data Warehouse and Data Mart; Data Warehouse Architecture; Data Warehouse vs. Data Mart; Dimensional Modeling; Design of Information Package; Star Schema; Snowflake Schema; Fact Constellation Schema; Factless Fact Tables; Aggregate Fact Tables; OLAP Operations. **ETL Process:** Basic steps of ETL process, different extraction methods, transformations, and different loading techniques.	8	CO1
2	Introduction to Data Lakes	Definition, key attributes of data lake, challenges, functionalities, architecture, Curating data lakes, Data Lake vs. data warehouse	3	CO2
3	Data Exploration and Data Preprocessing	KDD Process; Data Mining System Architecture; **Data Exploration:** Types of Attributes, Statistical Description of Data; **Data Visualization:** Box Plots, Line Charts, Bar Charts, and Scatter Plots; **Data Preprocessing:** Data Cleaning, Data Integration, Missing values ,Data Transformation, Data Reduction, and Data Summarization.	5	CO3
4	Classification	Introduction to Data Mining Techniques; **Classification:** Decision Tree Induction, Naïve Bayesian Classification; **Regression:** Simple Linear Regression and Multiple Linear Regression.	5	CO4
5	Clustering	Introduction to Clustering; **Partition-Based Clustering:** K-Means Algorithm; **Hierarchical Clustering Methods:** Agglomerative and Divisive Methods.	4	CO5
6	Mining frequent patterns and associations	**Basic Concepts:** Market Basket Analysis, Frequent Itemset, Closed Itemset, Association Rules; **Frequent Itemset Mining Methods:** Apriori Algorithm, Finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori Algorithm, Pattern Growth Approach for Mining Frequent Itemsets, Mining Frequent Itemsets Using Vertical Data Formats.	5	CO6
		Total	**30**	

Textbooks:

1. R. Kimball and M. Ross, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, 3rd ed. Indianapolis, IN, USA: Wiley, 2013.
2. Data Mining- Concepts and techniques- Jiawei Han, Micheline Kamber, Morgan Kaufmann Publishers, Elsevier, 3rd Edition, 2006.
3. P. Ponniah, *Data Warehousing Fundamentals for IT Professionals*, 2nd ed. Hoboken, NJ, USA: Wiley-Interscience, 2010.
4. W. H. Inmon, *Data Lake Architecture: Designing the Data Lake and Avoiding the Garbage Dump*. Basking Ridge, NJ, USA: Technics Publications, 2016.

Reference Books:

1. Introduction to Data Mining, Psng-Ning Tan, Vipin Kumar, Michael Steinbanch, Pearson Educatior.
2. J. Han, J. Pei, and H. Tong, *Data Mining: Concepts and Techniques*, 4th ed. Cambridge, MA, USA: Morgan Kaufmann/Elsevier, 2022.

Online Reference Material:

1. NPTEL, "Data Mining," IIT Kharagpur.: https://nptel.ac.in/courses/106105174
2. SWAYAM, "Introduction to Data Warehousing and Data Mining." https://onlinecourses.swayam2.ac.in/imb25_mg200/preview
3. Google Cloud, "What is a Data Lake?" Available: https://cloud.google.com/learn/what-is-a-data-lake

Course Name: Data Warehousing & Data Mining Lab

Course Code: PCIT10P

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge and Skills

Pre-requisite for: : Database Management Systems Lab

Recommended Semester: 5

Course Scheme:

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

Assessment guidelines:

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

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

Preamble:

In the modern data-centric environment, organizations depend on data warehousing and data mining techniques to store, process, and analyze large volumes of data. The **Data Warehousing and Mining Lab** provides hands-on exposure to ETL processes, OLAP operations, data preprocessing, and mining techniques. Learners will implement and analyze methods such as classification, clustering, association rule mining, and prediction using real-world datasets. This lab aims to develop practical skills in extracting meaningful insights for business intelligence and decision-making.

Course Objectives:

- Develop practical understanding of data warehouse schema design using star, snowflake, and galaxy schema concepts for organizing multidimensional data.
- Provide hands-on exposure to ETL, OLAP, data preprocessing, and visualization techniques for preparing datasets for analytical processing.
- Enable learners to implement data mining techniques such as regression, classification, clustering, and association rule mining on real-world datasets.
- Familiarize learners with business intelligence and decision-support tools for analyzing data and presenting meaningful results for effective decision-making.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Design data warehouse schemas such as star, snowflake, and galaxy schemas for efficient organization of multidimensional data.	Apply
CO2	Perform ETL, OLAP, data preprocessing, and visualization tasks for preparing datasets for analysis.	Apply
CO3	Implement regression, classification, clustering, and association rule mining techniques on real-world datasets.	Apply
CO4	Use business intelligence and decision-support tools to analyze data and present meaningful results for effective decision-making.	Analyse

Suggested list of experiments:

Sr. No.	List of experiments	CO's Mapped
1	Build a Data Warehouse/Data Mart for a given problem statement by identifying source tables, creating sample data, and designing dimensional models such as Star Schema, Snowflake Schema, and Fact Constellation Schema, wherever applicable.	CO1
2	Perform ETL operations on the given dataset by extracting data from source tables/files, applying cleaning and transformation rules, and loading the processed data into the data warehouse/data mart.	CO2
3	Perform OLAP operations such as Roll-up, Drill-down, Slice, Dice, and Pivot on the dimensional model to analyze multidimensional data.	CO2
4	Implement different data visualization techniques such as bar chart, line chart, scatter plot, histogram, and box plot on the given dataset to understand dataset characteristics.	CO2
5	Perform data preprocessing tasks such as handling missing values, removing duplicate records, normalization, data transformation, and data reduction on a real-world dataset.	CO2
6	Implement Simple Linear Regression and Multiple Linear Regression using Python/R to predict numerical output from the given dataset.	CO3

7	Perform attribute relevance analysis and implement Decision Tree Classification using Python/Weka/RapidMiner on a real-world dataset.	CO3
8	Implement Naïve Bayes Classification using Python/Weka/RapidMiner and evaluate the model using accuracy, confusion matrix, precision, recall, and F1-score.	CO3
9	Implement K-Means Clustering algorithm using Python/Weka/RapidMiner and analyze the formed clusters using suitable visualization techniques.	CO3
10	Implement Agglomerative Hierarchical Clustering algorithm using Python and represent the clustering result using a dendrogram.	CO3
11	Implement the Apriori algorithm using Python/Weka/RapidMiner to generate frequent itemsets and association rules from a transaction dataset.	CO3
12	Mini Project: Perform data preprocessing, visualization, and demonstrate classification, clustering, and association rule mining algorithms on a real-world dataset using Python/Weka/RapidMiner/R tool.	CO4

Course Name: Machine Learning

Course Code: PCIT15T

Vertical/ Sub-Vertical: PCC

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: VSEC03 (Skill Based Lab-Python)

Pre-requisite for: Next Gen AI & ML

Recommended Semester: 5

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT15T	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:

Machine Learning is a rapidly evolving field that enables systems to learn from data and improve their performance without being explicitly programmed. This course provides a comprehensive introduction to the foundational concepts of machine learning, covering supervised, unsupervised, and reinforcement learning techniques. Students will explore key algorithms such as regression, classification, clustering, and neural networks, along with essential concepts like feature selection, dimensionality reduction, model evaluation, and optimization. Through theoretical understanding and practical applications, the course aims to equip learners with the skills necessary to design, implement, and assess machine learning models for real-world problem-solving across various domains.

Course Objectives:

- To introduce the fundamental concepts and types of machine learning such as supervised, unsupervised, and reinforcement learning, including essential data preprocessing and dimensionality reduction techniques.

- To develop the ability to apply core machine learning algorithms including regression, classification (e.g., SVM, Random Forest), clustering, and neural networks to solve real-world problems.
- To build analytical skills for evaluating and optimizing machine learning models using performance metrics, ensemble techniques, and optimization strategies.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Recall fundamental concepts, terminologies, and categories of machine learning including supervised, unsupervised, and reinforcement learning techniques.	Remember
CO2	Explain the working principles of dimensionality reduction, regression, classification, clustering, and neural network models used in machine learning.	Understand
CO3	Apply suitable machine learning algorithms such as regression, SVM, Random Forest, clustering, and perceptron models to solve basic data-driven problems.	Apply
CO4	Analyze the performance of machine learning models using evaluation metrics, bias-variance analysis, regularization methods, and ensemble techniques.	Analyze
CO5	Evaluate and optimize machine learning solutions using hyperparameter tuning, model selection strategies, and optimization approaches for real-world scenarios.	Evaluate
CO6	Design basic machine learning workflows integrating preprocessing, model building, evaluation, and optimization techniques for practical applications.	Create

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to Machine Learning	Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Data formats, Applications, Feature Selection and Filtering, Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Valued Decomposition.	6	CO1, CO2, CO6
2	Supervised Learning-I	Regression: Linear regression models, Nonlinear regression (only introduction), SVM classifier Support Vector Machine classification algorithm, hyper plane, optimal separating hyperplanes, kernel functions, kernel selection, applications. Introduction to random forest, growing of random forest, random feature selection	6	CO2, CO3, CO6

3	Supervised Learning-II	Evaluation of classifiers: Accuracy, Precision, Recall, F1 score, TPR, TNR, Confusion matrix, ROC, Overfitting, Underfitting, Variance, Bias, Bias-Variance Trade-off, Concepts of regularization (L1 and L2) and generalization, Hyperparameter Tuning, Ensemble Learning: Basic concept, Stacking, Bagging, Boosting, Random Forest, AdaBoost, GBM, XG Boost	6	CO4, CO5, CO6
4	Unsupervised Learning	Types of Clustering algorithms, Graph Based Clustering: Clustering with minimal spanning tree. Model based Clustering: Expectation Maximization Algorithm. Density Based Clustering: DBSCAN, Evaluating clustering tendency, Evaluation of clusters	6	CO2, CO3, CO6
5	Introduction to Neural Networks	Biological neuron, models of a neuron, Introduction to Neural networks, network architectures (feedforward, feedback etc.), Perceptron, training a Perceptron, Multilayer Perceptron, Limitations of MLP.	4	CO2, CO3, CO6
6	Introduction to optimization	Introduction to optimization in ML, Role of Loss Functions and Optimization. Case Study.	2	CO5, CO6
Total			**30**	

Textbooks:

1. C. M. Bishop, Pattern Recognition and Machine Learning. New York, NY, USA: Springer, 2006.

2. T. M. Mitchell, Machine Learning. New York, NY, USA: McGraw-Hill Education, 1997.

3. A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.

4. A. C. Müller and S. Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists. Sebastopol, CA, USA: O'Reilly Media, 2016.

5. K. P. Murphy, Machine Learning: A Probabilistic Perspective. Cambridge, MA, USA: MIT Press, 2012.

Reference Books:

I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning. Cambridge, MA, USA: MIT Press, 2016.

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.

I. H. Witten, E. Frank, M. A. Hall, and C. J. Pal, Data Mining: Practical Machine Learning Tools and Techniques, 4th ed. Burlington, MA, USA: Morgan Kaufmann, 2016.

S. Raschka and V. Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, 3rd ed. Birmingham, U.K.: Packt Publishing, 2019.

S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th ed. Hoboken, NJ, USA: Pearson, 2021.

Online Reference Material:

- Ng, "CS229: Machine Learning Lecture Notes," Stanford University, Stanford, CA, USA. [Online]. Available: https://cs229.stanford.edu/
- MIT OpenCourseWare, "6.036 Introduction to Machine Learning," Massachusetts Institute of Technology, Cambridge, MA, USA, 2020. [Online]. Available: https://ocw.mit.edu/courses/6-036-introduction-to-machine-learning-fall-2020/
- Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016. [Online]. Available: https://www.deeplearningbook.org/
- Scikit-learn Developers, "Scikit-learn User Guide," 2025. [Online]. Available: https://scikit-learn.org/stable/user_guide.html
- Google Developers, "Machine Learning Crash Course with TensorFlow APIs," Google, Mountain View, CA, USA. [Online]. Available: https://developers.google.com/machine-learning/crash-course

Course Name: Machine Learning Lab

Course Code: PCIT15P

Vertical/ Sub-Vertical: PCC

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 5

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT15P	-	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 Machine Learning Laboratory course provides hands-on experience in implementing and evaluating machine learning techniques using modern tools and libraries. The course focuses on practical aspects of data preprocessing, supervised and unsupervised learning, dimensionality reduction, neural networks, and model evaluation. Learners will develop the ability to design, train, analyze, and optimize machine learning models for solving real-world data-driven problems. Through experimentation and visualization, students gain practical exposure to Python-based machine learning frameworks and analytical methodologies.

Course Objectives:

- To develop practical skills in data preprocessing, visualization, and feature engineering for machine learning applications.
- To implement and evaluate supervised and unsupervised machine learning algorithms using Python libraries.
- To analyze the performance of machine learning models using suitable evaluation metrics and optimization techniques.

- To build and experiment with neural network models and ensemble learning methods for real-world datasets.
- To enhance problem-solving abilities through hands-on implementation of machine learning workflows.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Apply data preprocessing, visualization, and feature engineering techniques on real-world datasets for machine learning tasks.	Apply
CO2	Implement supervised and unsupervised machine learning algorithms using suitable Python-based frameworks and tools.	Apply
CO3	Analyze the performance of machine learning models using evaluation metrics, visualization techniques, and comparative studies.	Analyze
CO4	Evaluate and optimize machine learning models using ensemble methods, hyperparameter tuning, and dimensionality reduction techniques.	Evaluate
CO5	Design and develop complete machine learning workflows for solving practical data-driven problems.	Create

Suggested List of Practical:

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

Sr No.	Suggested Experiments	CO's Mapped
1.	Load a dataset, handle missing values, encode categorical data, normalize features, and visualize data distributions using Python libraries.	CO1
2.	Implement Linear Regression and Logistic Regression for prediction and classification tasks and visualize model performance.	CO2, CO3
3.	Implement Support Vector Machine (SVM) classifier and analyze the effect of different kernel functions.	CO2, CO3
4.	Apply Random Forest classifier and evaluate performance for different numbers of trees and feature selections.	CO2, CO4
5.	Perform dimensionality reduction using PCA and LDA and visualize transformed feature spaces.	CO1, CO4
6.	Implement clustering algorithms such as K-Means and DBSCAN and evaluate clustering quality using suitable metrics.	CO2, CO3

7.	Assess clustering tendency and compare clustering techniques on benchmark datasets.	CO3
8.	Implement ensemble learning methods such as AdaBoost and Gradient Boosting and compare their performance.	CO3, CO4
9.	Generate Confusion Matrix, ROC curves, Precision-Recall curves, and compute AUC values for classifier comparison.	CO3
10.	Train and analyze a Multilayer Perceptron (MLP) using scikit-learn for classification tasks.	CO2, CO3
11.	Perform hyperparameter tuning using Grid Search and Cross Validation techniques for machine learning models.	CO4
12.	Design and implement a complete machine learning pipeline for a real-world dataset integrating preprocessing, model training, evaluation, and optimization.	CO5

Textbooks:

1. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.
2. A. C. Müller and S. Guido, *Introduction to Machine Learning with Python: A Guide for Data Scientists*. Sebastopol, CA, USA: O'Reilly Media, 2016.
3. S. Raschka and V. Mirjalili, *Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2*, 3rd ed. Birmingham, U.K.: Packt Publishing, 2019.
4. S. Raschka, Y. Liu, and V. Mirjalili, *Machine Learning with PyTorch and Scikit-Learn*. Birmingham, U.K.: Packt Publishing, 2022.
5. N. Shukla, *Practical Machine Learning with Scikit-Learn and TensorFlow*. New York, NY, USA: Apress, 2019.

Reference Books:

1. C. M. Bishop, *Pattern Recognition and Machine Learning*. New York, NY, USA: Springer, 2006.
2. T. M. Mitchell, *Machine Learning*. New York, NY, USA: McGraw-Hill Education, 1997. 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.
3. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016.
4. I.H. Witten, E. Frank, M. A. Hall, and C. J. Pal, *Data Mining: Practical Machine Learning Tools and Techniques*, 4th ed. Burlington, MA, USA: Morgan Kaufmann, 2016.

Online Reference Material:

1. Ng, "CS229: Machine Learning," Stanford University, Stanford, CA, USA. [Online]. Available: https://cs229.stanford.edu/
2. MIT OpenCourseWare, "6.036 Introduction to Machine Learning," Massachusetts Institute of Technology, Cambridge, MA, USA, 2020. [Online]. Available: https://ocw.mit.edu/courses/6-036-introduction-to-machine-learning-fall-2020/
3. Scikit-learn Developers, "Scikit-learn User Guide," 2025. [Online]. Available: https://scikit-learn.org/stable/user_guide.html
4. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016. [Online]. Available: https://www.deeplearningbook.org/
5. Google Developers, "Machine Learning Crash Course," Google, Mountain View, CA, USA. [Online]. Available: https://developers.google.com/machine-learning/crash-course

Course Name: Software Engineering with WDL

Course Code: PCIT12T

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: nil

Pre-requisite for: PCIT14T (Software Testing Quality Assurance)

Recommended Semester: 5

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT12T	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:

To apply role of SDLC in Software Project Development with the concepts and features of Web Technology. Explore the agile methodologies that drive modern development, emphasizing collaboration and adaptability. The art and science of crafting dynamic, user-friendly websites and applications journey from foundational concepts to advanced techniques, gaining proficiency in HTML, CSS, JavaScript, and more. Through hands-on projects, you'll hone your skills, cultivating a portfolio showcasing your evolving expertise.

Course Objectives:

- To provide knowledge of Software Engineering Discipline
- To Apply knowledge of Software Engineering Discipline for Web based applications
- To understand Requirement gathering process and design engineering
- To apply analysis and develop software solutions
- To demonstrate and evaluate real time projects with respect to web based software projects
- To apply and analyze testing and quality assurance in web based software solutions

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	**Remember** fundamental concepts of web technologies , and foundational software development life cycle (SDLC) models such as Waterfall, Incremental, and Spiral.	Remembering
CO2	**Understand** the software requirement engineering process, including requirement types, elicitation techniques, and agile methodologies like Scrum and Extreme Programming.	Understanding
CO3	**Apply** HTML5, CSS3, and JavaScript to develop user-centric web interfaces following established interaction design heuristics and frontend development best practices.	Applying
CO4	**Analyse** software process models, estimation techniques such as COCOMO, and project metrics to determine suitable approaches for diverse software project scenarios.	Analysing
CO5	**Evaluate** software quality assurance strategies including testing techniques, risk mitigation plans (RMMM), and configuration management processes.	Evaluating
CO6	**Create** a responsive web application using HTML, CSS, and JavaScript, integrating principles of project scheduling, task decomposition (WBS), and version control systems.	Creating

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to Web Programming and Concepts	Introduction to HTML, HTML Document Structure Text Elements, Images and Attributes, Hyperlinks, Semantic HTML, complex image maps, tables and nested tables, inserting web page, Setting & modifying field properties, Validating HTML CSS: Internal and External CSS, CSS Grid Overview, Sizing Grid Columns and Rows, Building a Simple CSS Grid Layout JavaScript & Document Object Model: Introduction to JavaScript, Variables and Objects, Decision Making Statement, Loops, Arrays, Functions & Prototypes, Core JavaScript Objects, DOM Introduction, Event Model, Function	4	CO1, CO3, CO6
2	The Software Process	Generic view of Process, Prescriptive Models: Waterfall Model, Incremental-RAD Model, Evolutionary Process Model-Prototyping, Spiral Agile Methodology, Scrum and Extreme Programming	6	CO1, CO2, CO4

3	Requirements Engineering andAnalysis	Requirement, Types of Requirements, Requirement Gathering, Requirement Engineering Task, SRS (Software Requirement Specification)	4	CO2, CO4
4	Software Estimation and Scheduling	Management Spectrum, 4Ps (people, product and process), Process and Project metrics, Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO Model, Project scheduling: WBS, defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule	6	CO4, CO6
5	Design Engineering	Software Design Concepts, Interaction Design, Design Golden Rules and Heuristics, UML Diagrams	3	CO3, CO4, CO6
6	Software Testing and Risk Management	Testing: Software Quality, Testing: Strategic Approach, Strategic Issues- Testing: Strategies for Conventional Software. Risk Management: Risk Identification, Risk Assessment, Risk Projection, RMMM, Software Configuration management, SCM process- Version Control, Change Control	7	CO5, CO6
Total			**30**	

Textbooks:

1. Roger Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Publications.

2. Ali Behfrooz and Fredeick J. Hudson, Software Engineering Fundamentals, Oxford University Press.

3. DT Editorial Services, HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery), 2nd Edition.

Reference Books:

1. Ugrasen Suman, Software Engineering – Concepts and Practices, Cengage Learning

2. Pankaj Jalote, An Integrated Approach to Software Engineering, Springer/Narosa.

3. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India,

Related/ Equivalent MOOC and Associated Certification:

1 IBM IT Scrum Master Professional Certificate

Platform: Coursera

Link: https://www.coursera.org/professional-certificates/ibm-it-scrum-master

2 Applied Software Engineering Fundamentals Specialization

Platform: Coursera

Link: https://www.coursera.org/specializations/software-engineering-fundamentals

3 Software Engineering by Prof. Rajib Mall, IIT Kharagpur

Platform: NPTEL

Link: https://onlinecourses.nptel.ac.in/noc25_cs108/pr

Course Name: Software Engineering with WDL LAB

Course Code: PCIT12P

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 5

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT12P	-	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 the institute level and published to the learners before the commencement of the semester.

Preamble:

The practical component offers project-based exposure to web development and software engineering. Students create web pages using HTML5, CSS, and JavaScript, perform validation, and prepare SRS, database design, DFD, UML diagrams, WBS, Gantt chart, test plan, and RMMM document, developing technical, documentation, planning, testing, and risk management skills.

Course Objectives

- To provide knowledge of Software Engineering discipline.
- To apply Software Engineering concepts for web-based applications.
- To understand requirement gathering and design engineering.
- To analyze and develop software project solutions.
- To demonstrate and evaluate real-time web-based projects.
- To apply testing and quality assurance in web-based solutions.

Course Outcomes:
After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome statements	Bloom Level
CO1	**Recall** the basic concepts of project selection, HTML5 elements, CSS properties, JavaScript validation rules, software documentation, testing, and risk management.	Remember
CO2	**Explain** the purpose and importance of SRS, database design, DFD, UML diagrams, WBS, Gantt chart, test case plan, and RMMM document in software project development.	Understand
CO3	**Apply** HTML5, CSS, and JavaScript to design web pages and perform client-side validation for user input fields.	Apply
CO4	**Analyze** project requirements to prepare SRS, database design, DFD, use case diagram, sequence/activity diagram, component diagram, and deployment diagram.	Analyze
CO5	**Evaluate** the quality, feasibility, risks, and testing needs of the project by preparing test case plans and RMMM documents.	Evaluate
CO6	**Create** complete project documentation and implementation plan by integrating project conceptualization, web design, diagrams, WBS, Gantt chart, testing, and risk management artifacts.	Create

Suggested List of Practical:

Sr. No.	List of Experiments	CO's mapped
1	Project Selection and Conceptualization	CO1, CO6
2	Create Simple Web Page using HTML5	CO3
3	Design a web page using CSS	CO3
4	Write JavaScript to validate Registration Page fields	CO3
5	Prepare SRS and Design Database for Project Topic	CO2, CO4
6	Prepare DFD for the Project Topic	CO2, CO4
7	Prepare Use Case Diagram and Sequence/Activity Diagram	CO2, CO4
8	Prepare Component and Deployment Diagram	CO2, CO4
9	Prepare WBS and Gantt Chart for Project Topic	CO2, CO6
10	Prepare Test Case Plan for Project Topic	CO5
11	Prepare RMMM Document for Project Topic	CO5
12	Mini Project	CO1-CO6

Textbooks:

- Roger Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Publications.
- Ian Sommerville, Software Engineering, 9th Edition, Pearson Education.
- Ali Behfrooz and Fredeick J. Hudson, Software Engineering Fundamentals, Oxford University Press.

- DT Editorial Services, HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery), 2nd Edition.

Reference Books:

- Ugrasen Suman, *Software Engineering – Concepts and Practices*, Cengage Learning
- Pankaj Jalote, *An Integrated Approach to Software Engineering*, Springer/Narosa.
- Jibitesh Mishra and Ashok Mohanty, *Software Engineering*, Pearson
- Rajib Mall, *Fundamentals of Software Engineering*, Prentice Hall India,

Related/ Equivalent MOOC and Associated Certification:

- IBM IT Scrum Master Professional Certificate

  Platform: Coursera

  Link: https://www.coursera.org/professional-certificates/ibm-it-scrum-master

- Applied Software Engineering Fundamentals Specialization

  Platform: Coursera

  Link: https://www.coursera.org/specializations/software-engineering-fundamentals

- Software Engineering by Prof. Rajib Mall, IIT Kharagpur

  Platform: NPTEL

  Link: https://onlinecourses.nptel.ac.in/noc25_cs108/pr

Course Name: Computer Graphics

Course Code: PCIT03T

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: VSEC01T (Structured Programming)

Pre-requisite for: IT68T **(**UX Design, Evaluation and ARVR)

Recommended Semester: 5

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT03T	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:

The goal of the course is to introduce students to the technical concepts behind creating synthetic computer-generated images, focusing on underlying mathematical concepts covering geometrical and attribute related features. This course attempts to uncover various 2D and 3D rendering techniques.

Course Objectives:

• To enable learners to understand the basics of computer graphics, including the principles of image representation, display technology, and color models.

• To enable learners to understand 2D and 3D geometric transformations, including translation, scaling, rotation, orthographic and perspective projection.

• To enable learners to design and implement graphical user interfaces (GUIs) for software applications.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain the core concepts of computer graphics including coordinate systems and graphics primitives.	Remember
CO2	Apply scan conversion and polygon filling techniques to generate and manipulate basic graphical primitives.	Apply
CO3	Apply the concepts of 2D and 3D transformations	Apply
CO4	Analyze visible surface detection algorithms and implement illumination and shading models for realistic rendering.	Analyse
CO5	Utilize and analyze viewing, clipping, and projection techniques to display 2D and 3D scenes accurately.	Analyse
CO6	Design and evaluate graphics systems and algorithms involving curves, surfaces, and display architectures.	Evaluate

Detailed Syllabus:

Module No.	Module name	Content	No. of Hours	CO's Mapped
1	Introduction and Overview of Graphics System.	Definition and Representative uses of Computer Graphics, Overview of Coordinate Systems, Rasterization and Rendering. Raster Scan & Random Scan Displays, Architecture of Raster Graphics System with display processor, Architecture of Random Scan Systems. ***Self-Learning Topics***: *Display devices, Resolution and its effect on display*	2	CO1
2	Raster Algorithms.	Scan Conversions of Point, Line, and Circle: DDA Algorithm and Bresenham's Algorithm for Line Drawing, Bresenham's and Midpoint Algorithm for Circle. Aliasing, Antialiasing Techniques Inside Outside Tests, Polygon Filling Algorithms: Scanline Polygon Fill Algorithm, Boundary Fill and Flood fill Algorithm	8	CO1, CO2

		Self-Learning Topics: Midpoint ellipse drawing algorithm		
3	Two Dimensional Geometric Transformations, Viewing and Clipping.	Basic transformations: Translation, Scaling, Rotation. Matrix Representation and Homogeneous Coordinates, Composite Transformation. Viewing Transformation Pipeline and Window to Viewport Coordinate Transformation. Clipping Operations: Point Clipping, Line Clipping Algorithms: Cohen–Sutherland, Midpoint Subdivision, Liang–Barsky, Polygon Clipping Algorithms: Sutherland–Hodgeman and Weiler – Atherton Algorithm ***Self-Learning Topics***: Cyrus Beck polygon clipping algorithm	8	CO3, CO5
4	Three-Dimensional Object Representations, Geometric Transformations and 3D Viewing.	Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal, Koch Curve, Hilbert Curve. 3D-Transformations: Translation, Rotation, Scaling. Composite Transformations: Rotation about an Arbitrary Axis. Projections– Parallel and Perspective Projection and their types. ***Self-Learning Topics***: 3D Reflection	6	CO3, CO5, CO6
5	Visible Surface Detection.	Classification of Visible Surface Detection Algorithm, Back Surface Detection Method: Depth Buffer Method, Scan Line Method, Area Subdivision Method. ***Self-Learning Topics***: Painter's Algorithm, Z-Buffer (Depth Buffer)	4	CO3
6	Illumination Models and Surface Rendering	Basic Illumination Models: Diffused reflection, Phong Specular Reflection Model, Halftone and Dithering Techniques, Polygon Rendering: Constant shading, Gouraud Shading, Phong Shading. ***Self-Learning Topics***: Shading Techniques Used in Modern Graphics Systems, Working of Lambert's Illumination Model	2	CO6
Total			**30**	

Textbooks:

1. Hearn & Baker, "Computer Graphics C version", 2nd Edition, Pearson Publication
2. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2nd Edition, Pearson Publication
3. Samit Bhattacharya, "Computer Graphics", Oxford Publication

References Books:

1. D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications.
2. Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum‟s Outlines McGraw-Hill Education
3. Rajesh K. Maurya, "Computer Graphics", Wiley India Publication.
4. F. S. Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications.

Online Reference Material:

1. Interactive Computer Graphics
   https://www.classcentral.com/course/interactivegraphics-2067
2. Graphics and Animation Development
   https://swayam.gov.in/nd2_ntr20_ed15/preview
3. Learn Computer Graphics
   https://www.edx.org/course/computer-graphics-2

Course Name: Computer Graphics Lab

Course Code: PCIT03P

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Recommended Semester: 5

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PCIT03P	--	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 Computer Graphics Laboratory is designed to provide students with practical knowledge of computer graphics concepts and visualization techniques through programming and implementation of graphical algorithms. The laboratory emphasizes hands-on experience in developing algorithms for drawing primitives, geometric transformations, clipping, filling techniques, curve generation, fractals, and rendering methods. Students will gain practical exposure to fundamental graphics concepts and modern rendering approaches using graphics programming and OpenGL functions. The course enables students to understand graphical object representation, manipulation, and rendering for developing interactive computer graphics applications.

Course Objectives

- To provide practical understanding of computer graphics fundamentals and graphical object representation techniques.
- To enable students to implement algorithms for drawing lines, circles, curves, and fractals.
- To develop skills in geometric transformations and clipping operations for graphical objects.
- To familiarize students with polygon filling and rendering techniques for realistic image generation.
- To provide practical exposure to graphics programming using OpenGL for surface rendering applications

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	**Apply** area filling and rendering techniques for graphical objects using polygon filling and OpenGL functions.	Applying
CO2	**Apply** line, circle, curve, and fractal generation algorithms for graphical object creation.	Applying
CO3	**Implement** geometric transformations and clipping techniques for manipulation of graphical objects.	Applying
CO4	**Develop** graphics programs for rendering and visualization of graphical objects using modern graphics concepts.	Creating

Suggested List of Practical:

Sr. No.	Suggested Experiments	CO's Mapped
1	Implement DDA Line Drawing algorithms and Bresenham's algorithm.	CO2
2	Implement midpoint Circle algorithm.	CO2
3	Implement Area Filling Algorithm: Boundary Fill, Flood Fill, Scan line Polygon Fill	CO1
4	Implement Curve: Bezier for n control points, B Spline (Uniform)	CO2
5	Implement Fractal (Koch Curve).	CO2
6	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.	CO3
7	Implement Line Clipping Algorithm: Cohen Sutherland	CO3
8	Implement Line Clipping Algorithm: Liang Barsky.	CO3

9	Implement polygon clipping algorithm.	CO3
10	Program to perform surface rendering using Open GL functions.	CO1, CO4

Textbooks:

1. Hearn & Baker, "Computer Graphics C version", 2nd Edition, Pearson Publication
2. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2nd Edition, Pearson Publication
3. Samit Bhattacharya, "Computer Graphics", Oxford Publication

Reference Books:

1. D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications.
2. Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum‟s Outlines McGraw-Hill Education
3. Rajesh K. Maurya, "Computer Graphics", Wiley India Publication.
4. F. S. Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications.

Online Reference Material:

1. Interactive Computer Graphics
   https://www.classcentral.com/course/interactivegraphics-2067
2. Graphics and Animation Development
   https://swayam.gov.in/nd2_ntr20_ed15/preview
3. Learn Computer Graphics
   https://www.edx.org/course/computer-graphics-2

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: 5

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:

After successful completion of the course, learners 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/

Course Name: Strategic Marketing and Business Planning

Course Code: MDMBD03

Category: Minor Degree Course (MDM)

Preamble:

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

Pre-requisites:

Introduction to Business Development and Marketing Principles, Financial Basics for Engineers and Technopreneurs

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:

After successful completion of the course, learners 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	Contents	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

Course Name: Strategic Marketing and Business Planning Tutorial

Course Code: MDMBD03

Category: Minor Degree Course (MDM)

Preamble:

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

Pre-requisites:

Introduction to Business Development and Marketing Principles, Financial Basics for Engineers and Technopreneurs

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:

After successful completion of the course, learners will be able to:

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

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory	Tutorial
-	1	-	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Tutorial	25	-	-	25

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.

Suggested list of Tutorial:

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

Textbooks:

1. Marketing for Entrepreneurs- Frederick Crane, Sage Publications

Reference Books:

1. How to Build a Startup - Udacity Free Course

Course Name: Innovation Management and Scaling Startups

Course Code: MDMIE03

Vertical/Sub-Vertical: MDC_MDM

Preamble:

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

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

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

Pre-requisites: NIL

Course Objectives:

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

Course Outcomes:

Students will be able to:

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

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

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

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

Course Scheme:

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

Assessment Guidelines:

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

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

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Innovation Strategy and Management	Meaning and types of innovation. Incremental, disruptive, architectural, and business model innovation. Innovation lifecycle and innovation portfolio. Open innovation, co-creation, and ecosystem-based innovation. Building a culture of innovation in growing organisations. Managing innovation in early-stage, growth-stage, and established organisations.	**8**
2	Product-Market Fit and AI-Enabled Product Development	Product-market fit and customer feedback loops. Product roadmap and feature prioritisation. Agile and Scrum fundamentals. Rapid prototyping and testing. No-code and low-code tools for prototyping. AI-assisted ideation, design, user research, content creation, code generation, and product workflows. Build versus buy decisions for digital and AI-enabled products.	**10**
3	Growth Strategy and Scaling Metrics	Startup growth models and growth loops. North Star Metric, KPIs, and OKRs. Customer acquisition, activation, retention, referral, and revenue. Growth experiments and data-driven decision-making. AI-assisted analytics, personalisation, and marketing automation. Scaling operations, customer support, teams, and organisational processes. Common scale-up challenges and failure patterns.	**10**
4	Funding, Partnerships and Global Scale-Up	Growth-stage funding and investor readiness. Basics of valuation, cap table awareness, and funding rounds. Strategic partnerships, alliances, platform thinking, and distribution partnerships. Role of incubators, accelerators, corporates, government bodies, and startup ecosystems. Internationalisation of startups, market entry models, and cross-border scaling challenges. Mergers, acquisitions, and acqui-hire concepts at an introductory level.	**8**

5	Responsible Innovation and Sustainable Entrepreneurship	Responsible innovation and ethical scaling. Responsible AI, data privacy, cybersecurity awareness, transparency, fairness, and accountability in digital products. ESG basics and triple bottom line. Social entrepreneurship and impact-driven business models. Impact measurement. Founder resilience, team well-being, and sustainable work culture during scale-up. Long-term resilience and governance in scaling ventures.	**9**
Total			**45**

Tutorials:

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

Textbooks:

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

Reference Reading:

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

Course Name: 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 Outcome:

After successful completion of the course, learners 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.

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

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

CO4: Analyze localization-based navigation methods and autonomous map-building techniques for mobile robot navigation.

CO5: Design path planning and obstacle avoidance strategies for autonomous mobile robots using planning and reacting approaches.

CO6: Evaluate navigation architectures, decomposition techniques, and modern autonomous navigation systems used in intelligent mobile robots.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Total
03	--	03

Assessment guidelines:

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

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

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction and Locomotion	Introduction to mobile robots; overview of mobile robotics; key issues in locomotion; legged mobile robots; leg configurations and stability; examples of legged locomotion; wheeled mobile robots; wheeled locomotion design space; case studies of wheeled mobile robots.	07
02	Mobile Robot Kinematics	Kinematic models and constraints; representation of robot position; forward kinematic models; wheel kinematic constraints; robot kinematic constraints; examples of robot kinematic models; mobile robot manoeuvrability; degree of mobility and steerability; robot workspace; holonomic robots; path and trajectory considerations; motion control — open loop and feedback control.	08
03	Perception	Sensors for mobile robots; sensor classification and performance; wheel and motor sensors; heading sensors; ground-based beacons; active ranging; motion and speed sensors; vision-based sensors; representing uncertainty;	07

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

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.

Course Name: E-waste and Environment Management

Course Code: VEC02

Vertical/Sub-Vertical: HSSM_VEC

Preamble:

Environmental Education helps learners to understand how their decisions and actions affect the environment, builds knowledge and skills necessary to address complex environmental issues, as well as ways we can take action to keep our environment healthy and sustainable for the future. It encourages character building and develop positive attitudes and values.

Pre-requisites: Nil

Course Objectives:

- To introduce the effective mechanism to regulate generation, collection, storage, transport, import, export, recycling, treatment and disposal of e-wastes and their legislative rules.
- This course will help the participants to understand why and how to manage e-waste in an environmentally sound manner and how action on e-waste could be taken in their own life, business, or organization.
- To instigate sustainable practices, green innovations, e-waste recovery and inclusive recycling business models.
- To present innovative research on technological solutions to reduce hazard by design.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Understand need and concept of e-waste management & recycling
CO2: To gain the knowledge of legislative rules and regulations related to E-waste management.
CO3: Recognize the tools and technologies required for e-waste recycling assessment and monitoring.
CO4: Address contemporary issues and analyse the local and global impact of computing and engineering solutions on individuals, organizations, and society
CO5: Apply the knowledge about E-waste management in routine daily life to minimize the hazards.

Course Scheme:

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

Assessment guidelines:

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

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

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Overview of E-waste & its management	Introduction, toxicity due to hazardous substances in e-waste and their impacts, domestic e-waste disposal, e-waste management, technologies for recovery of resource from electronic waste, guidelines for environmentally sound management of e-waste, occupational and environmental health perspectives of recycling e-waste in India.	6
2	E-Waste Recycling	Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials. Recovery of materials from e-waste, recovery of metals from e-waste	5
3	Exposure pathway of pollutants emitted from Recycling of E-Waste	Environmental and public health issues E-waste health risk assessment	4
4	E-Waste Management Rules of India (2011 and 2016 Rules)	Regulations in India - Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008, E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs. E-waste Management: Case Studies and Unique Initiatives from around the World The international legislation: The Basel Convention; The Bamako Convention. The Rotterdam Convention. Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union, Restrictions of Hazardous Substances (RoHS) Directive	6

5	Technological Advances to overcome Environmental problems	Concept of Green Buildings, Various indoor air pollutants and their effects on health. Carbon Credit: Introduction and general concept. Disaster Management: Techniques of Disaster Management to cope up with (i) Earthquake and (ii) Flood. Remote sensing and GIS – Introduction and its applications in environment sector	4
6	Environmental Assessment and Management	Environment Impact Assessment (EIA), Introduction to various symbols, Environmental audit and Eco-labelling, ISO - 14001, 18001 and 31001 Pollution Control Legislation- Functions and powers of Central and State Pollution Control Board. Environmental Clearance, Consent and Authorization Mechanism.	5
Total			**30**

Suggested Online Courses:

1. Beyond Sustainable Development Goals (SDGs): Addressing Sustainability and Development, offered by University of Michigan - https://www.coursera.org/learn/beyond-the-sustainable-development-goals-addressing-sustainability-and-development
2. Environmental Management & Ethics offered by Technical University of Denmark (DTU) - https://www.coursera.org/learn/environmental-management-ethics
3. Introduction to Sustainability offered by University of Illinois at Urbana-Champaign- https://www.coursera.org/learn/sustainability

Text Books:

1. G. Tyler Miller Jr. and Scott Spoolman, "Environmental Science", 13th Edition, Brooks/Cole, 2011

Reference Books:

1. Keerthinarayana and Daniel Yesudian, "Environmental Science and Engineering", 1st Edition, Hi-Tech Publications, 2008
2. G.M. Masters, "Introduction to Environmental Engineering and Science", Pearson Education Pvt Ltd., 2005
3. Anubha Kaushik and C.P. Kaushik, "Environmental Science and Engineering, 3rd Edition, New Age International, 2010
4. Boyle G., "Renewable Energy: Power for a Sustainable Future", Oxford publication, UK 3rd edition, 2012
5. Erach Bharucha, "Text Book of Environmental Studies", Universities Press (India) Pvt. Ltd., 2005
6. Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi.
7. Krishnamoorthy B., "Environmental Management, Text Book and Cases", PHI Learning (P) Ltd., New Delhi.
8. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.
9. MSW Management Rules 2016, Govt. of India, available online at CPCB website.
10. Hester R.E., and Harrison R.M., "Electronic Waste Management", Science, 2009.
11. Fowler B., "Electronic Waste" – 1st Edition (Toxicology and Public Health Issues), Elsevier, 2017

Course Name: Universal Human Values

Course Code: VEC03

Vertical/Sub-Vertical: HSSM_VEC

Preamble:

The present education system has become largely skill based. The prime emphasis is on science and technology. However, science and technology can only help to provide the means to achieve what is considered valuable in terms of facilities. Value Education is a crucial missing link in the present education system. Because of this deficiency, most of our efforts may prove to be counterproductive and serious crises at the individual, societal and environmental level are manifesting.
Values and skill complement each other. Values mean importance or participation and skills mean qualities, training, and capabilities. To fulfil our aspirations both values and skills are necessary. When we identify and set the right goals and produce in right direction, this is known as value domain, the domain of wisdom. Basically, we must know what really is useful to achieve human happiness, happiness to all and for all the time.
And when we learn and practice actualizing this goal to develop the techniques to make this happen in real life, in various dimensions of human Endeavour, this is known as domain of skills. Hence, there is an essential bonding between values and skills for the success of any human endeavor.
For a happy and successful life, it is important to know, explore, verify and practice universal human values, professional ethics.

Prerequisite: NIL

Course Objective:

- To help the student to see the need for developing a holistic perspective of life.
- To sensitize the student about the scope of life – individual, family, society and nature/existence.
- Strengthening self-reflection.
- To develop more confidence and commitment to understand, learn and act accordingly.

Course Outcomes:

Learner will be able to:
CO1: Learner will become more aware of themselves and their surroundings.
CO2: Learners will be more responsible in life and will able to handle critical problems.
CO3: Learners will develop better critical ability.
CO4: Learners will be more sensible towards commitment.
CO5: Learner will be able to apply human values in day to day life.
CO6: Learner will become a responsible citizen.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

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

Detailed Syllabus:

Module No.	Module Name	Content
1	Introduction to Value Education	Need for Value Education Basic Guidelines for Value Education The Content of Value Education The Process of Value Education Starting to observe inside What is Self-exploration? What is its Purpose? Content of Self-exploration Process of Self-exploration Natural Acceptance What is the State today? What is the way out? What do we need to do?

2	The Basic Human Aspirations Continuous Happiness and Prosperity	Continuous Happiness and Prosperity Our Basic Aspirations Exploring Happiness and Prosperity A Look at the Prevailing Notions of Happiness and Prosperity Some Possible Questions/Confusions Basic Requirements for Fulfilment of Human Aspirations What is our State today? Why are we in this State? - Living with Wrong Assumptions What is the Solution? The Need for Right Understanding Our Program: Understand and Live in Harmony at all Levels of Living Our State today Our Natural Acceptance for Harmony at all Levels of our Living Human and Animal Consciousness
3	Understanding the Human Being as Co-existence of Self ('I') and Body	Human Being is more than just the Body Understanding Myself as Co-existence of the Self and the Body Understanding Needs of the Self and Needs of the Body Understanding the Activities in the Self and the Activities in the Body Understanding the Self (I) as the Conscious Entity, the Body as the Material Entity Exercise on distinguishing Needs of the Self ('I') and Body Exercise on Distinguishing Activities of the Self (I) and Body Understanding the Body as an Instrument of 'I' (I' being the Seer, Doer and Enjoyer) Why should I study Myself? Getting to know the Activities in the Self (I) How are the Activities in T Related! The Activities in 'I' are Continuous Effects of the Problem.... What then is the Solution? Result of Realization and Understanding Living with Definiteness Our Body A Self-organized Unit Harmony of T with the Body: Sanyama and Svasthya What is our State today? What is the way out? Understanding and Living with Sayama Correct Appraisal of our physical needs

4	Harmony in the Family, Society, Nature- Understanding Values in Human Relationships	Family as the Basic Unit of Human Interaction Harmony in the Family. Justice (Nyaya) What is the State today? Values in Human Relationships Trust (Visvasa) Respect (Sammana The Basis for espect Assumed Bases for Respect Today The Problems due to Differentiation Difference between Attention' and 'Respect' What is the way out? Affection (Sneha) Care (Mamand) Guidance (Vatsalya) Reverence (Shraddha) Glory (Gaurava) Gratitude (Kritagayta) Love (Prema) Harmony from Family to World Family: Undivided Society Extending Relationship from Family to Society Identification of the Comprehensive Human Goal Where are we today? Programs Needed to Achieve the Comprehensive Human Goal: The Five Dimensions of Human Endeavour Education-Right Living (Siksha Sanskara) Health-Self-regulation (Svasthya-Sanyama) Justice-Preservation (Nyaya-Suraksha) Production-Work (Utpadana-Karya) Exchange-Storage (Vinimaya-Kosa) What is our State today? Harmony from Family Order to World Family Order: Universal Human Order The Four Orders in Nature Interconnectedness and Mutual Fulfilment (Parasparta aur Paraspara Purakata) Recyclability and Self-regulation in Nature Undertanding the Four Orders Things (Vastu) Activity (Kriya) Innateness (Dharana) Natural Characteristic (Sabha) Basic Activity Conformance Human Beings-our State today What is way out

5	Implications of the Right Understanding	Values in Different Dimensions of Human Living Universal Values naturally emerging from the Right Understanding Definitiveness of Ethical Human Conduct Identification of Snama leading to Svatantrata and Swarajya Development of Human Consciousness Implications of Value-based Living Identification of Comprehensive Human Goal Vision for the Holistic Alternative Basis for Humanistic Education and Humanistic Constitution Universal Human Order and its Implications
6	Professional Ethics Journey towards the Holistic Alternative	Profession-In the Light of Comprehensive Human Goal Ensuring Competence in Professional Ethics- The current Scenario Inherent Contradictions and Dilemmas and their Resolution Appreciating the Need for Self-Exploration Facilitating the Understanding of Harmony at various Levels Steps for Evolution at the Individual Level Steps for Transition at the Level of Family Society and Profession Promoting Mass Awareness and moving towards Humanistic Education Evolving Holistic Models of Living Amending Policies, Programs and Social Systems in tune with Comprehensive Human Goal Is the Transition too Difficult? Concluding Remarks

Course Name: Responsibility towards sustainable environment

Course Code: VEC04

Vertical/Sub-Vertical: HSSM_VEC

Preamble:

This course introduces learners with an aim to focus on holistic personality development, a wide platter of General Education courses is offered to First Year Engineering students. These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

Pre-requisites: NIL

Course Objectives:

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Demonstrate effective oral communication
CO2: Demonstrate the ability to think critically and creatively
CO3: Apply quantitative reasoning concepts and skills to solve problems
CO4: Illustrate the ability to self-reflect and access relevant ethical values

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

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

Detailed Syllabus:

Module No.	Module Name	Content
1	Responsibility towards sustainable environment	Sustainability, Pillars of sustainability, social equity, economic development, environmental protection, cultural/human sustainability. Sustainable development, United nation's sustainable development goals. Sustainable Environment, long term health of ecosystem, renewable resources, Global warming, protection of species diversity and ecological structure, Low carbon economy. Being responsible towards sustainable environment, dos and don'ts, Smart City – city functions, economic growth, quality of life, technology used.
Total Hours = 30		

Recommended Online Courses:

Nil

Reference Books:

As suggested by resource person in session

Course Name: Four Pillars of Democratic Nation

Course Code: VEC05

Vertical/Sub-Vertical: HSSM_VEC

Preamble:

This course introduces learners with an aim to focus on holistic personality development, a wide platter of General Education courses is offered to First Year Engineering students. These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

Pre-requisites: NIL

Course Objectives:

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

Course Outcomes:

Learner will be able to:
CO1: Demonstrate effective oral communication
CO2: Demonstrate the ability to think critically and creatively
CO3: Apply quantitative reasoning concepts and skills to solve problems
CO4: Illustrate the ability to self-reflect and access relevant ethical values

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

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

Detailed Syllabus:

Module No.	Module Name	Content
1	Four Pillars of Democratic Nation	The term 'Democracy', History of democracy, Indian Democracy, Responsibility of good citizen. Legislature – Six major functions of legislature Executive - President, Vice-President, Prime Minister, Cabinet Minister, Secretaries, and Civil services Judiciary – Indian Juridical system, Indian Constitution, Court structure Media - The basic right of freedom of speech and expression, Print Media and digital media
Total Hours = 30		

Recommended Online Courses:

Nil

Reference Books:

As suggested by resource person in session

Course Name: Professional Competency Development 2

Course Code: OEC15

Vertical/ Sub-Vertical: Open Elective Courses

K-S-A Mapping: Skill

Pre-requisite required: OEC14 (Professional Competency Development 1)

Pre-requisite for: OEC16 (Professional Competency Development 3)

Course Level:

Recommended Semester: 5

Course Scheme:

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

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	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:

Professional Competency Development 2 strengthens your problem-solving foundations through hands-on data structures, algorithms, and Java's Collections Framework. Emphasizing both competitive programming patterns and technical interview depth, the course builds fluency in stacks, queues, linked lists, trees, and graphs. You will analyze complexities, choose optimal structures for real problems, and implement efficient solutions. By the end, you'll be able to reason about performance, write clean code, and tackle end-to-end coding challenges with confidence.

Course Objectives:

• Build strong proficiency with core and advanced data structures in Java (Collections Framework), selecting the right structure for problem-specific constraints.

• Develop the ability to analyze and optimize algorithms using sliding window, prefix sums, and recurrence methods.

• Master implementation patterns for stacks, queues, linked lists, trees, and graphs, including iterative traversals, balanced BSTs, heaps, and tries.

• Apply competitive programming techniques and problem solving approach to design clean, efficient, and correct solutions.

• Cultivate industry-ready habits: clarity of thought, complexity-aware coding, test-driven validation, and effective use of standard libraries.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Describe and differentiate core Java Collections like lists, sets, maps, queues, and heaps with respect to their key operations, typical use cases, and trade-offs.	Understand
CO2	Apply sliding window, prefix sums, hashing, and two-pointers to solve coding problems efficiently.	Apply
CO3	Implement stack- and queue-based solutions and apply them to expression evaluation, recursion simulation, and other linear-time problem patterns.	Apply
CO4	Implement linked-list solutions like reverse, rotate, merge sorted lists, and detect cycles and intersections using correct pointer techniques and linear-time approaches.	Apply
CO5	Develop and analyze tree-based solutions by writing iterative traversals and level order, perform BST insert/delete, and leverage balanced trees, tries, and Huffman coding when they best fit the problem's constraints and efficiency goals.	Analyze
CO6	Model problems as graphs and solve using BFS/DFS, shortest paths, topological ordering, and MST algorithms, with complexity analysis.	Analyze

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Java Collection Framework	Arrays, String vs StringBuilder, ArrayList, Linked List, Stack, Queue Interface, Double Ended Queue, Priority Queue and Heap	05	CO1

		Hash Set, Linked Hash Set, Tree Set Hash Map, Linked Hash Map, Tree Map Understand the functions provided and problem specific usage.		
2	Advance Concepts and Algorithm Analysis	Topis for Competitive Coding: Strings and Substrings, Arrays and Hashing, Sliding Window Concept, Prefix Sum Topics for Technical Interview: Java Collection Framework, Asymptotic Analysis, Growth Functions, Recurrence Relation, Master Method	05	CO2
3	Advance Concepts on Stack, Queues	Topics for Competitive Coding: Monotonic Stack and Queues, Min-Stack, Max-Stack, Implement Queue using Two Stacks, Implement Stack Using Two Queues, Double Ended Queue, Priority Queue and Heap Topics for Technical Interview: Applications of Stack, Expression Conversion and Evaluation using Stack, Simulation of Recursion using Stack, Backtracking with Stack (Undo Operation)	05	CO3
4	Advance Concepts on Linked List	Topics for Competitive Coding: Detecting Cycle in Linked List, Concept of Slow-Fast Pointers, Intersection of Two Linked Lists Reversing Linked List and Sub List, Rotating Linked List, Merging Two Sorted Lists, Palindrome Linked List, Add Two Numbers Represented in Linked List, Topics for Technical Interview: Array Representation of Linked List, Array vs Linked List, Representing Polynomial Using Linked List, Array of Linked List	05	CO4
5	Advanced Concepts on Trees	Topics for Competitive Coding: Iterative Inorder/Postorder with Stack, Binary Tree Level Order Traversals, Diameter of Binary Tree, Deletion of Node from BST Topics for Technical Interview:	05	CO5

		Height Balanced Checks, AVL Trees – rotations, insertion, Tries, Red and Black Tree, Expression Tree, Huffman Encoding		
6	Advance Concepts on Graphs	Topics for Competitive Coding: Problems on Graph Traversals, Problems using Visited Array, All Paths from Source to Target, Shortest Path Problems, Directed and Undirected Graph Problems Topics for Technical Interview: Graph Representation, Topological Sorting, Minimum Cost Spanning Tree Algorithms, Directed Acyclic Graph,	05	CO6
Total			**30**	

Tools/ Technologies/ Programming Languages learnt:

- Programming Languages: Java.
- Integrated Development Environments (IDEs): Visual Studio Code, Eclipse.
- Code Practice Platforms: LeetCode, HackerRank, CodeSignal.
- Version Control Systems: Git and GitHub.
- Online Learning Platforms with Interactive Coding Environments: Jupyter Notebook, Repl.it.

Textbooks:

1. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, Algorithms. New York, NY, USA: McGraw-Hill, 2008.
2. M. T. Goodrich, R. Tamassia, and M. H. Goldwasser, Data Structures and Algorithms in Java, 6th ed. Hoboken, NJ, USA: Wiley, 2014.
3. Herbert Schildt, "JAVA: The Complete Reference", Oracle Press.
4. Sachin Malhotra and Saurabh Chaudhary, "Programming in JAVA", Oxford University Press

Reference Books:

1. M. A. Weiss, Data Structures and Algorithm Analysis in Java, 3rd ed. Upper Saddle River, NJ, USA: Addison-Wesley, 2012.
2. R. Sedgewick and K. Wayne, Algorithms, 4th ed. Upper Saddle River, NJ, USA: Addison-Wesley, 2011.
3. Stevan Jolzner, "JAVA Programming- Black Book", Dreamtech Press.

Online References:

1. Java Collection Framework

Link: https://docs.oracle.com/javase/tutorial/collections/index.html

2. Princeton Algorithms, Part I — Linked lists lecture/notes.
   Link: https://algs4.cs.princeton.edu/13stacks/

3. Codeforces EDU (theory + practice problemsets).
   Link: https://codeforces.com/edu

Course Name: Artificial Intelligence

Course Code: PEIT21T

Vertical/ Sub-Vertical: PEC (AIML)

K-S-A Mapping: Knowledge and Skills

Pre-requisite required:
1. PCIT01T (Data Structures and Algorithms)
2. ESC05T (Fundamental of Logic Circuits)

Pre-requisite for:
1. PEIT25T (Soft Computing)
2. PEIT41T (Natural Language Processing)

Recommended Semester: V

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT21T	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:

Artificial Intelligence is a core area of computing that focuses on designing intelligent systems capable of reasoning, learning, problem solving, decision making, and adapting to dynamic environments. The course introduces students to fundamental concepts of Artificial Intelligence, including intelligent agents, search strategies, knowledge representation, reasoning under uncertainty, planning, learning, and real-world AI applications. It enables learners to understand how AI techniques can be applied to solve computational and societal problems in domains such as healthcare, education, business, automation, security, and smart systems.

Course Objectives:

- To introduce the fundamental concepts, principles, and applications of Artificial Intelligence.
- To understand intelligent agents and AI-based problem-solving approaches.
- To apply uninformed, informed, adversarial, and local search techniques for solving computational problems.
- To understand knowledge representation and reasoning methods in Artificial Intelligence.
- To explore planning, learning, and uncertainty handling techniques used in intelligent systems.
- To analyze and design AI-based solutions for real-world and societal applications.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Explain the fundamental concepts, characteristics, and applications of Artificial Intelligence and intelligent systems.	Understand
CO2	Apply uninformed, informed, adversarial, and local search techniques to solve AI-based problems.	Apply
CO3	Demonstrate knowledge representation and reasoning techniques using propositional logic, first-order logic, and uncertainty models.	Apply
CO4	Analyze planning and learning approaches used in intelligent systems and AI agents.	Analyze
CO5	Evaluate the role of Artificial Intelligence applications in solving real-world and societal problems.	Evaluate
CO6	Design basic AI-based solutions or models for practical applications using appropriate AI techniques.	Create

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Introduction to Artificial Intelligence	• Introduction to Artificial Intelligence, • Characteristics and Foundations of AI, • Intelligent Systems and • Types of AI Applications of AI Current Trends in AI and Generative AI (Introduction)	4	CO1
2	Intelligent Agents and Multi-Agent Systems	• Agents and Environment • Rational Agents • PEAS Representation • Structure and Types of Intelligent Agents Learning Agents • Agent Communication	5	CO1, CO4

		• Negotiation and Bargaining Trust and Reputation in Multi-Agent Systems		
3	Problem Solving and Search Techniques	• Problem Solving using AI • Uninformed Search: BFS, DFS, Depth Limited Search, Iterative Deepening • Informed Search: Greedy Best First Search, A* Search, Heuristic Search • Adversarial Search: Minimax, Alpha-Beta Pruning Local Search and Optimization: Hill Climbing, Genetic Algorithms	6	CO2
4	Knowledge Representation and Reasoning	• Knowledge Representation in AI • Propositional Logic • First Order Logic (Syntax and Semantics) • Forward and Backward Chaining • Unification and Resolution • Knowledge Representation under Uncertainty Belief Networks and Simple Inference	6	CO3
5	Planning and Learning	• Planning Problem in AI • State Space Planning • Partial Order Planning • Hierarchical Planning • Conditional Planning • Forms of Learning, Theory of Learning, PAC Learning, Introduction to Statistical Learning,	5	CO4
6	Artificial Intelligence Applications and Ethics	• AI Applications in Healthcare, Education, Business, Cybersecurity, and Smart Systems • AI for Societal Applications • Ethical Issues in AI: Bias, Fairness, Transparency, Privacy Case Study Discussion / Real-Time AI Use Case Analysis	4	CO5, CO6
Total			**30**	

Textbooks:

1. Artificial Intelligence: A Modern Approach (AIMA), 4th Edition, Stuart J. Russell and Peter Norvig.
2. Artificial Intelligence, 3rd Edition, Elaine Rich, Kevin Knight, Shivashankar B. Nair, McGraw Hill
3. Artificial Intelligence, 6th Edition, George F. Luger, Pearson

Reference Books:

1. Artificial Intelligence, Patrick Henry Winston, Addison-Wesley
2. Artificial Intelligence: A New Synthesis, Nils J. Nilsson, Morgan Kaufmann,

3. Computational Intelligence: A Logical Approach, David Poole, Alan Mackworth, Oxford
4. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press

Online Reference Material:

1. Prof. Mausam, "An Introduction to Artificial Intelligence," NPTEL Course – IIT Delhi
   The course provides lecture videos, assignments, and study material covering intelligent systems, search algorithms, reasoning, planning, and machine learning concepts.
2. D. Poole and A. Mackworth, *Computational Intelligence: A Logical Approach*, Oxford University Press. [Online]. Available: Computational Intelligence Reference Material
   This online reference explains logical reasoning, intelligent agents, search methods, planning, and probabilistic reasoning techniques in Artificial Intelligence.
3. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed., Pearson Education, 2020. [Online]. Available: AIMA Official Website and Companion Resources
   This resource contains complete coverage of Artificial Intelligence concepts including intelligent agents, search techniques, knowledge representation, reasoning, planning, uncertainty, machine learning, and reinforcement learning.

Course Name: Artificial Intelligence Lab

Course Code: PEIT21P

Vertical/ Sub-Vertical: PCE (AIML)

K-S-A Mapping: Knowledge and Skills

Recommended Semester: V

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT21P	-	02	-	01

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 Artificial Intelligence Laboratory provides hands-on exposure to the implementation of fundamental AI techniques. The lab enables students to implement search algorithms, game-playing strategies, logic-based reasoning methods, and small AI applications. Through programming assignments, case studies, and mini-projects, learners will develop practical skills required to design, test, and evaluate intelligent systems for real-world problem-solving.

Course Objectives:

- To implement fundamental Artificial Intelligence algorithms using programming tools.
- To develop AI-based problem-solving techniques using search and reasoning methods.
- To design intelligent agents and game-playing solutions for real-world scenarios.
- To apply logic-based and knowledge representation techniques in AI applications.
- To analyze AI applications through case studies and mini projects.
- To develop professional practices including teamwork, ethics, documentation, and technical communication during laboratory work.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Implement uninformed and informed search algorithms for AI problem-solving.	Apply
CO2	Develop game-playing and intelligent agent-based solutions using AI techniques.	Apply
CO3	Apply logic-based knowledge representation and reasoning techniques in AI programs.	Apply
CO4	Analyze AI case studies and identify appropriate AI methods used in real-world applications.	Analyze
CO5	Design and develop basic AI applications or mini projects for real-world scenarios.	Create
CO6	Demonstrate professional practices, ethical behaviour, teamwork, and effective documentation during laboratory work.	Apply

Suggested List of Practical:

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

Sr No.	Suggested Experiments	CO's Mapped
1.	Case Study on AI Applications published in IEEE / ACM / Springer Journals	CO4, CO6
2.	Design of Intelligent Systems using PEAS Representation (Any One Application)	CO2, CO6
3.	Program on Uninformed Search Techniques – Breadth First Search (BFS)	CO1, CO6
4.	Program on Uninformed Search Techniques – Depth First Search (DFS)	CO1, CO6
5.	Program on Informed Search Techniques – A* Search Algorithm	CO1, CO6
6.	Program on Local Search Technique – Hill Climbing / Genetic Algorithm	CO1, CO5
7.	Program on Game Playing using Minimax Algorithm with Alpha-Beta Pruning	CO2, CO5
8.	Program on First Order Logic and Rule-Based Reasoning	CO3, CO6

9.	Program on Unification / Forward Chaining / Backward Chaining	CO3, CO6
10.	Program on Bayesian Belief Network and Simple Inference Mechanism	CO3, CO6
11.	Program on Simple NLP Tasks – Tokenization, POS Tagging, and Text Classification	CO4, CO5
12.	Mini Project – Development of a Small AI Application / Chatbot / Intelligent Assistant	CO5, CO6

Textbooks:

1. Python Machine Learning, Sebastian Raschka, Vahid Mirjalili, 3rd Edition, Packt Publishing
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, 3rd Edition, O'Reilly
3. Artificial Intelligence with Python, Prateek Joshi, Packt Publishing

Reference Books:

1. Natural Language Processing with Python, Steven Bird, Ewan Klein, Edward Loper
2. Programming Collective Intelligence, Toby Segaran,
3. Introduction to Machine Learning with Python, Andreas C. Müller and Sarah Guido

Online Reference Material:

1. P. Norvig, "AIMA Python Repository," [Online]. Available: AIMA Python Code Repository
This repository contains Python implementations of algorithms discussed in *Artificial Intelligence: A Modern Approach*, including search algorithms, logic, planning, games, and learning methods
2. A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd ed., O'Reilly Media, 2022. [Online]. Available: Hands-On Machine Learning GitHub Resources
The resource contains practical notebooks and implementations related to AI, machine learning, intelligent systems, optimization, and deep learning using Python.
3. Prof. Mausam, "Artificial Intelligence Laboratory and Programming Resources," IIT Delhi, [Online]. Available: NPTEL Artificial Intelligence Course – IIT Delhi
The course provides practical exposure to AI concepts through assignments, programming examples, and laboratory-oriented demonstrations.

Course Name: Advanced Database Management System

Course Code: PEIT22T

Vertical/ Sub-Vertical: PC_PCC

K-S-A Mapping: Knowledge & Skill

Pre-requisite required: PCIT07T (Database Management System).

Pre-requisite for: Big data Analytics

Recommended Semester: 3

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT22T	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:

Data Structures deals with the organization, management, and manipulation of data. This course covers basic data structures and their algorithms, design and analysis principles, and real-world applications. By the end, students will be able to apply their knowledge to solve complex problems.

Course Objectives:

1. To impart knowledge related to query processing and query optimization phases of a database management system.

2. To learn advanced techniques for data management and to overview emerging data models like Temporal, Mobile, and Spatial database.
3. To introduce advanced database models like distributed databases.
4. To create awareness of how enterprise can organize and analyse large amounts of data by creating a Data Warehouse.
5. To understand the process of data extraction, transformation and loading. 6 To understand the concept of Bigdata and NoSQL databases.
6. To learn different IR models and queries in IR Systems

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Measure query costs and design alternate efficient paths for query execution.	Create
CO2	Apply sophisticated access protocols to control access to the database.	Apply
CO3	Design distributed databases for improving resource utilization, availability and performance	Create
CO4	To apply the traits of temporal and spatial data models as per the need	Apply
CO5	Perform efficient and effective retrieval of information to facilitate the decision making	Analyze

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Query Processing and Optimization	Overview: Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions. Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression. Estimating Statistics of Expression Results Choice of Evaluation Plans. Self-learning Topics: Solve problems on query Optimization	6	CO1

2	Access Control Mechanism	Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role Based Access Control, Remote Database access protocol. Self-learning Topics: Learn Data Security concepts like Authentication ,Authorization and encryption.	6	CO2
3	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in distributed databases. Self-learning Topics: Query Optimization in Distributed Databases.	6	CO3
4	Enhanced Data Models	Active Database Concepts and Triggers, Temporal Database, Spatial Database, Introduction to Deductive Databases Self-learning Topics: Case Study like: "Temporal Dynamics in Information Retrieval: Modelling Temporal Relevance and Query Intent Shifts Over Time"	6	CO4
5	Introduction to Information Retrieval	Retrieval Models, Types of Queries in IR Systems, Text Preprocessing Self learning Topics: Case Study like "Information retrieval evaluation in practice".	6	CO5
		Total	**30**	

Textbooks:

1. Silberschatz, H. Korth, and S. Sudarshan, *Database System Concepts*, 6th ed., McGraw-Hill, 2011.
2. R. Elmasri and S. Navathe, *Fundamentals of Database Systems*, 6th ed., Pearson Education, 2011.
3. R. Ramakrishnan and J. Gehrke, *Database Management Systems*, 3rd ed., McGraw-Hill, 2003.

Reference Books:

1. P. Ponniah, *Data Warehousing: Fundamentals for IT Professionals*, Wiley India, 2010.
2. R. Kimball and M. Ross, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*, 3rd ed., Wiley India, 2013.
3. P. Rob and C. Coronel, *Database Systems Design, Implementation, and Management*, 9th ed., Cengage Learning, 2011.

Online Reference Material:

1. Introduction to Database Systems, IIT Madras by Swayam-NPTEL
   https://nptel.ac.in/courses/106105175
2. Advanced DBMS Concepts and Architecture
   https://www.scribd.com/document/725121603/Advanced-DBMS-Notes

Course Name: Advanced database Management System Lab

Course Code: PEIT22P

Category: PEC (Data Analytics)

Preamble:

The Advanced Database Laboratory immerses students in leading-edge database technologies and advanced concepts, expanding upon foundational knowledge from prerequisite courses. Through hands-on exploration, students delve into topics including NoSQL databases, distributed data management, query processing and optimization, and advanced SQL techniques. Practical exercises and projects facilitate a deeper understanding of database design, optimization, and administration. Additionally, students gain valuable insights into emerging trends and challenges within the dynamic realm of database management.

Pre-requisites: DBMS

Couse Objectives:

- Mastering Conceptual DB Design using EER Model and implementing it using SQL DDL
- Explore advanced SQL concepts
- Gain practical experience in working with distributed databases, temporal data bases, spatial data bases and active databases and proposing a solution using appropriate model(s).
- Learn how to integrate PHP scripts with MySQL databases to create dynamic web applications.
- Develop proficiency in designing, implementing, and optimizing complex database systems for real-world applications and interface a database with front end tools
- Apply best practices in database administration, security, and scalability to ensure robust and efficient database systems.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Design database schemas using EER model techniques and implement them using SQL.
CO2: Demonstrate proficiency in writing advanced SQL queries and understand query optimization principles.
CO3: Develop skills in accessing and manipulating databases through JDBC in Java programs.

CO4: Understand query evaluation plans, indexing strategies, and their impact on database performance.
CO5: Implement distributed database solutions, including partitioning strategies, for scalability and performance.

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT22P	-	2	-	1

Assessment guidelines:

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

Suggested list of experiments:

Sr. No.	List of experiments
1	Design EER Model for a real-life scenario and implement it using SQL
2	Understand and compare performance by rewriting queries using indexing
3	Implement the Program to estimate the cost of the query for various join operation
4	Build Web Applications with access control features
5	Explore the security and access control features of PostgreSQL (or equivalent system)
6	Implementation of fragmentation in distributed database environment.
7	Implementation of triggers for understanding features of active database
8	Design a temporal and spatial data base schema, map it to tables and solve queries involving temporal and spatial attributes

Textbooks:

1. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, 4th ed., Pearson Education/Addison-Wesley, 2007.
2. A. Silberschatz, H. F. Korth, and S. Sudarshan, *Database System Concepts*, 6th ed., Tata McGraw-Hill, 2011.

Reference Books:

1. M. T. Özsu and P. Valduriez, *Principles of Distributed Database Systems*, 3rd ed., Prentice Hall, Oct. 2011.
2. M. Fowler and P. J. Sadalage, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*, Addison-Wesley, 2012.

Course Name: Modern Sensors for Internet of Things

Course Code: PEIT23T

Category: PEC (IoT)

Preamble:

This course introduces students to the fundamental principles and applications of sensors in various engineering fields. It covers different types of sensors, their working mechanisms, and their integration into systems, including IoT, embedded systems, and other fields.

Pre-requisites: Nil

Course Objectives:

- Understand the basic principles and classifications of sensors.
- Learn about various types of sensors and their applications.
- Design and implement sensor systems in practical scenarios.
- Integrate sensors with IoT and embedded systems.
- Explore the use of sensors in biomedical applications

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Understand fundamentals of Sensors and their characteristics.

CO2: Use different type sensors in Embedded and IoT applications.

CO3: Apply knowledge of conditioning in the design of data acquisition system.

CO4: Create a small sensor network using knowledge of communication protocols.

CO5: Understand concept of communication protocols.

CO6: Designing small application using one or more sensor.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	15	20	40	075

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:

Sr. No.	Module name	Content	No of Hours
1	Sensors Fundamentals and Characteristics	Sensor Classification, Physical Principles of Sensors- Resistive, capacitive, inductive sensors, Optical, magnetic, and thermal sensors, Sensor Characteristics, Performance and Types, Error Analysis characteristics- Sensitivity, accuracy, precision, range, and resolution. Response time and stability, Applications in various fields and criteria to select sensor	5
2	Types of sensors	Optical Sensors- Photodetectors and phototransistors, Fiber optic sensors, Imaging sensors. Mechanical Sensors- Strain gauges and pressure sensors, Accelerometers and gyroscopes, Ultrasonic sensors. Chemical and Biological Sensors- Electrochemical sensors, gas sensors, humidity and temperature sensors, Biosensors	6
3	Data acquisition and Signal Conditioning	Analog and Digital data acquisition system, Data logger, Amplification, filtering, and Analog-to-Digital conversion, Noise reduction techniques, Calibration methods	5
4	Wireless Sensor Networks	Basics of wireless communication, Network topologies and protocols, Bluetooth, ZigBee, Ultra Wide Band (UWB), Near Field Communication (NF) and RFID, WiFi and IEEE 802.11architecture, applications in IoT.	6
5	IoT Systems Integration and	Introduction to IoT, Integrating sensors with microcontrollers (e.g., Arduino, Raspberry Pi), Communication protocols (I2C, SPI, UART),	4

	communication protocols		
6	Sensor applications	On board automobile sensing system, Home automation and Environment monitoring system, Biomedical sensing system, Radio sensing for industrial applications,	4
Total			**30**

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212
4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Course Name: Modern Sensors for Internet of Things Lab

Course Code: PEIT23P

Category: PEC (IoT)

Preamble:

This course introduces students to different types of sensors, their working mechanisms, and their integration into systems. Selection and interfacing of a sensor in the IoT and embedded systems design.

Pre-requisites: Nil

Course Objectives:

- To understand various sensors type and their characteristics.
- To understand different types of sensors and their application.
- To understand communication protocol and their use in sensor network.
- To understand various types of communication protocols required in IoT applications and their characteristics.
- To learn to develop small IoT or Embedded system using sensor.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Identify and test the characteristics of various sensors.

CO2: Select most appropriate sensor and design required signal condition for the same.

CO3: Implement communication and wireless communication protocol in IoT application.

CO4: Design and implement small IoT or Embedded system.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	50

Suggested List of Practical:

- Identification of sensors and their important characteristics.
- Testing and Calibration of sensors.
- Identification of Sensitivity, range, resolution, Response time parameters of sensors
- Develop a system to record one of the physical parameters using appropriate sensor
- Develop a system to communicate one or more physical parameters using wireless communication.
- Develop a system to communicate one or more physical parameters using communication protocol.
- Design and develop a small IoT system using one or more sensor and a communication protocol.

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212
4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers,2013,ISBN: 978-1-118-43062-0
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Course Name: Computer & Network Security

Course Code: PEIT24T

Vertical/ Sub-Vertical: PEC

K-S-A Mapping: Knowledge, Skill

Pre-requisite required: PCIT06T (Computer Networks)

Pre-requisite for: PEIT28T (System Security & Ethical Hacking)

Recommended Semester: V

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT24T	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:

Computer network security refers to the set of policies, practices, and technologies designed to protect the integrity, confidentiality, and availability of data transmitted across networks from unauthorized access, misuse, and cyberattacks. As digital connectivity continues to expand, networks face growing threats such as malware, phishing, and denial-of-service attacks, making robust security measures — including firewalls, encryption, intrusion detection systems, and access controls — essential for safeguarding sensitive information, ensuring business continuity, and maintaining trust in an increasingly interconnected world.

Course Objectives:

- Understand the fundamental concepts and principles of computer network security, including the CIA Triad and common threat landscapes.
- Identify and analyze various types of network vulnerabilities, attacks, and the mechanisms used to detect and prevent them.
- Apply core security techniques such as encryption, firewalls, VPNs, and access control to design and implement secure network systems.
- Evaluate and respond to real-world security incidents through the application of industry standards, best practices, and ethical guidelines.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Explain the fundamentals concepts of computer security and network security	Remember
CO2	Identify the basic cryptographic techniques using classical and block encryption methods	Understand
CO3	Study and describe the system security malicious software	Apply
CO4	Describe the Network layer security, Transport layer security and application layer security.	Analyze
CO5	Explain the need of network management security and illustrate the need for NAC	Evaluate
CO6	Identify the function of an IDS and firewall for the system security	Create

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours	CO's Mapped
1	Computer Security & Network Security	1. Computer Security and Network Security (Definition), CIA Triad, Services, Mechanisms and Attacks 2. Classical Encryption Techniques: Mono-alphabetic & Poly-alphabetic Substitution (Vigenere cipher, Playfair cipher) 3. Transposition Techniques: Keyed and Keyless Transposition Ciphers 4. Introduction to Steganography	4	**CO1**

2	Cryptography	1. Block Cipher Modes of Operation, DES, AES, RC5 Algorithm 2. Public Key Cryptography: RSA Algorithm 3. Hashing Techniques: SHA-256, SHA-512, HMAC and CMAC 4. Digital Signature Schemes – RSA, DSS 5. Digital Certificate: X.509, PKI	8	**CO2**
3	Malicious Software	1. SPAM, Trojan Horse, Viruses, Worms, System Corruption 2. Attack Agents, Information Theft, Trapdoor, Keyloggers 3. Phishing, Backdoors, Rootkits 4. Denial of Service (DoS) Attacks, Zombie	4	**CO3**
4	IP, Transport & Email Security	1. IP Security: Introduction to IPSec, IPSec Architecture, AH and ESP 2. Transport Level Security: VPN 3. Web Security Considerations, SSL Architecture, TLS, HTTPS 4. Secure Shell (SSH) Protocol Stack 5. Email Security: Secure Email S/MIME	8	**CO4**
5	Network Management Security & NAC	1. Network Management Security: SNMPv3 2. NAC: Principle Elements of NAC 3. Principle NAC Enforcement Methods 4. How to Implement NAC Solutions 5. Use Cases for Network Access Control.	4	**CO5**
6	System Security	1. Intrusion Detection Systems (IDS): Types and Functions 2. Firewall Design Principles 3. Characteristics of Firewalls 4. Types of Firewalls	**2**	**CO6**
Total			30	

Textbooks:

1. W. Stallings, *Cryptography and Network Security: Principles and Practice*, 8th ed. London, UK: Pearson, 2024.

2. W. Stallings, *Network Security Essentials: Applications and Standards*, 6th ed. Boston, MA, USA: Pearson, 2017.

3. W. Stallings and L. Brown, *Computer Security: Principles and Practice*, 5th ed. Hoboken, NJ, USA: Pearson, 2024.

Reference Books:

1. D. R. Stinson, *Cryptography: Theory and Practice*, 3rd ed. Boca Raton, FL, USA: CRC Press, 2005.

2. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, *Handbook of Applied Cryptography*. Boca Raton, FL, USA: CRC Press, 1996.

3. D. Mukhopadhyay and R. S. Chakraborty, *Hardware Security: Design, Threats, and Safeguards*. Boca Raton, FL, USA: CRC Press, 2014.

Online Reference Material:

1. "Cryptography and Network Security (CS6500) – IIT Madras Course Resources," IIT Madras. Available:
IIT Madras CNS Resources

2. J. Sen et al., "Computer and Network Security," *arXiv preprint arXiv:2007.16147*, 2020. Available:
arXiv Computer and Network Security Paper

3. T. Udupa A, S. Jayaram, and S. G. Hegde, "A Brief Study of Computer Network Security Technologies," *arXiv preprint arXiv:2403.11303*, 2024. Available:
arXiv Network Security Technologies Paper

Course Name: Computer & Network Security Lab

Course Code: PEIT24P

Vertical/ Sub-Vertical: PEC

K-S-A Mapping: Knowledge, Skill

Pre-requisite required: PCIT06P (Computer Networks Lab)

Pre-requisite for: PEIT28P (System Security & Ethical Hacking Lab)

Recommended Semester: V

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
PEIT24P	-	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 Computer and Network Security Laboratory provides students with hands-on practical exposure to cryptographic algorithms, network security protocols, and system security tools. Designed to complement the theory course, this lab enables students to implement encryption techniques, simulate network attacks and defenses, and configure security mechanisms such as firewalls, IDS, SSL/TLS, and IPSec. Through structured experiments mapped to Course Outcomes (COs), students develop the technical skills needed to identify vulnerabilities, apply countermeasures, and build secure network systems aligned with real-world cybersecurity practices.

Course Objectives:

- To provide practical exposure to network security concepts, tools, and techniques used for securing computer networks and systems.
- To develop skills in configuring, analyzing, and implementing security mechanisms such as firewalls, encryption, authentication, and intrusion detection systems.
- To enable students to identify network vulnerabilities and perform security testing using ethical hacking and penetration testing methodologies.
- To enhance understanding of secure communication protocols and best practices for protecting data confidentiality, integrity, and availability in networked environments.

Course Outcomes:

After successful completion of the course, learners will be able to:

Course Outcomes	Course Outcome Statement	Bloom's Level
CO1	Explain the fundamental concepts of computer security and network security, including the CIA Triad, OSI security architecture, and classical encryption techniques.	Remember
CO2	Identify and apply basic cryptographic techniques including block ciphers (DES, AES), public key cryptography (RSA), hashing algorithms, digital signatures, and PKI.	Understand
CO3	Describe and analyze system security threats posed by malicious software such as viruses, worms, trojans, rootkits, and denial-of-service attacks.	Apply
CO4	Describe and implement network layer, transport layer, and application layer security mechanisms including IPSec, SSL/TLS, HTTPS, SSH, and secure email (S/MIME).	Analyze

List of Experiments:

Sr No.	Suggested Experiments	CO's Mapped
1.	**Implementation of Classical Encryption Techniques** Implement Caesar cipher, Vigenere cipher, Playfair cipher, and Rail Fence transposition cipher using Python/Java to understand classical cryptographic techniques.	CO1
2.	**Implementation of DES and AES Algorithms** Implement Data Encryption Standard (DES) and Advanced Encryption Standard (AES) block cipher algorithms and observe encryption/decryption with different key sizes.	CO2

3.	**Implementation of RSA Public Key Cryptography** Implement the RSA algorithm for key generation, encryption, and decryption. Demonstrate asymmetric encryption and its application in secure communication.	CO2
4.	**Implementation of Hashing Algorithms and Digital Signatures** Implement SHA-256 and MD5 hashing techniques, verify data integrity, and implement Digital Signature Scheme (DSS/RSA) to sign and verify messages demonstrating non-repudiation.	CO2
5.	**Malware Analysis and Simulation** Simulate and analyze behavior of malicious software types (virus, worm, trojan, rootkit). Study system vulnerabilities, infection mechanisms, and deploy appropriate countermeasures.	CO3
6.	**Phishing and Social Engineering Attack Simulation** Demonstrate phishing attack techniques, keyloggers, and backdoors in a controlled environment. Analyze attack vectors and implement defensive strategies against information theft.	CO3
7.	**SSL/TLS and HTTPS Configuration** Configure SSL/TLS protocols and set up an HTTPS server. Analyze secure handshake mechanisms, certificate validation, and encrypted data transmission.	CO4
8.	**VPN Setup and IPSec Configuration** Set up a Virtual Private Network (VPN) and configure IPSec (AH & ESP) protocols. Analyze secure tunneling, authentication headers, and encapsulating security payload.	CO4
9.	**Firewall Configuration and IDS Implementation** Configure firewall rules using iptables and install/configure an IDS tool (e.g., Snort). Write detection rules, simulate network attacks, and analyze alerts and logs.	CO4
10.	**Mini Project: Secure Network Application Design** Design and implement a secure network application integrating cryptographic techniques (AES/RSA), digital signatures, secure communication protocols (TLS/HTTPS), and access control mechanisms. Present with threat model, security features, and live demonstration.	**CO1–CO4**

Textbooks:

1. W. Stallings, *Cryptography and Network Security: Principles and Practice*, 8th ed. London, UK: Pearson, 2024.

2. C. Kaufman, R. Perlman, and M. Speciner, *Network Security: Private Communication in a Public World*, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2002.

3. B. Schneier, *Applied Cryptography: Protocols, Algorithms, and Source Code in C*, 2nd ed. Hoboken, NJ, USA: Wiley, 2015.

Reference Books:

1. W. Stallings and L. Brown, *Computer Security: Principles and Practice*, 5th ed. Boston, MA, USA: Pearson, 2024.

2. N. Daswani, C. Kern, and A. Kesavan, *Foundations of Security: What Every Programmer Needs to Know*. Berkeley, CA, USA: Apress, 2007.

3. D. R. Stinson and M. Paterson, *Cryptography: Theory and Practice*, 4th ed. Boca Raton, FL, USA: CRC Press, 2018.

Online Reference Material:

1. "Cryptography and Network Security Laboratory Manual," IIT Kharagpur. [Online]. Available: https://cse.iitkgp.ac.in

2. "Computer Network Security Course Resources," IIT Madras. [Online]. Available: https://www.cse.iitm.ac.in

3. Cisco Networking Academy, "Introduction to Cybersecurity." [Online]. Available: https://www.netacad.com/courses/cybersecurity/introduction-cybersecurity