B. Tech in Artificial Intelligence and Machine Learning

Modified Scheme of Studies/Examination

Semester VII

w.e.f. the session 2025-26

S. No.	Course Code	Subject	L:T:P	Hours/Week	Credits	Examination Schedule				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1	PE	Elective-III	3:0:0	3	3	75	25	0	100	3
2	PE	Elective-IV	3:0:0	3	3	75	25	0	100	3
3	OE	Open Elective-II	3:0:0	3	3	75	25	0	100	3
4	PROJ-PC-AI-401A	Project-II	0:0:12	12	6	0	40	60	100	3
5	PE- AI-LA	Elective-III Lab	0:0:2	2	1	0	40	60	100	3
6	PE-AI- LA	Elective-IV Lab	0:0:2	2	1	0	40	60	100	3
Total				25	17	225	195	180	600	
7	SIM-401*	Seminar on Summer Internship	2:0:0	2	0	0	50	0	50	

PE- Elective-III	
Computer Graphics and Animation: PE-AI- 403A	Computer Graphics and Animation Lab: PE- AI-413LA
Signal and System: PE-AI-405A	Signal & System Lab: PE-AI-415LA
Speech and Natural Processing: PE-CS- D407A	Speech and Natural Processing Lab: PE- AI-417LA
PE- Elective-IV	
Problem Solving, Reasoning in Robotics: PE- AI-409A	Problem Solving, Reasoning in Robotics Lab: PE-AI-419LA
Cloud Computing: PE-CS-A402A	Cloud Computing Lab: PE-CS-A402LA
Introduction to R Programming: PE-AI-411A	Introduction to R Programming Lab: PE- AI-421LA
OE- Elective-II	
Cyber Law & Ethics: OE-CS-401A	
Software Engineering: OE-AI-405A	
Android Application & Development: OE-AI-403A	

The course of both (PE) & (OE) will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

***Note:** SIM-401* **is** a mandatory credit-less course in which the students will be evaluated for Summer Internship undergone after 6th semester and students will be required to get passing marks to qualify.

PE-AI- 403A	Computer Graphics and Animation						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	Provide an introduction to the theory and practice of Computer Graphics and Animation. Provide an insight to applications of Graphics and the graphics hardware devices and software used. Introduce the principles needed to design a graphics system and the algorithms related with them.						
Course Outcomes (COs)							
CO 1	Have a knowledge of graphics applications and components and devices required to support the applications;						
CO 2	Develop algorithms for scan converting geometrical primitives such as lines, circles, ellipses, and curves along with algorithms for filling polygons, required for designing real-world applications.						
CO 3	Design algorithms for carrying out manipulations in pictures using geometric transformations, viewing transformations , and clipping operations;						
CO 4	Model 3-dimensional objects and apply viewing, visible –surface determination, and shading techniques to the models for achieving realism. The student will also learn to design and develop animation sequences						

Unit –I

Introduction to Computer Graphics and its Components: Overview of Computer Graphics, its functions & elements; Introduction to GUI, Computer Vision, Augmented Reality and other Applications of Graphics; Popular Graphics Software; Components and Working of Interactive Graphics; Raster Scan and Random Scan systems and Display Processors; Look-up table; Loading the Frame Buffer; Coordinate Systems.

Graphics Devices: Display Technologies: Resolution, Aspect Ratio, Refresh CRT , Color CRT , Flat Panel Displays; Interactive Input Devices for Graphics , Image and Video Input Devices.

Unit –II

Scan Conversion: Drawing Geometry; Output Primitives; Lines and Pixel Graphics; Anti Aliasing; Scan Converting Lines: DDA line drawing algorithms, Bresenham's line Algorithm; Scan Converting Circles: Polynomial method for circle drawing, circle drawing using polar coordinates, Bresenham's circle drawing; Algorithms for Generation of ellipse; Line Styles; Generation of Bar Charts, Pie-Charts.

Curve Representation: Parametric Curves, Parametric Representation of a Circle, Parametric representation of cubic curves, drawing Bezier curves.

Filled-Area Primitives: Basic Stack based fill algorithms: Flood fill algorithm, Boundary fill algorithm; Scan-line polygon fill algorithm and its computational structures.

Unit –III

Two-Dimensional Transformations: Coordinate and Geometric Transformations; Translation, Rotation, Scaling; Matrix representations and Homogeneous coordinates, Composite transformations, General Pivot Point rotation, General Fixed Point Scaling, Shearing; Reflection ; Reflection about an arbitrary line.

2-D Viewing: Viewing pipeline; Window, Viewport, Window-to-Viewport transformation; Zooming, Panning; Pointing and Positioning techniques; Rubber band technique; Dragging.

Clipping operations: Point and Line clipping, Cohen-Sutherland line clipping, Mid-Point Subdivision line clipping, Liang-Barsky line clipping, Sutherland-Hodgman polygon clipping; Weiler-Atherton polygon

clipping

Unit –IV

3-D Graphics & Modeling: Visualization techniques for Realism; 3D Object Representation; Solid Model Representation Schemes; Euclidean Geometry methods: Regularized Boolean Set Operations, Primitive Instancing, Boundary Representations, Curved lines and surfaces, Sweep Representations, Spatial-Partitioning Representations - Octree representation, Constructive Solid Geometry; Procedural Methods: Fractals, Shape Grammars, Particle systems, Physically Based modeling, Visualization techniques; 3D transformations.

Three-Dimensional Viewing: Viewing Pipeline**; P**arallel Projection: Orthographic and Oblique Projection; Perspective Projection.

Visible-Surface Determination: Z-buffer, Depth-Sorting, Area Subdivision, BSP-Tree method; Ray casting.

Illumination and Shading: Modeling Light Intensities; Basic Illumination Models; Gouraud Shading; Phong Shading.

Introduction to Animation: Designing of Animation Sequences; Key-Frame Systems; Animation Techniques: Tweening , Morphing.

Text Books:

1. Donald Hearn, M. Pauline Baker, Computer Graphics, Pearson Education.
2. J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Computer Graphics -Principles and Practice, Pearson Education.

Reference Books:

1. Newmann & Sproull, Principles of Interactive Computer Graphics, McGraw Hill.
2. Rogers, David F., Procedural Elements of Computer Graphics, McGraw Hill.
3. Zhigang Xiang, Roy Plastock, Computer Graphics, Tata McGraw Hill.
4. Malay K. Pakhira, Computer Graphics, Multimedia and Animation, PHI
5. Steven Harrington, Computer Graphics, A Programming Approach, McGraw Hill.

PE- AI-413LA	Computer Graphics and Animation Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	0	2	1	60	40	100	3 Hrs.
Course Outcomes (COs)							
CO 1	Have a knowledge of graphics applications and components and devices required to support the applications;						
CO 2	Develop algorithms for scan converting geometrical primitives such as lines, circles, ellipses, and curves along with algorithms for filling polygons, required for designing real-world applications;						
CO 3	Design algorithms for carrying out manipulations in pictures using geometric transformations, viewing transformations, and clipping operations;						
CO 4	Model 3-dimensional objects and apply viewing, visible –surface determination, and shading techniques to the models for achieving realism. The student will also learn to design and develop animation sequences						

List of Experiments

1.Implementation of Algorithms for drawing 2D Primitives – Line (DDA, Bresenham) – all slopes Circle (Midpoint)
2. 2D Geometric transformations – Translation, Rotation Scaling, Reflection Shear, Window- Viewport .
3. Composite 2D Transformations
4. Line Clipping
5. 3D Transformations - Translation, Rotation, Scaling.
6. 3D Projections – Parallel, Perspective.
7. Creating 3D Scenes.
8. Image Editing and Manipulation - Basic Operations on image using any image editing software, creating gif animated images, Image optimization.
9. 2D Animation – To create Interactive animation using any authoring tool.

PE-AI-405A	Signal and System						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	Provide a foundational understanding of how signals and systems are mathematically modeled, analyzed, and designed, equipping students with the skills to apply these concepts in various engineering disciplines.						
Course Outcomes (COs)							
CO 1	Analyze different types of signals.						
CO 2	Represent continuous and discrete systems in time and frequency domain using different transforms.						
CO 3	Understand sampling theorem and its implications**.**						
CO 4	Determine Fourier transforms for continuous-time and discrete-time signals (or impulse-response functions), and understand how to interpret and plot Fourier transform magnitude and phase functions. Understand the Laplace transform and its implications.						

Unit-I

Introduction to Signals: Continuous and discrete time signals, deterministic and stochastic signals, periodic and a periodic signals, even and odd signals, energy and power signals, exponential and sinusoidal signals and singular functions. Signal representation in terms of singular functions, orthogonal functions and their use in signal representation

Introduction to Systems: Linear and non-linear systems, time invariant and time varying systems, lumped and distributed systems, deterministic and stochastic systems, casual and non-causal systems, analog and discrete/digital memory and memory less systems.

Unit-II

Random Variables: Introduction to Random Variables, pdf, cdf, moments, distributions, correlation functions.

Linear Time Invariant Systems: Introduction to linear time invariant (LTI) systems, properties of LTI systems, convolution integral, convolution sum, causal LTI systems described by differential and difference equations, Concept of impulse response.

Unit-III

Discretization of Analog Signals: Introduction to sampling, sampling theorem and its proof, effect of undersampling, reconstruction of a signal from sampled signal.

Fourier Series : Continuous time Fourier series (CTFS), Properties of CTFS, Convergence of Fourier series, Discrete time Fourier Series (DTFS), Properties of DTFS **,** Fourier series and LTI system, Filtering.

Unit-IV

Fourier Transform: Continuous Time Fourier Transform (CTFT), Properties of CTFT, Systems characterized by linear constant- coefficient differential equations, Discrete time fourier transform (DTFT), Properties of DTFT, Duality, Systems characterized by Linear constant coefficient difference equations.

Laplace Transform: Introduction to Laplace transform, Region of convergence for laplace transform, Inverse laplace transform, Properties oflaplace transform, Analysis and characterization of LTI systems using laplace transform, System function algebra and block diagram representations,Unilateral laplace transform.

Text Books:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Signals and Systems, Prentice Hall India, 2nd Edition, 2009

Reference Books:

1. Simon Haykins – "Signal & Systems", Wiley Eastern
2. Tarun Kumar Rawat , Signals and Systems , Oxford University Press.
3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4. M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.

PE- AI-415LA	Signal & System Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	0	2	1	60	40	100	3 Hrs.

Course Outcomes (COs)	
CO 1	Analyze different types of signals.
CO 2	Represent continuous and discrete systems in time and frequency domain using different transforms.
CO 3	Understand sampling theorem and its implications**.**
CO 4	Determine Fourier transforms for continuous-time and discrete-time signals (or impulse-response functions), and understand how to interpret and plot Fourier transform magnitude and phase functions. Understand the Laplace transform and its implications.

List of Experiments

1. Introduction of the MATLAB/SciLab/Octave software.
2. To demonstrate some simple signal.
3. To explore the effect of transformation of signal parameters (amplitude-scaling, time-scaling and time- shifting).
4. To visualize the complex exponential signal and real sinusoids.
5. To identify a given system as linear or non-linear.
6. To explore the time variance and time invariance property of a given system.
7. To explore causality and non-causality property of a system.
8. To determine Fourier transform of a signal.
9. To determine Laplace transform of a signal.
10. To demonstrate the time domain sampling of bandlimited signals (Nyquist theorem).
11. To demonstrate the sampling in frequency domain (Discrete Fourier Transform).
12. To demonstrate the convolution and correlation of two continuous-time signals.

Note: Atleast ten (10) experiments from the above list are mandatory to perform for the students.

PE-CS-D407A	Speech and Natural Processing						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	To provide the understanding of the mathematical and linguistic foundations underlying approaches to the various areas in NLP.						
Course Outcomes (COs)							
CO 1	Be familiar with syntax and semantics in NLP.						
CO 2	To implement various concepts of knowledge representation using Prolog.						
CO 3	To classify different parsing techniques and understand semantic networks.						
CO 4	To identify/explain various applications of NLP.						

Unit-I

Speech recognition and speech synthesis: concept overview, key algorithms in the noisy channel paradigm. Fundamental components of Natural Language Processing: Lexicography, syntax, semantics, prosody, phonology, pragmatic analysis, world knowledge.Knowledge Representation schemes: Semantic net, Frames, Conceptual Dependency, Scripts.

Unit-II

Representing knowledge using rules: Logic Programming, Introduction to LISP and Prolog, Rules based deduction systems, General concepts in knowledge acquisition.Syntax Analysis: Formal Languages and grammars, Chomsky Hierarchy, Left- Associative Grammars, ambiguous grammars, resolution of ambiguities.

Unit-III

Computation Linguistics: Recognition and parsing of natural language structures- ATN and RTN, General Techniques of parsing- CKY, Earley and Tomitas algorithm.Semantics: Knowledge representation, semantics networks logic and inference pragmatics, graph models and optimization.

Unit-IV

Applications of NLP: Intelligent work processor, Machine translation, user interfaces, Man-Machine interfaces, natural language querying, tutoring and authoring systems, speech recognition, commercial use of NLP.

Suggested Books:

1. Daniel Jurafsky, James H. Martin, "Speech *and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition"*, 2nd edition, Pearson Edu., 2013.
2. James Allen, "Natural Language Understanding", Pearson Education, Second Edition, 2003.
3. Ivan Bratko, "Prolog: Programming for Artificial Intelligence", 3rd Edition, Pearson Education, Fifth Impression 2009.
4. G. Gazder, "Natural Language processing in prolog", Addison Wesley, 1989.

PE- AI-417LA	Speech and Natural Processing Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	0	2	1	60	40	100	3 Hrs.
Course Outcomes (COs)							
CO 1	To understand the basic concepts of software.						
CO 2	To explore properties of various types of signals and systems.						
CO 3	To explore different properties of signals and systems.						
CO 4	To understand the concept of sampling in time and frequency domain.						

List of Experiments

1. Write a python program to perform tokenization by word and sentence using nltk.
2. Write a python program to eliminate stopwords using nltk.
3. Write a python program to perform Parts of Speech tagging using nltk.
4. Write a python program to perform lemmatization using nltk.
5. Write a python program to perform Named Entity Recognition using nltk.
6. Write a python program to find Term Frequency and Inverse Document Frequency (TF-IDF).
7. Write a python program to find all unigrams, bigrams and trigrams present in the given corpus
8. Write a python program for CYK parsing (CockeYounger-Kasami Parsing) or Chart Parsing.
9. Write a python program to find the probability of the given 31 statement "This is my cat" by taking the an example corpus into consideration
10. Write the python code to perform sentiment analysis using NLP

PE-AI-409A	Problem Solving, Reasoning in Robotics						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3Hrs.
Purpose	Problem-solving and reasoning are fundamental in robotics to ensure robots can operate autonomously, adapt to changes, and make intelligent decisions.						
Course Outcomes (COs)							
CO 1	It helps to explain the importance of problem-solving and reasoning in robotics.						
CO 2	It Enables to utilize constraint satisfaction techniques to optimize robotic actions.						
CO 3	To understand the use Boolean logic and rule-based systems for robot decision-making.						
CO 4	To learn to apply machine learning techniques to improve robotic decision-making.						

Unit-I

Introduction to Problem-Solving in Robotics: Definition and Importance of Problem-Solving in Robotics, Types of Problems in Robotics (Navigation, Manipulation, Decision-Making)
Problem-Solving Techniques: Brute Force, Heuristics, and Optimization, Role of Artificial Intelligence in Robotics Problem-Solving

Unit-II

Search and Path Planning Algorithms: Uninformed Search Algorithms: Breadth-First Search (BFS), Depth-First Search (DFS), Informed Search Algorithms: A* Algorithm, Dijkstra's algorithm, Graph-based Path Planning in Robotics, Real-world Applications: Robot Navigation, Obstacle Avoidance

Unit-III

Logical and Computational Reasoning in Robotics: Commonly used Mathematical Functions, Commonly used Summ Introduction to Reasoning in Robotics, Types of Reasoning: Deductive Reasoning (Rule-Based Systems), Inductive Reasoning (Pattern Recognition), Abductive Reasoning (Hypothesis Generation), Boolean Logic and Fuzzy Logic for Robotics, Expert Systems and Rule-Based Decision Making, array Functions, Commonly used String Functions, User-defined functions, local and global variable

Unit-IV

Probabilistic Reasoning and Uncertainty Handling: Introduction to Uncertainty in Robotics
Probabilistic Reasoning Models: Bayesian Networks, Hidden Markov Models (HMM), Kalman Filter and Particle Filter for Sensor Fusion, Applications in Robotic Perception and Localization.

Suggested Books:

1. **"Principles of Robot Motion: Theory, Algorithms, and Implementations"** – *Howie Choset et al.*
2. **"Robot Modeling and Control"** – *Mark W. Spong, Seth Hutchinson, M. Vidyasagar*
3. **"Introduction to Autonomous Robots"** – *Nikolaus Correll, Bradley Hayes, Bradley Leigh*

Note: The paper setter will set the paper as per the question paper templates provided.

PE-AI-419LA	Problem Solving, Reasoning in Robotics Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	0	2	1	60	40	100	3Hrs.
Purpose	Problem-solving and reasoning are fundamental in robotics to ensure robots can operate autonomously, adapt to changes, and make intelligent decisions.						
Course Outcomes (COs)							
CO 1	It helps to explain the importance of problem-solving and reasoning in robotics.						
CO 2	It Enables to utilize constraint satisfaction techniques to optimize robotic actions.						
CO 3	To understand the use Boolean logic and rule-based systems for robot decision-making.						
CO 4	To learn to apply machine learning techniques to improve robotic decision-making.						

List of Experiments

1. Implement a simple rule-based decision system for a robot.
2. Simulate a robot's response to basic logical conditions (e.g., "If object detected, stop").
3. Design a state machine for a robot's behavior (e.g., vacuum cleaner states: idle, cleaning, returning to sdock).
4. Implement Depth-First Search (DFS) and Breadth-First Search (BFS) for robot path finding.
5. Use Dijkstra's algorithm for optimal path selection in a grid-based environment.
6. Implement A search algorithm* for real-time robot navigation.
7. Simulate a robotic obstacle avoidance system using search algorithms.
8. Implement Boolean logic for robot decision-making (e.g., robotic arm picking or rejecting objects based on size).
9. Design a fuzzy logic system for a temperature-controlled robot.
10. Develop a rule-based expert system for warehouse robots to sort packages.
11. Simulate Bayesian reasoning for a robot's sensor fusion (e.g., predicting object location with noisy data).
12. Implement a Kalman filter for a self-balancing robot.
13. Use a Particle Filter for robot localization in a dynamic environment.

PE-CS-A402A	Cloud Computing						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	To familiar the concepts of cloud services and storage to deploy various resources and arbitrary software.						
Course Outcomes (COs)							
CO 1	Summarize main concepts, key technologies, strengths and limitations of Cloud Computing.						
CO 2	Explore various cloud service and deployment models to utilize different cloud services.						
CO 3	Interpret various data, scalability & cloud services in order to get efficient database for cloud storage.						
CO 4	To deal with various security threats and their controlling mechanism for accessing safe cloud services.						

Unit-I

Overview of Computing Paradigm: Recent trends in Computing, Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing, evolution of cloud computing, Business driver for adopting cloud computing. Cloud Computing (NIST Model): History of Cloud Computing, Cloud service providers, Properties, Characteristics & Disadvantages, Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing, Role of Open Standards.

Unit-II

Cloud Computing Architecture: Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models (XaaS) - Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud, Cloud Architecture and open source.

Unit-III

Service Management in Cloud Computing: Service Level Agreements (SLAs), Billing & Accounting, comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously, Managing Data- Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing, Cloud management with Puppet.

Case study: Eucalyptus, Microsoft Azure, Amazon EC2.

Unit-IV

Cloud Security: Infrastructure Security, Network level security, Host level security, Application level security, Data security and Storage, Data privacy and security Issues, Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations, DROPS: Division and Replication of data in Cloud for Optimal Performance and Security.

Suggested Books:

- Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 2010.
- Rajkumar Buyya, James Broberg, Andrzej M. Goscinski,Cloud Computing: Principles and Paradigms, Wiley, 2011.
- Nikos Antonopoulos, Lee Gillam, Cloud Computing: Principles, Systems and Applications, Springer, 2012.
- Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley-India, 2010.

PE-CS-A402LA	Cloud Computing Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	0	2	1	60	40	100	3Hrs.
Purpose	Introduce fundamental soft computing concepts and non-traditional problem-solving techniques, focusing on handling imprecisely defined problems. Explore nature-inspired metaheuristics, including recent trends in evolutionary algorithms and natural computing for optimization.						
Course Outcomes (COs)							
CO 1	Possess an understanding of soft computing techniques and their practical applications across various domains.						
CO 2	Apply fuzzy logic theory to immediately defined problems.						
CO 3	Utilize neural network concepts to solve problems where traditional algorithmic methods are infeasible or computationally expensive.						
CO 4	Develop efficient and high-quality solutions for optimization and search problems using genetic algorithms.						

List of Experiments

1. Install Virtualbox /VMware Workstation with different flavours of linux or windows OS on top of windows 7 or 8.
2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
3. Install Google App Engine. Create hello world app and other simple web applications using python/java.
4. Use GAE launcher to launch the web applications.
5. Simulate a cloud scenario using Cloud Sim and run a scheduling algorithm that is not present in Cloud Sim.
6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Find a procedure to launch virtual machine using trystack (Online Open stack Demo Version)
8. Install Hadoop single node cluster and run simple applications like word count.

PE-AI-411A	Introduction to R Programming						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3Hrs.
Purpose	To familiarize the students to develop research for academic and industry use.						
Course Outcomes (COs)							
CO 1	It helps you to store, manipulate, and analyze data efficiently.						
CO 2	It Enables importing data from various file formats like CSV, Excel, JSON, XML, SQL databases, and APIs.						
CO 3	Functions avoid code repetition by allowing reusable blocks of code.						
CO 4	Chat functionalities in R can be used for automating responses, interactive analysis, and AI-driven tasks.						

Unit-I

Introduction to R: What is R. Why R. Installing R, R environment, How to get help in R, R console and Editor.

Understanding R data structure: Variables in R, Scalars, Vectors, Matrices, List, Data frames, Using c, C bind, R bind, attach and detach functions in R, Factors

Unit-II

Importing data: Reading Tabular Data files, Reading CSV files, Importing data from excel, Importing data from SAS, Accessing database, Saving in R data, Loading R data objects, Writing to files

Manipulating Data: Selecting rows/observations, Selecting columns/fields, Merging data, Re - labelling the column names Converting variable types, Data sorting, Data aggregation

Unit-III

Using functions in R: Commonly used Mathematical Functions, Commonly used Summary Functions, Commonly used String Functions, User-defined functions, local and global variable.

R Programming: While loop, If loop, For loop, Arithmetic operations

Unit- IV

Descriptive Statistics: Data Range, Frequencies, Mode, Mean and Median.Mean Applying Trim Option , Applying NA Option, Median-Mode-Standard Deviation – Correlation - Spotting Problems in Data with Visualization: visually Checking Distributions for a single Variable-R–**Pie Charts:** Pie Chart title and Colors–Slice Percentages and Chart Legend, 3D Pie Chart – R Histograms – Density Plot - R – Bar Charts: Bar Chart Labels, Title and Colors .Line Chart ,Scatter plot, Developing graphs, Box Plot, Drawing line, circle, rectangle, triangle using R language

Suggested Books:

1. **R for Data Science** – Hadley Wickham & Garrett Grolemund
2. **Hands-On Programming with R** – Garrett Grolemund
3. **The Art of R Programming** – Norman Matloff

PE- AI-421LA	Introduction to R Programming Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Practical**	**Minor Test**	**Total**	**Time**
0	0	2	1	60	40	100	3 Hrs.
Course Outcomes (COs)							
CO 1	Apply R programming fundamentals to manage data structures and control flows effectively.						
CO 2	Manipulate and analyze datasets using file handling, filtering, summarization, and joining techniques in R.						
CO 3	Visualize data using various plots and interpret insights through graphical representations.						
CO 4	Implement machine learning techniques like decision trees and linear regression using relevant R packages.						

List of Experiments

1. Installation of R and R-studio.
2. Working with directories in R
3. Working with variables and data structure in R
    - Vector
    - List
    - Matrix
    - Array
4. Show the usage of inbuilt functions in R
5. Demonstrate the use of control statements in R
6. Demonstrate the use of user defined functions in R
7. Data manipulation in CSV Files:
    - Filtering
    - Aggregation
    - Summarization etc.
    - Aggregate Data
    - Join Data Frames
8. Data visualization using R:
    - Histograms
    - Dot plots
    - Bar plots
    - Heat map
    - Time Series plot

9. Demonstrate the use of packages related to decision tree.
10. Implement Linear Regression

OE-CS-401A	Cyber Law & Ethics						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	The course aims to equip students with a comprehensive understanding of Cyber Laws and Ethics, focusing on cyber space, cyber crimes, and legal regulations. Students will explore global and Indian responses to cyber crimes, criminal liability, and related challenges. Additionally, the course emphasizes precautionary measures and prevention strategies in the digital world.						
Course Outcomes (COs)							
CO 1	Understand basic concepts of Cyber Law.						
CO 2	Understand about the Information Technology Act.						
CO 3	Analyze the role of organization for securing cyberspace.						
CO 4	Understand and apply ethical principles in business and information technology.						

Unit–I

Evolution of computer technology, emergence of cyber space. Cyber Jurisprudence, Jurisprudence and law, Doctrinal approach, Consensual approach, Real Approach, Cyber Ethics, Cyber Jurisdiction, Hierarchy of courts, Civil and criminal jurisdictions, Cyberspace-Web space, Web hosting and web Development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.

Unit –II

Overview of IT Act, 2000, Amendments and Limitations of IT Act, Digital Signatures, Cryptographic Algorithm, Public Cryptography, Private Cryptography, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offences, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.

Unit –III

Evolution and development in E-commerce, paper vs paper less contracts E-Commerce modelsB2B, B2C,click wrap contracts, applicability of Indian contract act 1872 E-security. Business, taxation, electronic payments, supply chain, EDI, E-markets, Emerging Trends.

Unit –IV

Ethics, Ethics in the Business World, Corporate Social Responsibility, Fostering Corporate Social Responsibility and Good Business Ethics, Improving Business Ethics, Ethical Considerations in Decision Making, Ethics in Information Technology, Managing IT Worker Relationship, Encouraging Professionalism of IT Workers - Professional Codes of Ethics, Professional Organizations, Certifications and Licensing , Encouraging Ethical Use of IT Resources among Users.

Suggested Books:

1. Cyber Law and E-Commerce" by Dr. Sandeep K. Bhatnagar (This book offers a detailed overview of Cyber Law, IT Act 2000, amendments, digital signatures, cryptography, and e-commerce models)
2. Information Technology Law: The Law and Society" by Andrew Murray (addresses e-commerce, cybercrime, and the legal recognition of electronic records and signatures.)
3. Cyber Law in India" by S. K. Verma

OE-AI-405A	Software Engineering						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	To learn the architecture and programming of Intel family microprocessors and its interfacing.						
Course Outcomes(COs)							
CO 1	Introduction to Software and Requirement Analysis of Software						
CO 2	To implement Software project planning						
CO 3	To learn and analyze Software Design						
CO 4	Testing types and Maintenance of Software						

Unit-I

Introduction: Software Crisis-problem & causes, Software Processes, Development models: Waterfall, Prototype, Evolutionary & Spiral models, Quality Standards like ISO 9001, SEI-CMM.
Requirement Analysis: Structured Analysis, Behavioral& non-behavioral requirements, Software requirement specification: components & characteristics, Function point metric.

Unit-II

Software Project Planning: Cost estimation, static, Single & multivariate models, COCOMO model, Putnam Resource Allocation Model, Risk management, project scheduling, personnel planning, team structure, Software configuration management, quality assurance, project monitoring.

Unit-III

Software Design: Fundamentals, problem partitioning & abstraction, design methodology, Function Oriented Design, Cohesion, Coupling & their classification, User Interface Design, Detailed design, Information flow metric, Cyclomatic complexity.
Coding: Style, structured programming, Metrics: LOC, Knot count, live variable, Halstead's measures.

Unit-IV

Testing: Static & dynamic testing, Functional testing: Boundary Value Analysis, Equivalence class testing, Decision table testing, Cause effect graphing; Structural testing: Control-flow & data-flow based testing, loop testing, mutation testing; performance testing; testing strategies: unit & integration testing, System testing, Alpha & Beta testing, debugging.
Maintenance: Types & characteristics of maintenance, Reverse Engineering & Re-engineering.

Text Books:

1. Pressman R. S., "Software Engineering – A Practitioner's Approach", Tata McGraw Hill.
2. Jalote P., "An Integrated approach to Software Engineering", Narosa.

Reference Books:

1. Sommerville, "Software Engineering", Pearson Education.
2. Fairley R., "Software Engineering Concepts", Tata McGraw Hill.
3. James Peter, W Pedrycz, "Software Engineering", John Wiley & Sons.

OE-AI-403A	Android Application & Development						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	0	0	3	75	25	100	3 Hrs.
Purpose	This course aims to provide in-depth knowledge of mobile application development, with a focus on Android. It will help students learn how to develop and publish their own mobile apps.						
Course Outcomes(COs)							
CO 1	Understand mobile application fundamentals, models, and the role of mobile device profiles in development.						
CO 2	Design and implement interactive user interfaces using various Android UI components.						
CO 3	Implement and manage fragments to build modular, multi-screen Android applications.						
CO 4	Create custom graphics using Canvas, shadows, and gradients to enhance UI design.						

Unit –I

Introduction: Mobile Applications, Characteristics and Benefits, Application Models, Mobile devices Profiles. Basics of Android, Importance and scope, Android Versions, Features of Android, Android Architecture, Android Stack, Android Applications Structure, Android Emulator, Android SDK, Overview of Android Studio, Android and File Structure, Android Virtual Device Manager, DDMS, LogCat, Understanding Activities.

Android User Interface: Measurements –Device and pixel density independent measuring units. Layouts – Linear, Relative, Grid and Table Layouts.

Unit –II

User Interface (UI) Components –Editable and non-editable Text Views, Buttons, Radio and Toggle Buttons, Checkboxes, Spinners, Dialog and pickers, List View, Spinner View.

Event Handling –Handling clicks or changes of various UI components.

Intents and Broadcasts: Intent –Using intents to launch Activities, Explicitly starting new Activity, Implicit Intents, Passing data to Intents, Getting results from Activities, Native Actions, using Intent to dial a number or to send SMS

Services-Callbacks and Override in application, Application Signing, API keys for Google Maps, Publishing application to the Android Market.

Unit –III

Fragments –Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities, Multi-screen Activities

Location and Mapping: location based services, Mapping, Google Maps activity, Working with MapView and MapActivity; Playing and Recording of Audio and Video in application; Sensors and Near Field .Communication; Native libraries and headers, Building client server applications.

Unit –IV

Using Graphics: Canvas Drawing, Shadows, Gradients.

Persisting Data to files: Saving to Internal Storage, Saving to External Storage

Introduction to SQLite database: creating and opening a database, creating tables, inserting retrieving and deleting data, Registering Content Providers, Using content Providers (insert, delete, retrieve and update).

B. Tech in Artificial Intelligence and Machine Learning
Modified Scheme of Studies/Examination
Semester VIII
(w.e.f. session 2025-2026)

S.No	Course Code	Subject	L:T:P	Hours/ Weeks	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1	PE	Elective-V	3:0:0	3	3	75	25	0	100	3
2	OE-AI	Open Elective-III	2:0:0	2	2	75	25	0	100	3
3	OE-AI	Open Elective-IV	2:0:0	2	2	75	25	0	100	3
4	PROJ-PC-AI-402A	Project-III	0:0:12	12	6	0	40	60	100	3
5	PE-AI-LA	Elective-V Lab	0:0:4	4	2	0	40	60	100	3
		Total		**23**	**15**	**225**	**155**	**120**	**500**	

The course of both (PE-AI) & (OE-AI) will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

PE-Elective-V	
Internet of Things: PE-AI-402A	Internet of Things Lab: PE-AI-412LA
Data Handling & Visualization: PE-AI-404A	Data Handling & Visualization Lab: PE-AI-414LA
Software Reliability: PE-CS-A406A	Software Reliability Lab: PE-CS-A416LA
OE-AI Elective-III	**OE-AI Elective-IV**
Intellectual Property Rights: OE-AI-402A	Web and Internet Technology: OE-AI-408A
AI and Expert System: OE-AI-404A	Image Processing: OE-AI-410A
Cluster Computing: OE-AI-406A	Distributed Operating System: OE-AI-412A

PE-AI-402A	Internet of Things (IoT)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3 Hours**
Purpose	To learn the IoT (Internet of Things) is to understand how interconnected devices work, communicate, and impact various industries.						
Course Outcomes(COs)							
CO 1	Understand the basics of IoT.						
CO 2	Implement the state of the Architecture of an IoT.						
CO 3	Understand design methodology and hardware platforms involved in IoT.						
CO 4	Understand how to analyze and organize data, and compare IoT applications in industrial and real-world scenarios.						

Unit - I

Fundamentals of IoT- Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

Unit - II

IoT Protocols - IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA, Application Layer Protocols: CoAP and MQTT.

Unit - III

Design and Development- Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board details

Unit - IV

Data Analytics and Supporting Services- Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M, Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models,
Case Study and Application: IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments, Industry 4.0 concepts.

Text Books:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.
2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.

Reference Books:

1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012.

PE-AI-412 LA	Internet of Things (IoT) Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Practical**	**Total**	**Time**
0	**0**	**4**	**2**	**40**	**60**	**100**	**3 Hours**
Purpose	To make students aware about the Internet of Things architecture(IoT) and IoT sensor's application in IoT.						
	Course Outcomes(COs)						
CO 1	To understand basics of Internet of Things architecture.						
CO 2	To understand the role of cloud and fog in IoT.						
CO 3	To understand the role of sensors in IoT.						
CO 4	To understand Software Hardware Frameworks.						

List of Practicals

1. Introduction to IoT and Sensor Data Collection.
2. IoT and Cloud Integration using MQTT.
3. Connection of an Arduino board with ESP8266 Wifi module.
4. IoT based control of an LED using Arduino.
5. IoT and cloud based data logger using LM35 and Arduino.
6. IoT based home automation using Arduino.
7. IoT based street light control using Arduino.
8. IoT based DC motor speed control using Arduino.
9. Building Intrusion Detection System with Arduino and Ultrasonic Sensor.

PE-AI-404A	Data Handling & Visualization						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3 Hours**
Purpose	To Learn the **Data Handling and Visualization** is to efficiently manage, analyze, and present data for insightful decision-making and effective communication.						
Course Outcomes(COs)							
CO 1	To Learn to collect, clean, process, and analyze data using Python, web scraping, APIs, databases, and essential libraries like NumPy and Pandas.						
CO 2	To Understand analysis techniques to handle large datasets.						
CO 3	To Master data visualization techniques, Enabling effective representation and analysis of complex datasets.						
CO 4	To Expertise in diverse visual analysis techniques, including time-series, data visualization, spatial analysis.						

Unit - I

Introduction to Data Handling: Data collection, Data Preparation Basic Models-Web Scraping, Binary Data Formats, Interacting with Web APIs, Interacting with Databases, Data Cleaning and Preparation, Handling Missing Data, Data Transformation, String Manipulation.
Python: Introduction to Python, How to Install, Introduction to Jupyter Notebook, Python scripting basics, Numpy and Pandas.

Unit - II

Data Wrangling and Analysis: Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Analysis: The problems you face when handling large data, General techniques for handling large volumes of data, General programming tips for dealing with large data sets, Case study 1: Predicting malicious URLs, Case study 2: Building a recommender system inside a database.

Unit - III

Data Visualization Techniques: Overview of data visualization - Data Abstraction - Task Abstraction - Analysis: Four Levels for Validation Scalar and Point techniques – Color maps – Contouring – Height Plots - Vector visualization techniques – Vector properties – Vector Glyphs – Vector Color Coding – Matrix visualization techniques.
Data Visualization Tools in Python: Introduction to Matplotlib, Basic plots using matplotlib, Specialized Visualization Tools using Matplotlib, Advanced Visualization Tools using MatplotlibWaffle Charts, Word Clouds.

Unit - IV

Diverse Types of Visual Analysis: Time- Series data visualization – Text data visualization – Multivariate data visualization and Case studies.
Introduction to Seaborn: Seaborn functionalities and usage, Spatial Visualizations and Analysis in Python with Folium.

Text Books:

1. Core Python Programming - Second Edition, R. Nageswara Rao, Dreamtech Press.
2. McKinney, W.(2017). Python for Data Analysis: Data Wrangling with Pandas, NumPyand IPython. 2nd edition. O'Reilly Media.

Reference Books:

1. Sharath Chandra Guntuku, Abha Belorkar, Anshu Kumar, Shubhangi Hora, “Interactive DataVisualization with Python” - [S.l.]: Packt Publishing, Second Edition. (2020).
2. Mario Döbler, “Data Visualization with Python” Packt Publishing, (2019).

PE-AI-414 LA	Data Handling & Visualization Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Practical**	**Total**	**Time**
0	**0**	**4**	**2**	**40**	**60**	**100**	**3 Hours**
Purpose	To make students aware about data analysis techniques, analysis tools and to get familiar with data handling and visualization.						
	Course Outcomes(COs)						
CO 1	To Learn the **Data Handling and Visualization** is to efficiently manage, analyze, and present data for insightful decision-making and effective communication.						
CO 2	To Understand analysis techniques to handle large datasets.						
CO 3	To Master data visualization techniques, Enabling effective representation and analysis of complex datasets.						
CO 4	To Expertise in diverse visual analysis techniques, including time-series, data visualization, spatial analysis.						

List of Practicals

1. Web Scraping and API Interaction.
2. Data Cleaning and Transformation using Pandas.
3. Data Wrangling – Merging, Reshaping, and Pivoting.
4. Handling Large Datasets and Optimization.
5. Case Study – Predicting Malicious URLs.
6. Case Study – Building a Recommender System.
7. Basic Data Visualization Using Matplotlib.
8. Scalar and Point Visualization Techniques.
9. Vector and Matrix Visualization Techniques.
10. Specialized and Advanced Visualization in Matplotlib.
11. Time-Series Data Visualization.
12. Text Data Visualization.
13. Multivariate Data Visualization.
14. Spatial Visualization with Folium.
15. Case Study – Real-World Data Visualization.

PE-CS-A406A	Software Reliability						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3 Hours**
Purpose	Understanding and applying fault handling, failure forecasting, and reliability models to build dependable software systems.						
Course Outcomes(COs)							
CO 1	Understand reliable software systems.						
CO 2	Apply the fault handling and failure forecasting techniques in software systems.						
CO 3	Apply different time dependent and time independent software reliability models.						
CO 4	Examine reliability models for software systems.						

Unit - I

Introduction: The need for Reliable Software, Software Reliability Engineering concepts, Basic Definitions, Technical terms: Fault Prevention, Fault Removal, Fault Tolerance, Fault/Failure Forecasting, The Software Reliability Engineering Process, Software Reliability and Hardware Reliability.

Unit - II

Software Reliability and System Reliability: Dependability Concept, Failure behaviour of X-ware System, Failure behaviour of X-ware System with Service Restoration.
Developing Operational Profiles: Concepts, Development Procedure, Test Selection.

Unit - III

Software Reliability Modeling Survey: Introduction, Historical Perspective and Implementation, Exponential Failure Time Class of Models: Non Homogeneous Poisson Process, Musa's Basic execution time model, Weibull and Gamma Failure Time Class of Models: Weibull model, Infinite Failure Category Models: Duane's Model, Model Relationships, Software Reliability Prediction in Early Phases of the Life Cycle.

Unit - IV

Software Metrics for Reliability Assessment: Introduction, Static Program Complexity, Dynamic Program Complexity, Software Complexity and Software Quality, Software Reliability Modeling.
Software Testing and Reliability: Introduction,, Overview of Software Testing, Operational Profiles, Time/Structure-Based Software Reliability Estimation.

Text Books:

1. J.D. Musa, Software Reliability Engineering, McGraw Hill, New York , 2004
2. H. Pham, Software Reliability, Springer Verlag, New York , 2000

Reference Books:

1. Patric D. T.O Connor, Practical Reliability Engineering, 4th Edition, John Wesley & Sons, 2003
2. D. Reled, Software Reliability Methods, Springer Verlag, New York , 2001

PE-CS-A416 LA	Software Reliability Lab						
Lecture	**Tutorial**	**Practical**	**Credit**	**Minor Test**	**Practical**	**Total**	**Time**
0	**0**	**4**	**2**	**40**	**60**	**100**	**3 Hours**
Purpose	In this course the student will understand the working of software reliability models and reliability prediction models, and able to design reliability models.						
	Course Outcomes(COs)						
CO 1	To study the computation method for evaluation of software Reliability.						
CO 2	Understand the mechanisms for Evaluation Testing methods in Software Reliability.						
CO 3	Understand the working of Software Reliability Models.						
CO 4	To Study and understand procedure of software Reliability Prediction.						

List of Practicals

1. To study the Computation of software reliability.
2. To implement software Reliability Evaluation Testing methods.
3. To understand the working of Functional and Operational Profiles.
4. To understand the concept of Time Dependent Software Reliability Models.
5. To understand the concept of Time Independent Software Reliability Models..
6. To study Software Reliability Modeling.
7. To identify the role of various phases included in software Reliability Prediction.
8. To study software Reliability Analyzing Predictive.
9. To study software Reliability Recalibration.

OE-AI-402A	Intellectual Property Rights						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	Students will able to acquire knowledge of regulatory bodies ,acts and organization indulge in creating a balancing force between advent in technology with monitoring their impacts on human and ecology along with bio safety measures with ethical conduct to society.						
Course Outcomes (COs)							
CO 1	Students will be able to describe the basic terms and procedure for IPR, patent filing and implications on society of commercialized products.						
CO 2	Students will be able to learn and describe various act, policies, different organizations and guidelines for biosafety.						
CO 3	Students will develop knowledge of outbreak and risk assessment and management at laboratory level along with health impacts.						
CO 4	Students will develop awareness of ecological impact of release of genetically modified organisms and monitoring methods.						

Unit - I

Introduction: Intellectual Property Rights, Copyrights, Trademarks, Trade secrets, Geographical indications, Patents, Patent Filing, Indian Patent act and amendments, Implications of intellectual property rights on the commercialization of Biotechnology products, Patented products in Market and Success story.

Unit - II

Policies, Agreements and Organization: National bio safety policies and law, The Cartagena protocol on bio safety, Convention on biological diversity, Cross border movement of germ plasm and agreements, World Trade Organization and agreements, Updated Regulatory frameworks.

Unit - III

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications, New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Computer Software.

Unit - IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Reference Books:

1. Niebel , Product Design, McGraw Hill.
2. Asimov, Introduction to Design, Prentice Hall.
3. Mayall, “Industrial Design” , McGraw Hill, 1992.

OE-AI-404A	AI And Expert Systems						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	In this course the student will learn the methodologies used to transfer the knowledge of a human expert into an Artificial intelligent program that can be used to solve real-time problems.						
Course Outcomes(COs)							
CO 1	Examining the fundamentals and terminologies of AI and expert system.						
CO 2	To facilitate students to implement various knowledge representation techniques for acquisition and validate various structures in experts system domain.						
CO 3	Signifying AI techniques to solve social, industrial and environmental problems.						
CO 4	Application of professional aspects in multi-disciplinary approach to meet global standards towards design, realizing and manufacturing.						

Unit - I

Introduction: Background and history, Overview of AI applications areas, the predicate calculus: Syntax and semantic for propositional logic and FOPL, Clausal form, inference rules, resolution and unification, knowledge representation: Network representation- Associative network & conceptual graphs, Structured representation- Frames & Scripts.

Unit - II

Search strategies: Strategies for state space search-data driven and goal driven search; Search algorithms- uninformed search (depth first, breadth first, depth first with iterative deepening) and informed search (Hill climbing, best first, A* algorithm, mini-max etc.), computational complexity, Properties of search algorithms - Admissibility, Monotonicity, Optimality, Dominance.

Unit - III

Introduction to Expert Systems: Architecture of expert system, Representation and organization of knowledge, Basics characteristics, and types of problems handled by expert systems, expert System Tools: Techniques of knowledge representations in expert systems,knowledge engineering, System-building aids, support facilities, stages in the development of expert systems.

Unit - IV

Building an Expert System: Expert system development, Selection of tool, Acquiring Knowledge, Building process, problems with expert Systems, Difficulties, common pitfalls in planning, dealing with domain, expert, difficulties during development.

Suggested Books:

1) Luger, G. F. (2009). Artificial Intelligence: Structures and Strategies for Complex Problem Solving (6th ed.). Pearson Education.
2) Russell, S., & Norvig, P. (2010). Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall.
3) Waterman D.A., “A Guide to Expert Systems”, Addison Wesley Longman, 1985.

OE-AI-406A	Cluster Computing						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	To introduce students to the concepts, principles, technologies, and applications associated with distributed and parallel computing systems that are built using clusters of computers.						
Course Outcomes(COs)							
CO 1	To Understand Cluster Computing Concepts.						
CO 2	To Understand Cluster Design and Configuration.						
CO 3	To Understand the concepts of Parallel computing in Cluster Systems.						
CO 4	To Understand the Tools and security in Cluster computing.						

Unit - I

Introduction to Cluster Computing: Overview of Cluster Computing, Definition, history, and significance of cluster computing.

Types of Clusters: High-Performance Computing (HPC) clusters, Beowulf clusters, Grid computing vs Cluster computing. Basic Components of a Cluster: Nodes, interconnects, storage systems, topology.

Cluster Management Tools: Open MPI, MPICH, SLURM, Hadoop for managing clusters.

Unit - II

Cluster Design and Configuration: Cluster Architecture,Single-node vs. multi-node architecture, hardware requirements, and network.

Cluster System Architecture: Design considerations for clustering, CPU, memory, and storage considerations.

Cluster Communication: Message passing interface (MPI), remote direct memory access (RDMA), and other communication protocols.

Operating System and Network Requirements: Linux-based systems, network setup, NFS, and cluster file systems.

Unit - III

Parallel Computing in Cluster Systems, **Parallel Programming Models**: Shared memory, distributed memory, and hybrid approaches.

Programming Paradigms: Message passing, threads, and parallel computing using MPI, PVM (Parallel Virtual Machine).

Parallel Algorithms: Techniques for parallelizing problems, synchronization, and load balancing.

Performance Analysis: Benchmarks, scalability, and profiling of parallel systems.

Unit - IV

Cluster Computing Software Tools and Security, **Cluster Management and Scheduling**: Resource management systems, job scheduling in clusters, grid scheduling.
Distributed File Systems: NFS, GPFS, Lustre, and HDFS (Hadoop Distributed File System).
Cluster Computing Frameworks: Hadoop, Spark, MPI, and Condor.
Monitoring and Fault Tolerance: Tools for monitoring cluster health, fault detection, and recovery strategies.
Security Risks: Network attacks, data breaches, and unauthorized access in cluster environments
Data Privacy and Encryption: Ensuring data protection across a distributed system.

Recommended References:

1."Parallel Programming with MPI" by Peter S. Pacheco.
2."Hadoop: The Definitive Guide" by Tom White.
3."Designing and Building Parallel Programs" by Ian Foster.
4."Cluster Computing: Distributed and Parallel Computing" by Raghunath Nambiar and R. K. Gupta.

OE-AI-408A	Web and Internet Technology						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	To learn the architecture and programming of Internet and study of scripting language: Python						
Course Outcomes(COs)							
CO 1	To Learn the basic concepts of internet and its connectivity.						
CO 2	To Learn about the services of internet, designing and its architecture.						
CO 3	To Learn the basic concepts of Python and its applications in information industry.						
CO 4	To Acquaint the knowledge of latest programming language for the implementation of object based and procedure based applications using Python.						

Unit – I

Introduction to Internet: Internet, Growth of Internet, Owners of the Internet, Anatomy of Internet, ARPANET and Internet history of World Wide Web, basic Internet Terminology, Internet Applications Commerce on the Internet, Governance on the Internet, Impact of Internet on Society- Crime on / through the Internet, role of Information Architect, Collaboration and communication, Organizing information, Organizing web sites and intranets, Creating cohesive organization systems, designing navigation systems, types of navigation systems, Integrated navigation elements, Searching systems, Searching your web site, designing the search interface.

Unit – II

Internet Services and Web Publishing: Setting up a connection, Hardware requirement, Selection of a Modem, Software Requirement, Modem Configuration, Common terminologies: Node, Host, Workstation, bandwidth, Interoperability, Network administrator, network security, Network Components: Severs, Clients, Communication Media, Service options – E-mail, News Firewall, etc**.**

Introduction to XHTML and HTML5: Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms in HTML, Syntactic Differences between HTML5 and XHTML, Cascading Style Sheets: Introduction, Levels of Style Sheets, Style Specification Formats, Selector Forms, Property Value Forms, Font Properties, List Properties, Color, Alignment of Text, Box Model, Background Images.

Unit – III

Introduction of Scripting Language: Introduction to Python, Applications of Python in information industry, Introduction to Python, Data Types, Branching Programs, Control Structures, Array and Input, Iteration. Functions and Scoping: Functions and scoping, Recursion and Global variables. Creation, insertion and deletion of items: Strings, Tuples, Lists and Dictionaries.

Unit – IV

Advanced Python: Classes and Object-Oriented Programming, Abstract Data Types and Classes, Inheritance, Encapsulation and Information Hiding. File Handling, Exceptions Handling, Data base (My SQL db) operation: file check, table creation, insertion and deletion of data, Regular Expressions – REs in Python and Plotting.

Suggested Books:

1. "Information Architecture on the World Wide Web", By Peter Morville, Louis Rosenfeld, O'Reilly Media, 2006.
2. "Programming The World Wide Web", By Robert W.Sebesta,8th Edition, Pearson India, 2015.
3. Thomas A Powell, "HTML The Complete Reference", Tata McGrow Hill Publications.

OE-AI-410A	Image Processing						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	Provide an introduction to the basic concepts and methodologies for Digital Image Processing. To develop a foundation that can be used as a basis for further studies and research. Introduce the fundamental techniques and algorithms used for acquiring, processing and extracting useful information from images.						
Course Outcomes(COs)							
CO 1	Get acquainted with digital image fundamentals and its applications and get acquainted with the image representation and description methods.						
CO 2	Learn and perform image pre-processing and enhancement to improve the image for further processing.						
CO 3	Reconstruct photometric properties degraded by the imaging process and partition a digital image into multiple segments.						
CO 4	Represent and analyze images at different resolutions , process images according to their shapes, and apply compression techniques to reduce the storage space of images.						

Unit – I

Digital Image Fundamentals: Introduction to Digital Image Processing and its applications, Components of an Image Processing System.

Image Representation and Description: Image Representation, Digital Image Properties, Boundary descriptors, Regional descriptors, Phases in Digital Image Processing, Elements of Visual perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationship between Pixels, Color Representation.

Data Structures for Image Analysis: Levels of Image Data Representation, Traditional Image Data Structures: Matrices, Chains, Topological Data Structures, Relational Structures; Hierarchical Data Structures: Pyramids, Quad trees, Other Pyramidal Structures.

Unit – II

Image Pre-Processing: Pixel Brightness Transformations, Position-Dependent Brightness Correction, Gray- Scale Transformation, Geometric Transformations: Pixel Co-ordinate Transformations, Brightness Interpolation, Local Pre-Processing.

Image Enhancement: Spatial Domain, Gray level transformations, Histogram processing; enhancement using arithmetic and logic operators, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filtering.

Frequency Domain: Introduction to Fourier Transform, Filtering in the Frequency Domain, Smoothing and Sharpening frequency domain filters, Homomorphic Filtering.

Unit – III

Image Restoration and Segmentation: Noise models, Mean Filters, Order Statistics; Adaptive filters; Noise Reduction by Frequency Domain Filtering; Inverse and Wiener filtering; Constrained Least Squares Filtering.

Segmentation: Point, line, and Edge Detection, Edge Linking and Boundary detection; Thresholding; Region based segmentation, Edge based Segmentation, Segmentation by Morphological Watersheds, Matching.

Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing.

Unit – IV

Wavelets And Multi resolution Processing: Background Image Pyramids, Subband coding, Multi resolution expansions.

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms.

Compression – Fundamentals, Image Compression models, Error-Free Compression, Variable Length Coding, LZW coding, Bit-Plane Coding, Lossless Predictive Coding, Lossy Compression, Lossy Predictive Coding, Transform Coding, wavelet Coding; Image Compression Standards.

Text Books:

1. Rafael C. Gonzales, Richard E. Woods, Digital Image Processing, Pearson Education.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing Using MATLAB, Tata Mc Graw Hill.
2. Anil Jain K., Fundamentals of Digital Image Processing, PHI.
3. Willliam K Pratt, Digital Image Processing, John Willey.
4. Malay K. Pakhira, Digital Image Processing and Pattern Recognition, PHI.
5. S. Jayaraman, S. Esakkirajan and T. Veera kumar, Digital Image Processing, McGraw Hill.
6. B. Chanda , D.Dutta Majumder, Digital Image Processing and Analysis, PHI.
7. Vipula Singh, Digital Image Processing with MATL.

OE-AI-412A	Distributed Operating System						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**75**	**25**	**100**	**3 Hours**
Purpose	The purpose for a **Distributed Operating Systems (DOS)** subject, specifically from the **student's perspective,** are designed to equip them with the skills, knowledge, and tools needed to understand, design, and manage distributed systems.						
Course Outcomes(COs)							
CO 1	To Understand the concept of Distributed operating system.						
CO 2	To Understand communication in distributed system.						
CO 3	To Understand the concept the process management in distributed system.						
CO 4	To understand distributed synchronization and concurrency control.						

Unit - I

Introduction to Distributed Operating Systems: Overview of Distributed Systems: Definition, Characteristics, Types of distributed operating system**,** Advantages and challenges of distributed systems, Applications of distributed operating systems**,** Synchronous vs. asynchronous systems**,** Basic principles of distributed computing and operating systems.

Unit - II

Communication in Distributed Systems: Inter-process Communication :Communication models: client-server communication, peer-to-peer communication.**,** Remote Procedure Call (RPC): Design and implementation of RPC. Stub generation, binding, and communication mechanisms, Distributed Shared Memory: Concepts of global memory space in distributed systems. Techniques for managing shared memory in distributed environments.

Unit - III

Process Management in Distributed Systems: Process Coordination: Process scheduling and load balancing in a distributed environment, Distributed scheduling algorithms.**,**Distributed Mutual Exclusion: Algorithms for achieving mutual exclusion (e.g., Lamport's algorithm, Ricart–Agrawala algorithm).

Deadlock Detection and Recovery: Distributed deadlock detection algorithms,Prevention, avoidance, and recovery strategies in distributed systems, Fault Tolerance in Process Management: Techniques for handling failures and ensuring fault tolerance in process coordination.

Unit - IV

Distributed Synchronization and Concurrency Control, Clock Synchronization: Clock synchronization algorithms: Network Time Protocol (NTP), Berkeley algorithm, Lamport clocks, Vector clocks, Distributed database and transaction management, Concurrency control

algorithms for distributed databases (e.g, Two-phase locking, Timestamp-based protocols),Atomicity and Consistency: Understanding the concept of atomic transactions in distributed systems, Ensuring consistency and durability (e.g., ACID properties in distributed transactions).

Reference Books:

1. "Distributed Systems: Concepts and Design"by George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair.

2. "Distributed Operating Systems" by A. S. Tanenbaum and Maarten van Steen

3**. "Distributed Computing: Principles, Algorithms, and Systems"** by Ajay D. Kshemkalyani and Mukesh Singhal.