SYLLABUS

(With effect from 2022 -23)

Bachelor Degree

In

Computer Science & Engineering

(Artificial Intelligence & Machine Learning)

VII & VIII Semester

Out Come Based Education

With

Choice Based Credit System

[National Education Policy Scheme]

P.E.S. College of Engineering, Mandya - 571 401, Karnataka

[An Autonomous Institution affiliated to VTU, Belagavi,

Grant – in – Aid Institution (Government of Karnataka),

Accredited by NBA (All UG Programs), NAAC and Approved by AICTE, New Delhi]

Ph : 08232- 220043, Fax : 08232 – 222075,Web : www.pescemandya.org

VISION

"To develop skilled professionals in the field of Artificial Intelligence & Machine Learning contributing globally to the benefit of industry and society."

MISSION

- *To impart knowledge in cutting edge Artificial Intelligence technologies that meets industry standards.*
- *Tocollaborate with industry to uplift innovative research and development in Artificial Intelligence & Machine Learning and related domains to meet societal demands.*
- *To produce successful Computer Science and Engineering graduates with a specialization in Artificial Intelligence & Machine Learning with personal and professional responsibilities, and a commitment to lifelong learning.*

QUALITY POLICY

Highly committed in providing quality, concurrent technical education and continuously striving to meet expectations of stake holders.

CORE VALUES

***P**rofessionalism*
***E**mpathy*
***S**ynergy*
***C**ommitment*
***E**thics*

Department of Computer Science and Engineering (AI & ML)

The Vision of the department is:

"To develop skilled professionals in the field of Artificial Intelligence & Machine Learning contributing globally to the benefit of industry and society".

The mission of the department is:

DM1: To impart knowledge in cutting edge Artificial Intelligence technologies that meets industry standards.

{Required to create professionally competent engineers}

DM2: To collaborate with industry to uplift innovative research and development in Artificial Intelligence & Machine Learning and related domains to meet societal demands.
{Required to create professionally competent engineers and socially responsible engineers}

DM3: To produce successful Computer Science and Engineering graduates with a specialization in Artificial Intelligence & Machine Learning with personal and professional responsibilities and a commitment to lifelong learning.
{Required to create professionally competent engineers}

Program Educational Objectives (PEOs)

PEO1: Graduates will have the ability to adapt, contribute and innovate new technologies and systems in the key domains of Artificial Intelligence and Machine Learning.

PEO2: Graduates will be able to pursue higher education in reputed institutions with AI Specialization.

PEO3: Graduates will have the ability to explore research areas and produce outstanding contribution in various areas of Artificial Intelligence and Machine Learning.

PEO4: Graduates will be ethically and socially responsible solution providers and entrepreneurs in the field of Computer Science and Engineering with AI/ML Specialization.

The National Board of Accreditation (NBA) has defined twelve Program Outcomes for Under Graduate (UG) engineering programs as listed below.

Program Outcomes (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problem.
2. **Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess Societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The Under Graduate (UG) of B.E Computer Science & Engineering Program has defined **Program Specific Outcomes (PSO**) which are listed below.

PSO1: Apply the knowledge of programming and designing algorithms to develop solutions for engineering problems pertaining to AI&ML

PSO2: Analyse and develop models in Machine Learning, Deep Learning using knowledge of AI and modern tools.

Bachelor of Engineering – Computer Science & Engineering [Artificial Intelligence & Machine Learning] VII Semester										
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs/Week**			**Credits**	**Examination Marks**		
				L	**T**	**P**		**CIE**	**SEE**	**Total**
1	P22AI701	Generative AI	AIML / CS	3	-	-	3	50	50	100
2	P22AI702X	Professional Elective Course–IV	AIML / CS	3	-	-	3	50	50	100
3	P22AI703X	Professional Elective Course -V	AIML / CS	3	-	-	3	50	50	100
4	P22AI704	Deep Learning and Reinforcement Learning	AIML / CS	3	-	2	4	50	50	100
5	P22CS705	Research Methodology and IPR	Any Dept.	3	-	-	3	50	50	100
6	P22CS706	Project Work Phase–I	AIML / CS	-	-	-	4	100	-	100
Total							**20**	**350**	**250**	**600**

Professional Elective Course–IV (P22AI702X)	
Course Code	**Course Title**
P22AI7021	Cognitive Science & Analytics
P22AI7022	Social Network Analysis
P22AI7023	Explainable and Responsible AI
P22AI7024	Time Series Analysis

Professional Elective Course–V (P22AI703X)	
Course Code	**Course Title**
P22AI7031	Data Security and Privacy
P22AI7032	Embedded System and IOT
P22AI7033	Agentic AI Systems
P22AI7034	Federated Learning

Bachelor of Engineering – Computer Science & Engineering [Artificial Intelligence & Machine Learning] VIII Semester										
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs / Week**			**Credits**	**Examination Marks**		
				L	**T**	**P**		**CIE**	**SEE**	**Total**
1	P22CS801	Self-Study Course	-	-	-	-	2	100	-	100
2	P22INT802	Research/Industry Internship– III	-	-	-	-	6		100	100
3	P22CS803	Project Work Phase–II	AIML / CS	-	-	-	8	100	100	200
Total							**16**	**200**	**200**	**400**

GENERATIVE AI

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI701**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Explain the core principles and concepts of generative artificial intelligence.
- Explore various types of generative modelling techniques.
- Develop skills in implementing and training generative models.
- Encourage critical thinking about the ethical implications of generative AI.

UNIT – I	**8 Hours**

Introduction to Generative AI: Using Generative AI, The ChatGPT effect, The Drivers, Skeptics, Dangers of Hype.

Data The Fuel for Generative AI: Value of Data, The Amazing Growth of Data, Big Data, Databases, Cloud Models, Data Collection, Data Evaluation, Data Wrangling, Data Labeling, Quantity, Privacy Laws and Regulations, Generative AI for Data Wrangling.

Textbook - 1: Ch. 1, 2

Self-study component:	Generative AI for Data Preparation
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

AI Fundamentals - Understanding the Core Foundations of Generative AI: How Deep Learning Works, Types of Deep Learning, The Brain and AI, Drawbacks with Deep Learning, Overfitting and Underfitting, AI Tools, AI Systems for Beginners.

Core Generative AI Technology: Generative vs. Discriminative Models, Probability Theory, Types of Generative AI Models.

Textbook - 1: Ch. 3,4

Self-study component:	DALL-E 2
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	**8 Hours**

Large Language Models: How Generative AI Understands Language, Language and Intelligence, Natural Language Processing (NLP), Word2Vec Model, Transformers, BERT (Bidirectional Encoder Representations from Transformers), GPT Systems and ChatGPT, Dolly, Issues, New Startup Model, Prompt Engineering.

Textbook - 1: Ch. 5,6

Self-study component:	Empathy

Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – IV	**8 Hours**

Variational Autoencoders: Autoencoders, Joining the Encoder to the Decoder, Analysis of the Autoencoder, Building a Variational Autoencoder, The Loss Function, Analysis of the Variational Autoencoder, Using VAEs to Generate Faces, Morphing Between Faces.

Generative Adversarial Networks: Ganimals¸ Introduction to GANs, Training the GAN¸ GAN Challenges, Uninformative Loss, Hyperparameters, Wasserstein GAN, Training the WGAN.

Textbook – 2 Ch. 3, 4

Self-study component:	Analysis of the WGAN
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – V	**8 Hours**

Long Short-Term Memory Networks: Your First LSTM Network, The LSTM Architecture, The LSTM Layer, The LSTM Cell, Generating New Text, RNN Extensions, Gated Recurrent Units, Bidirectional Cells, A Question and Answer Generator, Model Architecture.

The Future of Generative Modeling: Five Years of Progress, The Transformer, Advances in Image Generation, Big GAN, StyleGAN.

Textbook – 2 Ch. 5,9

Self-study component:	Applications of Generative Modeling
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:

CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Explain** the core concepts, principles, and applications of Generative AI.	Explain	L2
CO2	**Apply** and design the basic generative models.	Apply	L3
CO3	**Analyze** and Compare different generative modelling techniques.	Analyze	L4
CO4	**Identify** the ethical implications of Generative AI.	Identify	L4

Textbook:

- Generative AI: How ChatGPT and Other AI Tools Will Revolutionize Business, Tom Taulli, 2023
- Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, David Foster, Published by O'Reilly Media,2019.

Reference Book(s):

- Application Generation AI for Beginners: Practical Knowledge on diffusion models, ChatGPT, and other LLMs by Akshay Kulkarni, Adarsh Shivanada.
- Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- Generative Adversarial Networks: An introductory guide by Luke Metz. Autoencoders: Neural Networks for Unsupervised Learning by Ian Goodfellow

COGNITIVE SCIENCE AND ANALYTICS

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7021**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- To understand the interdisciplinary nature and historical evolution of cognitive science.
- To explore various theoretical models of cognition science.
- To apply computational models and representations to simulate cognitive processes.

UNIT – I	**8 Hours**

Introduction: The Challenge of Cognitive Science: Cognitive Science: An Interdisciplinary Endeavor, Levels of Explanation: The Contrast between Psychology and Neuroscience, The Challenge of Cognitive Science. **The Prehistory of Cognitive Science:** The Reaction against Behaviorism in Psychology, The Theory of Computation and the Idea of an Algorithm, Linguistics and the Formal Analysis of Language.

Textbook - 1: Chapter-1

Self-study component:	Information-Processing Models in Psychology
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

The Discipline Matures: Three Milestones: Language and Micro-worlds, How Do Mental Images Represent? An Interdisciplinary Model of Vision. The Turn to the Brain-1: Cognitive Systems as Functional Systems? The Anatomy of the Brain and the Primary Visual Pathway.

Textbook - 1: Chapter-2, Chapter-3

Self-study component:	Extending Computational Modeling to the Brain
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	**8 Hours**

The Turn to the Brain-2: Mapping the Stages of Lexical Processing, Studying Memory for Visual Events, The Neural Correlates of the BOLD Signal.

Physical Symbol Systems and the Language of Thought: The Physical Symbol System Hypothesis, From Physical Symbol Systems to the Language of Thought.

Textbook - 1: PART I: Chapter 3 PART II: Chapter 4

Self-study component:	The Russian Room Argument and the Turing Test
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – IV	8 Hours
Neural Networks and Distributed Information Processing: Neurally Inspired Models of Information Processing, Single-Layer Networks and Boolean Functions, Multilayer Networks, Information Processing in Neural Networks: Key Features. **Applying Dynamical Systems Theory to Model the Mind:** Cognitive Science and Dynamical Systems, Applying Dynamical Systems: Two Examples from Child Development, **Textbook – 2** Chapter 5, Chapter 6	
Self-study component:	Assessing the Dynamical Systems Approach
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – V	8 Hours
Bayesianism in Cognitive Science: Bayesianism: A Primer, Perception as a Bayesian Problem, Neuroeconomics: Bayes in the Brain. **Modules and Architectures:** Architectures for Artificial Agents, Fodor on the Modularity of Mind, The Massive Modularity Hypothesis, Hybrid Architectures: The Example of ACT-R. **Strategies for Brain Mapping:** Structure and Function in the Brain, Studying Cognitive Functioning: Techniques from Neuroscience. **Textbook – 2** Chapter 7, Chapter 8	
Self-study component:	Structure and Function in the Brain
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:

CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Understand** the foundational concepts, interdisciplinary nature, and theoretical frameworks of cognitive science.	Understand	L2
CO2	**Apply** cognitive models, neural network concepts, and computational theories to represent and simulate cognitive processes	Apply	L3
CO3	**Analyze** brain-based approaches and cognitive architectures to evaluate mental representations and cognitive functionality.	Analyze	L4

Textbook:

- Cognitive Science: An Introduction to the Science of the Mind, Jose Luis Bermudez 2020 & 3rd Edition, Cambridge University Press, New York.

Reference Book(s):

- Emerging Trends and Applications in Cognitive Computing, Pradeep Kumar Mallick, Samarjeet Borah, 2019 & 1st Edition, IGI Global Publishers.
- Cognitive computing and Big Data Analytics, Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, 2015 & 1st Edition, Wiley.
- Cognitive Computing: Theory and Applications, Vijay Raghvan, Venu Govindaraju, C.R. Rao, 2016 Edition & 1st, Elsevier publications, North Holland.

Web links and Video Lectures (e-resources):

- https://youtu.be/LlSdZLsiAzo.
- https://youtu.be/Pwm6DqdC4pU.
- https://youtu.be/NsID1iM8gRw.
- https://www.coursera.org/learn/philosophy-cognitive-sciences
- https://www.coursera.org/learn/neurobiology.

SOCIAL NETWORK ANALYSIS

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7022**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- To understand the concept of Social Network Analysis.
- To define Network centrality components like density, reachability, connectivity, and reciprocity
- To understand similarity and structural equivalence in SNA
- To understand two modes of networks in SNA
- To learn the visualization of social networks.

UNIT – I	**8 Hours**

Introduction to the Semantic Web and Social Networks: The Semantic Web, Limitations of the current Web, The semantic solution, Development of the Semantic Web and the emergence of the social web.

Self-study component:	Case study on this topic covered in the syllabus: work on face book
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

Social Network Analysis: What is network analysis, Development of Social Network Analysis Key concepts and measures in network analysis, The global structure of networks, The macro-structure of social networks, Personal networks.

Self-study component:	Google PageRank algorithm
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	**8 Hours**

Centrality and power : Centrality and centralization in SNA

Introduction: The several faces of power , Degree centrality, Degree: Freeman's approach, Closeness centrality, Closeness: Path distances, Closeness: Reach Closeness: Eigenvector of geodesic distances , Betweenness Centrality , Betweenness: Freeman's approach to binary relations.

Self-study component:	**Degree:** Bonacich's approach , Closeness: Hubbell, Katz, Taylor, Stephenson and Zelen influence **Discussion:** Case study on this topic covered in the syllabus: work on Twiiter
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – IV			8 Hours
Two-mode networks for SNA Understanding mode networks- Bi-partite data structures, visualizing two-mode data, quantitative analysis using two-mode Singular value decomposition (SVD) analysis two-mode factor analysis, two-mode correspondence analysis.			
Self-study component:	Case study on this topic covered in the syllabus: work on Linkdin		
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions		
UNIT – V			**8 Hours**
VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS Visualization, Visualizing Online Social Networks, Node-Link Diagrams , Adjacency Matrix Representations and applications of Social Network Analysis.			
Self-study component:	Online Advertising in Social Networks: Applications of Social Network Advertising.		
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions		
Course Outcomes: On completion of this course, students are able to:			
CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Design** and develop semantic web related applications	Apply	L3
CO2	**Understand** the fundamental concepts of social network analysis	Understand	L2
CO3	**Analyze** the centrality and centralization in SNA	Analyze	L4
CO4	**Ability** to represent two-mode networks in SNA	Apply	L3
CO5	**Learn** the Visualization of social networks	Remember	L1

Textbook:

- Social Networks and the Semantic Web, ISBN-13: 978-0-387-71000-6 e-ISBN-13: 978-0-387-71001-3, Peter Mika Peter Mika Yahoo! Research Barcelona Barcelona, Spain, Springer publication (Unit 1 and Unit 2).
- Introduction to Social Network Methods, Robert A. Hanneman, Mark Riddle, Mark Riddle,University of California, 2005, [Published in digital form and available athttp://faculty.ucr.edu/~hanneman/nettext/index.html](Unit 3 and Unit 4).
- Social Network Analysis for Startups, Finding connections on the social web ISBN 978-1-4419-7141-8 e-ISBN 978-1-4419-7142-5 (Unit 5), 2011, Maksim Tsvetovat, Alexander Kouznetsov.

Reference Book(s):

- Computational Social, Perspectives and Applications AjithAbraham and Aboul-Ella Hassanien.
- Dion Goh and Schubert Foo, Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.
- Statistical Analysis ofNetwork Data with R: Eric D, Kolaczyk, Gábor Csárdi, Springer, 2014.
- Social Network Analysis, Methods and applications Stanley wasserman university of illinolskatherine faust university of south carolina cambridgeuniversity press.

Web links and Video Lectures (e-resources):

- http://faculty.ucr.edu/~hanneman/nettext/index.html
- https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- https://nptel.ac.in/courses/106106239
- https://www.coursera.org/learn/social-network-analysis
- https://visiblenetworklabs.com/guides/social-network-analysis-101/

EXPLAINABLE AND RESPONSIBLE AI

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7023**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Explain the basics of Explainable AI, Ethical issues and Usage of Explainability
- Describe the consumers of explainable AI
- Develop the Explainability for tabular data image data and Text data.
- Understand the Bias and Fairness in data and model

UNIT – I	**8 Hours**

Basics of Explainable and Responsible AI

Introduction

Why Explainable AI ,What Is Explainable AI , Who Needs Explain ability, Challenges in Explain ability, Evaluating Explain ability, How Has Explain ability Been Used, How LinkedIn Uses Explainable AI , PwC Uses Explainable AI for Auto Insurance Claims, Accenture Labs Explains Loan Decisions, DARPA Uses Explainable AI to Build "Third-Wave AI".

Brief Overview of AI and Its Potential ,Foundations of AI: From Concept to Reality AI in Action: A Multifaceted Landscape ,The Promise of AI: Unlocking Boundless Potential Frontier, Importance of Responsible AI ,Ethics in the Age of AI: The Call for Responsibility, Mitigating Bias and Discrimination: Pioneering Fairness and Equity, Privacy in the Age of Surveillance: Balancing Innovation and Security, Human-Centric Design: Fostering Collaboration Between Man and Machine Ethics in AI Governance: Navigating a Complex Landscape Conclusion: The Ongoing Dialogue of Responsibility , Core Ethical Principles -Bias and Fairness: Cornerstones of Responsible AI Transparency and Explain ability, Privacy and Security, Robustness and Reliability .

Textbook 1,2: Ch. 1

Self-study component:	Comparative analysis on Ethics and Explainability
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

Explain ability explained

An Overview of Explain ability

What Are Explanations ,Interpretability and Explain ability ,Explain ability Consumers ,Practitioners—Data Scientists and ML Engineers ,Observers—Business Stakeholders and Regulators ,End Users—Domain Experts and Affected Users ,Types of Explanations ,Premodeling Explainability ,Intrinsic Versus Post Hoc Explainability ,Local, Cohort, and Global Explanations,Attributions, Counterfactual, and Example-Based Explanations ,Themes Throughout Explainability ,Feature Attributions ,Surrogate Models Activation.

Explainability for Tabular Data: Permutation Feature Importance ,Permutation Feature Importance from Scratch ,Permutation Feature Importance in scikit-learn ,Shapley Values SHAP (SHapley Additive exPlanations) ,Visualizing Local Feature Attributions ,Visualizing Global Feature Attributions, Interpreting Feature Attributions from Shapley Values ,Managed Shapley Values,

Explaining Tree-Based Models ,From Decision Trees to Tree Ensembles ,SHAP's TreeExplainer, Partial Dependence Plots and Related Plots ,Partial Dependence Plots (PDPs) Individual Conditional Expectation Plots (ICEs) ,Accumulated Local Effects (ALE) Textbook 1: Ch. 2,3	
Self-study component:	User centric understanding of Explainability
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	**8 Hours**

Explainability in Text and Image

Explainability for Image Data Integrated Gradients (IG) ,Choosing a Baseline ,Accumulating Gradients

Improvements on Integrated Gradients ,XRAI How XRAI Works ,Implementing XRAI ,Grad-CAM

How Grad-CAM Works Implementing Grad-CAM ,Improving Grad-CAM

LIME ,How LIME Works Implementing LIME.

Explainability for Text Data: Overview of Building Models with Text ,Tokenization ,Word Embeddings and Pretrained Embeddings LIME How LIME Works with Text ,Gradient x Input, Intuition from Linear Models From Linear to Nonlinear and Text Models ,Grad L2-norm ,Layer Integrated Gradients ,A Variation on Integrated Gradients ,Layer-Wise Relevance Propagation (LRP), How LRP Works ,Deriving Explanations from Attention

Which Method to Use? ,Language Interpretability Tool

Textbook 1: Ch. 4, 5

Self-study component:	Applicability of Text Data and Image Data analysis in Explainability
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – IV	**8 Hours**

Transparency and Explainability

Bias and Fairness

Understanding Bias in Data and Models ,Importance of Understanding Bias ,How Bias Can Impact Decision-Making Processes, Types of Bias ,Examples of Real-world Cases Where Models Exhibited Biased Behavior, Techniques to Detect and Mitigate Bias,Techniques to Detect Bias ,Techniques to Mitigate Bias

Implementing Bias Detection and Fairness ,Stage 1: Data Bias Dataset Details Stage ,2: Model BiasConclusion

Transparency and Explainability : Transparency ,Explainability,Importance of Transparency and Explainability in AI Models,Real-world Examples of the Impact of Transparent AI, Methods for Achieving Explainable AI Explanation Methods for Interpretable Models: Decision Trees and Rule-Based Systems

Generating Feature Importance Scores and Local Explanations Tools, Frameworks, and Implementation of Transparency and ExplainabilityOverview of Tools and Libraries for AI Model Transparency

Implementation of Explainable AI Stage 1: Model Building,Stage 2: SHAPStage 3: LIME,Stage 4: ELI5Challenges and Solutions in Achieving Transparency and Explainability,Addressing the "Black Box" , Nature of AI Models Balancing Model Performance and Explainability Trade-offs between Model Complexity, Performance, and Explainability .

Textbook 2: Ch. 2,3

Self-study component:	Study on Reliability and security
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – V	**8 Hours**

Privacy and Security

Privacy and Security: Privacy Concerns in AI Privacy, Privacy Attacks in AI Models, Mitigating Privacy Risks in AI Security Concerns in AI, Potential Threats to Security Mitigating Security Risks in AI.

Robustness and Reliability : Concepts of Robustness and Reliability, Importance in AI Systems Metrics for Measuring Robustness and Reliability ,Challenges in Achieving Robustness Sensitivity to Input Variations ,Model Overfitting, Outliers and Noise

Textbook 2: Ch. 4,5

Self-study component:	Comparative study on Transparency and Explainability.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:

CO's	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	**Understand** the fundamentals of Explainable AI, Ethical issues and Usage of Explainability	Understanding	L2
CO2	**Describe** the consumers of explainable AIand Explainability for tabular data	Understanding	L2
CO3	**Develop** Explainability for image data and text data	Applying	L3
CO4	**Explain** Bias and Fairness and Transparency	Understanding	L2
CO5	**Explain** Security and Privacy	Understanding	L2

Textbook:

- Michael Munn & David Pitman Foreword by Ankur Taly, Explainable AI for practitioners,OREILLY 2022.
- Avinash Manure ,Saravanan S , Shaleen Bengani Introduction to Responsible AI: Implement Ethical AI Using Python, Apress 2023.

Reference Book(s):

- Virginia Dignum, Responsible AI ,Artificial intelligence, foundation theory and algorithm Springer 2019.

TIME SERIES ANALYSIS

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7024**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Learn the importance of time series analysis on the data.
- Identify approaches to handle linear stationary and non stationary models.
- Analyse ways of model building and parameter estimation.
- Recognize methods to handle multivariate time series data.

UNIT – I	**8 Hours**

Introduction, Five Important Practical Problems, **Autocorrelation Function and Spectrum of Stationary Processes:** Autocorrelation Properties of Stationary Models, Spectral Properties of Stationary Models, **Linear Stationary Models:** General Linear Process, Autoregressive Processes, Moving Average Processes.

Ch. 1.1, Ch. 2.1,2.2 Ch. 3.1,3.2,3.3,3.4

Self-study component:	Mixed Autoregressive--Moving Average Processes.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

Linear Nonstationary Models: Autoregressive Integrated Moving Average Processes, Three Explicit Forms for the ARIMA Model, Integrated Moving Average Processes.

Forecasting : Minimum Mean Square Error Forecasts and Their Properties, Calculating Forecasts and Probability Limits, Examples of Forecast Functions and Their Updating.

Ch. 4.1,4.2,4.3, Ch. 5.1,5.2,5.3,5.4,5.5.

Self-study component:	Use of State-Space Model Formulation for Exact Forecasting
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	**8 Hours**

Model Identification: Objectives of Identification, Identification Techniques, Initial Estimates for the Parameters, Model Multiplicity.

Parameter Estimation: Study of the Likelihood and Sum-of-Squares Functions, Nonlinear Estimation, Some Estimation Results for Specific Models, Likelihood Function Based on the State-Space Model.

Ch. 6.1,6.2,6.3,6.4 Ch. 7.1,7.2,7.3,7.4,7.5.

Self-study component:	Estimation Using Bayes' Theorem
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – IV	8 Hours
Model Diagnostic Checking: Checking the Stochastic Model, Overfitting, Diagnostic Checks Applied to Residuals, Use of Residuals to Modify the Model, **Analysis of Seasonal Time Series:** Parsimonious Models for Seasonal Time Series, Some Aspects of More General Seasonal ARIMA Models, Structural Component Models and Deterministic Seasonal Components. Ch. 8.1,8.2,8.3 Ch. 9.1,9.2,9.3,9.4,9.5	
Self-study component:	Regression Models with Time Series Error Terms.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions
UNIT – V	**8 Hours**
Multivariate Time Series Analysis: Stationary Multivariate Time Series, Vector Autoregressive Models, Vector Moving Average Models, Vector Autoregressive--Moving Average Models, Forecasting for Vector Autoregressive--Moving Average Processes, State Space Form of the VARMA Model. Ch. 14.1,14.2,14.3,14.4,14.5,14.6,14.8	
Self-study component:	Nonstationary and Cointegration
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:

CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Apply** the fundamental concept of Time series analysis for Autocorrelation Function and spectrum on linear stationary models.	Apply	L3
CO2	**Develop** non-linear stationary models and perform forecasting.	Develop	L5
CO3	**Identify** models and estimate the various parameters .	Identify	L4
CO4	**Recognize** ways to perform model diagnostic checking and analyze the seasonal time series .	Recognize	L4
CO5	**Analyze** multivariate time series data.	Analyze	L4

Textbook:

- George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, "Time Series Analysis – Forecasting and Control", Wiley Publications , 2016..

Reference Book(s):

- Paul S.P. Cowpertwait and Andrew V. Metcalfe, Introductory Time Series with R, Springer Verlag, New York, 2009.
- Rob J. Hyndman and George Athanasopoulos, Forecasting: Principles and Practice, One line, Open Access Textbooks.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/103106123
- https://www.youtube.com/watch?v=GE3JOFwTWVM
- https://www.youtube.com/watch?v=tepxdcepTbY
- https://www.youtube.com/watch?v=rDwczdWBlTA

DATA SECURITY AND PRIVACY

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7031**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Understand the basics of, Security, its principle and Cryptography
- To study various symmetric and asymmetric cryptographic Algorithm
- Apply the knowledge of Cryptography to various fields
- Study the key management system
- Understand the necessity of data security

UNIT – I	**8 Hours**

A model for Network Security, Classical encryption techniques: Symmetric cipher model, Substitution ciphers-Caesar Cipher, Mon alphabetic Cipher, Play fair Cipher, Hill Cipher, Polyalphabetic Ciphers, One time pad, Steganography

Block Ciphers and Data Encryption Standards: Traditional Block Cipher structures, data Encryption Standard (DES), A DES Example

Text book 1: Chapter 1: 1.8 Chapter 3: 3.1, 3.2, 3.5 Chapter 4: 4.1, 4.2, 4.3, 4.4, 4.5

Self-study component:	The strength of DES, Block cipher design principles
Teaching-Learning Process	Lecture, Case Studies, Demonstration and Flipped Classroom

UNIT – II	**8 Hours**

Pseudorandom number Generators: Linear Congruential Generators, Blum Blum Shub Generator

Public key cryptography and RSA: Principles of public key cryptosystems-Public key cryptosystems, Requirements for public key cryptography, Public key Cryptanalysis, The RSA algorithm: Description of the Algorithm, Computational aspects, The Security of RSA

Diffie-Hellman key exchange: The Algorithm, Key exchange Protocols, Man-in-the-middle Attack, Elliptic Curve Cryptography: Analog of Diffie-Hellman key Exchange, Elliptic Curve Encryption/Decryption, Security of Elliptic Curve Cryptography

Text book 1: Chapter 8: 8.2 Chapter 9: 9.1, 9.2 Chapter 10: 10.1, 10.4

Self-study component:	Applications for public key cryptosystems
Teaching-Learning Process	Lecture, Case Studies, Demonstration and Flipped Classroom

UNIT – III	**8 Hours**

Key management fundamentals, Key lengths and lifetimes, Key generation, Key establishment, Key storage, Key usage, Governing key management. Public-Key Management: Certification of public keys, The certificate lifecycle, Public-key management models.

Text book 2: Chapter 10, Chapter 11

Self-study component:	Alternative approaches
Teaching-Learning Process	Lecture, Case Studies, Demonstration and Flipped Classroom

UNIT – IV			8 Hours
Web security consideration, Transport layer security. **IP Security:** IP Security overview, IP Security Policy, Encapsulating Security Payload, Combining security associations. **Text book1:** Chapter 17: 17.1, 17.2 Chapter 20: 20.1, 20.2, 20.3 20.4, 20.5			
Self-study component:	Internet key exchange.		
Teaching-Learning Process	Lecture, Case Studies, Demonstration and Flipped Classroom.		
UNIT – V			**8 Hours**
Data Security: Data hiding in Text-Basic features, Watermarking, Intuitive Methods, Simple Digital methods, Data hiding in Text, Innocuous Text, Mimic Functions. **Data hiding in Images:** LSB encoding, BPCS Steganography, Lossless data hiding **Textbook 3:** Chapter 10: 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8 Chapter 11: 11.1, 11.2, 11.3			
Self-study component:	Applications of data hiding		
Teaching-Learning Process	Lecture, Case Studies, Demonstration and Flipped Classroom.		
Course Outcomes: On completion of this course, students are able to:			
CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Explain** the basic concepts of Security and Cryptography	Explain	L2
CO2	**Analyze** various Cryptographic Algorithm	Analyze	L4
CO3	**Describe** various key management scenarios.	Describe	L2
CO4	**Explain** about IP security and Web security.	Explain	L2
CO5	**Apply** the Data security concepts for Text and images.	Apply	L3

Textbook:

1. Cryptography and Network Security", William Stallings, Pearson Publication, Seventh Edition.
2. Everyday Cryptography: Fundamental Principles and Applications Keith M. Martin Oxford Scholarship Online: December 2013.
3. Data Privacy and Security, Salomon, David, Springer, 2003.

Reference Book(s):

1. Cryptography and Network Security, Behrouz A Forouzan, Dedeep Mukhopadhyay, TMH, 2nd edition, 2013
2. Information Security: Principles and practice, Mark Stamp, Wiley Inter Science, 2011

EMBEDDED SYSTEM AND IOT

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7032**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Introduce the fundamentals of embedded systems, including hardware and software components.
- Explain the communication mechanisms between devices and embedded systems using serial, parallel, and wireless communication.
- Teach device driver programming and interrupt handling mechanisms used in embedded applications.
- Provide an overview of the Internet of Things (IoT) and the architecture, technologies, and protocols that support it.
- Develop skills for prototyping and designing embedded software and hardware systems for IoT applications.

UNIT – I	**8 Hours**

Introduction to Embedded Systems: Embedded systems, Processor embedded into a system, Embedded hardware units and device in a system, Embedded software in a system, Examples of embedded systems, Design process in embedded system, Formalization of system design, Design process and design examples, Classification of embedded systems, skills required for an embedded system designer.

Text1: 1.1,1.2,1.3,1.4,1.5,1.8,1.9,1.10,1.11,1.12

Self-study component:	Study case studies of embedded systems in real-time applications
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

Devices and communication buses for devices network: IO types and example, Serial communication devices, Parallel device ports, Sophisticated interfacing features in device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, Networked embedded systems, Serial bus communication protocols.

Text1:3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10

Self-study component:	Study the structure and applications of CAN and PCI buses.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	8 Hours
Device drivers and interrupts and service mechanism: Programming-I/O busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing (Handling) Mechanism, Multiple interrupts, Classification of processors interrupt service mechanism from Context-saving angle, Direct memory access,. **Programming Concepts and Embedded Programming in C**: Software Programming in Assembly Language (ALP) and in High-Level Language 'C',C Program Elements: Header and Source Files and Preprocessor Directives, Program Elements: Macros and Functions, Program Elements: Data Types, Data Structures, Modifiers, Statements, Loops and Pointers. Text1:4.1,4.2,4.3,4.5,4.7,4.8, ,5.1,5.2,5.3,5.4	
Self-study component:	Linux device drivers and explore basic Linux kernel module development.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions
UNIT – IV	**8 Hours**
Internet of Things: An Overview Internet of Things, IoT Conceptual Framework ,IoT Architectural View ,Technology Behind IoT, Sources of IoT,M2M Communication, Examples of IoT **Prototyping the Embedded Devices for loT and M2M:** Introduction, Embedded Computing Basics, Embedded Platforms for Prototyping, Things Always Connected to the Internet/Cloud Text 2:1.1,1.2,1.3,1.4,1.5,1.6,1.7,8.1,8.2,8.3,8.4	
Self-study component:	Case studies on smart cities, agriculture, and healthcare using IoT.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions
UNIT – V	**8 Hours**
Design Principles for Web Connectivity: Introduction, Web Communication Protocols for Connected Devices **Prototyping and Designing the Software for IoT Applications:** Introduction, Prototyping Embedded Device Software, Devices, Gateways, Internet and Web/Cloud Services Software-Development, Prototyping Online Component APIs and Web APIs. Text 2:3.1,3.2.9.1,9.2,9.3,9.4	
Self-study component:	Develop a simple cloud-connected project using NodeMCU and Blynk/ThingSpeak.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:			
CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Apply** knowledge of the fundamental components and their functionality in Embedded Systems and the Internet of Things (IoT)	Apply	L3
CO2	**Analyze** the problem statement and recommend suitable devices and mechanisms.	Analyse	L4
CO3	**Design** and prototype embedded hardware and software for IoT-based applications using real- world APIs and cloud services.	Design	L5

Textbook:

- G Embedded Systems: Architecture, Programming, and Design, Raj Kamal, 2nd / 3rd edition, Tata McGraw hill.
- Internet of Things- Architecture and Design Principles, Raj Kamal, 2nd edition, McGraw Hill Education (India) Private Limited.

Reference Book(s):

- The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, second edition, Pearson Education.
- Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, 3rd edition, Wiley.

Web links and Video Lectures (e-resources)

- https://nptel.ac.in/courses/108102045
- https://nptel.ac.in/courses/117106114
- https://nptel.ac.in/courses/106101163
- https://nptel.ac.in/courses/106105166
- https://nptel.ac.in/courses/108107211

AGENTIC AI SYSTEMS

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7033**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Demonstrate an understanding of generative AI and agentic systems by explaining core concepts, identifying model types and applications, and analyzing the architecture, autonomy, and behavior of intelligent and multi-agent systems.
- Explain and apply the essential components and reflective capabilities of intelligent agents to design adaptive, generative AI-based systems.
- Design intelligent agents by integrating knowledge representation, reasoning, learning, and generative AI to build adaptive and reflective agentic systems.
- Design and develop trustworthy agentic AI systems by applying environment modeling, memory architecture, processing workflows, and ethical principles such as transparency and explainability.
- Demonstrate an understanding of safety, ethical considerations, and real-world applications in the design and deployment of agentic AI systems.

UNIT – I	**8 Hours**

Fundamentals of Generative AI: Introduction to generative AI, Types of generative AI models, Applications of generative AI, Challenges and Limitations of generative AI.

Principles of Agentic Systems: Technical requirements, Understanding self-governance, agency and autonomy, Exploring the architecture of agentic systems, Reviewing intelligent agents and their characteristics.

Self-study component:	Understanding multi-agent systems.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

Essential Components of Intelligent Agents: Technical requirements, Knowledge representation in intelligent agents, Reasoning in intelligent agents, Learning mechanisms for adaptive agents, Decision-making and planning in agentic systems, Enhancing agent capabilities with generative AI.

Designing and Implementing Generative AI-Based Agents: Technical requirements, The importance of reflection in agents, Use cases and examples, Introspection in intelligent agents.

Self-study component:	Implementing reflective capabilities.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	8 Hours
Enabling Tool Use and Planning in Agents: Technical requirements, Understanding the concept of tool use in agents, Planning algorithms for agents, Integrating tool use and planning. **Exploring the Coordinator, Worker, and Delegator Approach: Technical** requirements, Understanding the CWD model, Designing agents with role assignments, Communication and collaboration between agents, Implementing the CWD approach in generative AI systems.	
Self-study component:	Exploring practical implementations.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions
UNIT – IV	**8 Hours**
Effective Agentic System Design Techniques: Technical requirements, Focused system prompts and instructions for agents, State spaces and environment modeling, Agent memory architecture and context management, Sequential and parallel processing in agentic workflows. **Trust, Safety, Ethics, and Applications:** Technical requirements, Importance of trust in AI, Techniques for establishing trust, Implementing transparency and explainability.	
Self-study component:	Handling uncertainty and biases.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions
UNIT – V	**8 Hours**
Managing Safety and Ethical Considerations: Understanding potential risks and challenges, Ensuring safe and responsible AI, Exploring ethical guidelines and frameworks. **Common Use Cases and Applications:** Creative and artistic applications, Natural language processing and conversational agents, Decision support and optimization.	
Self-study component:	Addressing privacy and security concerns.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:			
CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Explain** the fundamental concepts, model types, and applications of generative AI and agentic systems.	Explain	L2
CO2	**Apply** the principles of knowledge representation, reasoning, and learning to design intelligent and adaptive agents.	Apply	L3
CO3	**Develop** generative AI-based agentic systems with reflective capabilities for real-world problem-solving.	Develop	L5
CO4	**Implement** environment modeling, memory management, and workflow techniques to build safe, transparent, and trustworthy agentic AI systems.	Implement	L5
CO5	**Analyze** ethical, safety, and societal implications of agentic AI and apply responsible practices in various application domains.	Analyze	L4

Textbook:

- **Building Agentic AI Systems** by Anjanava Biswas & Wrick Talukdar, Packt Publishing, 2025

Reference Book(s):

- **AI Agents in Action** by Michael Lanham, Manning Publications Co. (Shelter Island, NY), 2025

FEDERATED LEARNING

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22AI7034**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory**	**SEE Marks:**	**50**

Course Learning Objectives:

- Understand the foundational concepts of Federated Learning (FL).
- Explore the different FL architectures and algorithms.
- Learn privacy-preserving techniques and their implementation in FL.
- Apply FL methods to real-world scenarios.
- Evaluate and optimize FL models for performance and scalability.

UNIT – I	**8 Hours**

Motivation, Federated Learning as a Solution, The Definition of Federated Learning, Categories of Federated Learning, Current Development in Federated Learning, Privacy Preserving Machine, PPML and Secure ML, Threat and Security Models, Privacy Threat Models, Adversary and Security Models, Privacy Preservation Techniques, Secure Multi Party Computation, Homomorphic Encryption, Differential Privacy

Text Book: 1 Ch:1.1-1.2, 1.3.1, 2.1 – 2.4

Self-study component:	Research Issues in Federated Learning.
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – II	**8 Hours**

Distributed Machine Learning: Introduction to DML , The Definition of DML , DML Platforms, Scalability- Motivated DML , Large-Scale Machine Learning , Scalability Oriented DML Schemes , Privacy-Motivated DML , Privacy-Preserving Decision Trees , Privacy-Preserving Techniques , Privacy-Preserving Gradient Descent , Vanilla Federated Learning , Privacy-Preserving Methods

Text Book: 1 Ch:3.1-3.4

Self-study component:	Privacy-Preserving DML
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – III	**8 Hours**

Horizontal Federated Learning: The Definition of HFL, Architecture of HFL, The Client Server Architecture, The Peer-to-Peer Architecture, Global Model Evaluation, The Federated Averaging Algorithm, Federated Optimization , The FedAvg Algorithm, The Secured FedAvg Algorithm, Communication Efficiency, Client Selection Vertical Federated Learning: The Definition of VFL, Architecture of VFL, Algorithms of VFL, Secure Federated Linear Regression, Secure Federated Tree-Boosting.

Text Book: 1 Ch:4.1-4.4, 5.1 – 5.3

Self-study component:	Improvement of the FedAvg Algorithm
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – IV	**8 Hours**

Heterogeneous Federated Learning, Federated Transfer Learning, The FTL Framework, Additively Homomorphic Encryption, The FTL Training Process, The FTL Prediction Process, Security Analysis, Secret Sharing-Based FTL Federated Learning for Vision, Language, and Recommendation, Federated Learning for Computer Vision Federated CV, Federated Learning for NLP, Federated NLP, Federated Learning for Recommendation Systems, Recommendation Model.

Text Book : 1 Ch:6.1-6.3, 8.1 – 8.3

Self-study component:	Federated Recommendation System
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

UNIT – V	**8 Hours**

Federated Reinforcement Learning, Introduction to Reinforcement Learning, Policy, Reward, Value Function, Model of the Environment, Reinforcement Learning Algorithms, Distributed Reinforcement Learning, Asynchronous Distributed Reinforcement Learning, Synchronous Distributed Reinforcement Learning Finance, Healthcare, Education, Urban Computing and Smart City, Edge Computing and Internet of Things , Blockchain

Text Book : 1 Ch:9.1-9.3, 10.1 – 10.7

Self-study component:	5G Mobile Networks
Teaching-Learning Process	Interactive Teaching through PPT Slides Hands-on Sessions

Course Outcomes: On completion of this course, students are able to:

CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Understand** basic concepts, architecture, and applications of federated learning	Understand	L2
CO2	**Implement** and utilize various federated learning algorithms and architectures.	Implement	L5
CO3	**Analyze** privacy and security issues in federated learning systems.	Analyze	L4
CO4	**Solve** in a team a real-world scenarios in the field of federated learning.	Solve	L5

Textbook:

- Qiang Yang, Yang Liu, Tianjian Chen, Yong Cheng, Yan Kang, Han Yu, "Federated Learning", Morgan & Claypool Publishers, https://www.morganclaypoolpublishers.com/catalog_Orig/samples/9781681736983_sample.pdf

Reference Book(s):

- Peter Kairouz, H. Brendan McMahan, et al., "Advances and Open Problems in Federated Learning," arXiv:1912.04977, 2019.
- Tan, A. Z., Yu, H., Cui, L., & Yang, Q. (2022). Towards personalized federated learning. IEEE Transactions on Neural Networks and Learning Systems. https://ieeexplore.ieee.org/abstract/document/9743558
- 3. Li, Q., Wen, Z., Wu, Z., Hu, S., Wang, N., Li, Y., ... & He, B. (2021). A survey on federated learning systems: Vision, hype and reality for data privacy and protection. IEEE Transactions on Knowledge and Data Engineering, 35(4), 3347-3366.

DEEP LEARNING AND REINFORCEMENT LEARNING

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER - VII

Course Code:	**P22CI704**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:2**	**CIE Marks:**	**50**
Total Hours of Pedagogy:	**40 Hours Theory + 20 Hours Practical**	**SEE Marks:**	**50**

Course Learning Objectives:

- Understand the fundamentals of deep learning.
- Know the theory behind Convolutional Neural Networks, RNN.
- Illustrate the strength and weaknesses of many popular deep learning approaches.
- Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems

UNIT – I	**8 Hours**

Introduction to Deep Learning

Introduction, Shallow Learning, Deep Learning, Why to use Deep Learning, How Deep Learning Works, Deep Learning Challenges,. How Learning Differs from Pure Optimization.

Textbook 1: Ch 1.1 – 1.6, Textbook 2: 8.1,8.2

Self-study component:	Challenges in Neural Network Optimization.
Teaching-Learning Process	PPT and videos Hands-on sessions using Python
Practical Topics:	1. Design and implement a neural based network for generating word embedding for words in a document corpus 2. Write a program to demonstrate the working of a deep neural network for classification task.

UNIT – II	**8 Hours**

Basics of Supervised Deep Learning

Introduction, Convolution Neural Network, Evolution of Convolution Neural Network, Architecture of CNN, Convolution Operation

Textbook 1: Ch 2.1 – 2.5

Self-study component:	Applications of CNN
Teaching-Learning Process	PPT and videos Hands-on sessions using Python
Practical Topics:	3. Desing and implement a Convolutional Neural Network(CNN) for classification of image dataset 4. Build and demonstrate an auto encoder network using neural layers for data compression on image dataset.

UNIT – III	8 Hours
Training Supervised Deep Learning Networks Training Convolution Neural Networks, Gradient Descent-Based Optimization Techniques, Challenges in Training Deep Networks. Supervised Deep Learning Architectures: LetNet-5,AlexNet Text Book - 1 : Ch 3.2,3.4,3.5, Ch 4.2,4.3	
Self-study component:	Challenges in Training Deep Networks
Teaching-Learning Process	PPT and videos Hands-on sessions using Python
Practical Topics:	5. Desing and implement a deep learning network for classification of textual documents. 6. Design and implement a deep learning network for forecasting time series data.
UNIT – IV	**8 Hours**
Recurrent and Recursive Neural Networks Unfolding Computational Graphs, Recurrent Neural Network, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory. Gated RNNs. Text Book – 2: 10.1-10.3, 10.5, 10.6, 10.10	
Self-study component:	Applications of Recurrent and Recursive Neural Networks
Teaching-Learning Process	PPT and videos Hands-on sessions using Python
Practical Topics:	7. Write a program to enable pre-train models to classify a given image dataset
UNIT – V	**8 Hours**
Deep Reinforcement Learning: Introduction, Stateless Algorithms: Multi-Armed Bandits, The Basic Framework of Reinforcement Learning. Textbook – 3: Chapter 9: 9.1,9.2,9.3, 9.7	
Self-study component:	Case studies
Teaching-Learning Process	PPT and videos Hands-on sessions using Python
Practical Topics:	8. Simple Grid World Problem: Design a custom 2D grid world where the agent navigates from a start position to a goal, avoiding obstacles. Environment: Custom grid (easily implemented in Python)

Course Outcomes: On completion of this course, students are able to:			
CO's	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Demonstrate** the implementation of deep learning techniques	Apply	L3
CO2	**Examine** various deep learning techniques for solving the real world problems	Analyze	L4
CO3	**Design** and implement research-oriented scenario using deep learning techniques in a team	Design	L5

Textbook:

1. M. Arif Wani Farooq Ahmad Bhat Saduf Afzal Asif Iqbal Khan, Advances in Deep Learning, Springer, 2020
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
3. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, 2018.

Reference Book(s):

1. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, 2009
2. N.D. Lewis, "Deep Learning Made Easy with R: A Gentle Introduction for Data Science", January 2016
3. Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly publications

Web and Video link(s):

1. https://cedar.buffalo.edu/~srihari/

Course Title: Research Methodology and IPR		
Academic Year: 2025-26	Semester: VII	Scheme: P22
Course Code: P22RMI705	CIE Marks:50	CIE Weightage: 50%
Teaching hours/week (L:T:P): 3:0:0	SEE Marks: 100	SEE Weightage: 50%
Teaching hours of Pedagogy:40	Exam Hours: 3	
Credits:03		

Course learning Objectives:

CLO1: Gain comprehensive understanding of research methodology & IPR importance
CLO2: Create a framework for literature review and data sample collection
CLO3: Interpret and write research reports
CLO4: Understand the life cycle of IPR and its related legal aspects

Unit 1:	**Hrs:8**

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.
Research Problem: Introduction, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.

Self-Study Content: Case study to define research problem in the area of your interest.

Unit 2:	**Hrs:8**

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs: principles of replication, randomization and local control

Self-Study Content: Important Experimental Designs

Unit 3:	**Hrs:8**

Design of Sampling: Introduction, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of Good Sample Design.
Measurement Technique: Introduction, Measurement Scales, Sources of Error in Measurement, Technique of Developing Measurement Tools.
Data Collection: Collection of Primary Data, Difference between Questionnaires and Schedules, Collection of Secondary Data, Selection of Appropriate Method for Data Collection.

Self-Study Content: Case Study on Method of data collection

Unit4:	**Hrs:8**

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.
Intellectual Property: Introduction, Intellectual Property Regime in India, Copyrights, Trademarks, Patents, Designs, Trade Secrets, Geographical Indications and their Salient Features, Trade Related

Aspects of Intellectual Property Rights (TRIPS) Agreement, Issues Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS.	
Self-Study Content: Berne and Paris Conventions	
Unit 5:	**Hrs:8**
Indian Patent Law: Introduction to patent law, Patents Act 1970, Amendments to the Patent Act 1970, Elements of Patentability, Non- Patentable Subject Matter, Duration of Patents - Law and Policy Consideration, Procedure for Filing Patent applications and Types of Applications.	
Self-Study Content: Ownership and Maintenance of Patents	

Course Outcomes (COs)

CO1: Explain the fundamental concepts of research methodology, types of research, and techniques for defining research problems.

CO2: Apply appropriate methods for literature review, research design, data collection, and sampling to address research objectives.

CO3: Analyze collected data to derive valid conclusions and prepare structured research reports in accordance with academic and professional standards.

CO4: Identify the protection of intellectual property under Indian laws and international agreements, including patents, copyrights, and trademarks.

Project Work Phase – I

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VII

Course Code:	**P22CI706**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**0:0:0**	**CIE Marks:**	**100**
Total Number of Teaching Hours:	**-**	**SEE Marks:**	**-**

Project Work: The Project Work (Phase I + Phase II) carries 12 credits (4 credits+8 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter- disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co- guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.

Self-Study Course

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VIII

Course Code:	**P22CI801**	**Credits:**	**02**
Total Number of Teaching Hours:	**-**	**CIE Marks:**	**100**
		SEE Marks:	**-**

The student has to choose and study the course related to the program discipline with her / his own efforts under the guidance of Course Instructor / Project guide, using study materials available in Open Sources i.e., Massive Open Online Courses (MOOCs) – NPTEL Courses. The intention of the course is to encourage the habit of self-learning. In this regard, the department has to release the pool of courses from the list of available 8 weeks NPTEL online courses according to NPTEL calendar of events. The student has to register for the course from the available pool during VII / VIII Semester and the same will be reflected in the Grade Card of VIII Semester. The 100 marks CIE assessment is based on the final NPTEL score (i.e. Online assignments: 25%

+ Proctored exam: 75%). The NPTEL score will be mapped directly to the CIE marks as per the calculation below only if he /she has completed the NPTEL course (i.e. Certification).

CIE = (NPTEL Score X 1.5) = [Maximum CIE should be 100 Marks] [Ex. –

1: If NPTEL Score is 52 then the CIE will be = 52 X 1.5 = 78

Ex. – 2: If NPTEL Score is 80 then the CIE will be = 80 X 1.5 = 100 (Subjected to a Maximum CIE Marks of 100)]

If the student fails to complete the NPTEL course at the end of the VIII Semester, then the department has to constitute a committee consisting of the Head of the department, two senior faculty members of the department, one of them may be the internal guide. The evaluation is based on a Report, Presentation, and Viva-Voce of the NPTEL chosen topic and the assessment is a relative evaluation in context to the student's completed NPTEL course Certification (i.e. the CIE Score should be less than the score of the student who cleared the NPTEL Course).

Note: The student who fails to enroll and appear for the proctored exam in NPTEL is considered to have failed.

Research / Industry Internship - III [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VIII**			
Course Code:	**P22INT802**	**Credits:**	**06**
Teaching Hours/Week (L:T:P):	**0:0:0**	**CIE Marks:**	**-**
Total Number of Teaching Hours:	**-**	**SEE Marks:**	**100**

Guidelines for Internship:

I. Internship is of minimum Fifteen weeks duration and to be completed between the vacation period of VI & VII semester and VII & VIII semester.

II. The internship can be carried out in any industry/ R & D Organization/ Research/ Institute/ Educational institute of repute/ Internshala (ACITE MoU Internship).

III. The Department/college shall nominate staff member/s to facilitate, guide and supervise students under internship.

IV. The Internal Guide has to visit place of internship at least once during the student's internship.

V. The students shall report the progress of the internship to the guide in regular intervals and seek his/her advice.

VI. After the completion of Internship, students shall submit a report with completion and attendance certificates to the Head of the Department with the approval of both internal and external guides.

VII. There will be 100 marks for Viva Voce conducted during Semester End Examination (SEE) of VIII Semester. For the conduction of Internship Semester End Examination following instructions are issued:

a. The Semester End Examination (SEE) for 100 marks shall be conducted similar to final semester project work / lab examination.

b. Internal & External Examiners shall be appointed by the BoE – Chairperson in consultation with HoD and approval of the same by the Principal & Controller of Examination.

c. External Examiner may be from the Industry. If the external examiner from the industry is not available, alternative arrangement shall be made by the BoE - Chairperson by appointing a faculty from out of the available faculty in the department, wherein the student is studying.

VIII. The students are permitted to carry out the internship anywhere in India or abroad. The Institution will not provide any kind of financial assistance to any student for carrying out the Internship.

IX. Failing to undergo Internship: Internship is one of the head for obtaining degree, therefore completion of internship is mandatory.

Project Work Phase – II

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VIII

Course Code:	**P22CI803**	**Credits:**	**08**
Teaching Hours/Week (L:T:P):	**0:0:0**	**CIE Marks:**	**100**
Total Number of Teaching Hours:	**-**	**SEE Marks:**	**100**

Project Work: The Project Work (Phase I + Phase II) carries 12 credits (4 credits+8 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter- disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co- guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.

IV. The weekly progress of the Project work shall be monitored and reviewed by the Project Guide assigned by DUGC. The method of evaluation, including intermediate assessment shall be evolved by the pertinent DUGC.

V. A candidate shall submit N+3 (No. of candidates+3) copies of the Report of the Project Work to Head, DUGC on or before the specified date. The report shall be in the format prescribed by the Institute. The candidate shall submit a report of the project work (dissertation) duly approved by the guide and co-guide. The project report shall be countersigned by the guide, co-guide (if any) and the Head of the Department

VI. The last date for the submission of Report shall be Two weeks before the closure of the semester in which the project work credits have been registered for and is expected to be completed or as announced by the COE. The date of submission of the dissertation may be extended up to a maximum of eight academic years, from the date of commencement of the first semester in which the candidate has taken admission to the course.

VII. The final evaluation (CIE & SEE) for Project Work - Phase II is done by a Project Work Evaluation Committee (PWEC) constituted by the pertinent DUGC. There shall be an open seminar followed by a viva – voce examination as part of the final evaluation. After the final evaluation, appropriate letter grade is awarded.

VIII. If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the minimum passing grade 'E' (Fair) in the case of project, the PWEC shall value and instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modification

has been incorporated.

IX. The Assessment marks in case of Project Work - Phase II and seminar shall be based on the evaluation, as per the guidelines, at the end of the 8th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department (one of them may be the internal guide).

X. The Assessment marks sheet shall bear the signature of all those concerned, along with the date and seal of the Principal.