# Pandit Deendayal Energy University

## School of Technology

## Department of Information and Communication Technology

**Post Graduate Curriculum Handbook (Academic Year 2024-28)**

# M. Tech. (Artificial Intelligence)
# w. e. f. July 2024

# Department of Information and Communication Technology (ICT)
# School of Technology, PDPU

**Vision:**

- Build a teaching and research ecology which promotes innovations, results in societal transformation and sustainable development.

**Mission:**

- Strive and sustain intrinsically motivated learning and research environment focusing on Innovative Technologies, Information and Communication Technology infrastructure and services.
- Provide quality undergraduate and graduate education to create future technocrats for societal transformation.
- Develop collaborations with all stakeholders and undertake real-world projects leading to sustainable development.

**Program Educational Objectives (PEOs):**

- Prepare professionals for industry, research organizations and academia in the field of Information and Communication Technology.
- Impart knowledge and technical skills to students for contribution to the design and development in Computer Science and Information Technology, Communication and Signal Processing, and Electronic Systems.
- Motivating graduates for lifelong learning with leadership qualities, ethics, and life skills.

**Program Outcomes (POs):**

The graduates of ICT department will be able to:

1. ***Engineering knowledge:*** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. ***Problem analysis:*** Identify, formulate, review research literature and analyze 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 the public health and safety, and the 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 modeling 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 teamwork:*** 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 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 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.

**Programme Specific Outcomes (PSO):**

1. Introduction to the basic concepts of Artificial Intelligence and Machine Learning.

2. Train to solve real world problems using Artificial Intelligence, Machine Learning techniques using state of art tools.
3. Explore the ability to identify new problems and design solutions to address those problems using AI and ML techniques and report them as a dissertation.

# M. Tech. AI. Course Outline

| Semester | Category Code | Course Name | Theory | Tutorial | Practical | Hr. | Credits |
|---|---|---|---|---|---|---|---|
| Semester I | PCC | Fundamentals of AI | 3 | 0 | 0 | 3 | 3 |
| | PCC | Pattern Recognition & Machine Learning | 3 | 0 | 0 | 3 | 3 |
| | PCC | Optimization Methods for AI/ML | 3 | 0 | 0 | 3 | 3 |
| | PCC | Neural Networks and Deep Learning | 3 | 0 | 0 | 3 | 3 |
| | PCC | Essential Mathematics for AI | 3 | 1 | 0 | 4 | 4 |
| | PCC | Fundamentals of AI - Lab. | 0 | 0 | 2 | 2 | 1 |
| | PCC | Neural Networks and Deep Learning Lab | 0 | 0 | 2 | 2 | 1 |
| | Project | Scientific Writing and Publication Ethics | 2 | 0 | 0 | 2 | 2 |
| **Total of 1st Sem** | | | **18** | **0** | **4** | **22** | **20** |
| Semester II | **Category Code** | **Course Name** | **Theory** | **Tutorial** | **Practical** | **Hr.** | **Credits** |
| | PCC | Reinforcement Learning | 3 | 0 | 0 | 3 | 3 |
| | PCC | Reinforcement Learning Lab | 0 | 0 | 2 | 2 | 1 |
| | PCE | Professional Core Elective – 1 | 2 | 0 | 2 | 3 | 3 |
| | PCE | Professional Core Elective - 2 | 2 | 0 | 2 | 3 | 3 |
| | PCE | Professional Core Elective - 3 | 2 | 0 | 2 | 3 | 3 |
| | PCE | Professional Core Elective - 4 | 3 | 0 | 0 | 3 | 3 |
| | PCC | Advance AI Lab | 0 | 0 | 2 | 2 | 1 |
| | Project | Research Methodology | 2 | 0 | 0 | 2 | 2 |
| | Project | Seminar | 0 | 0 | 0 | 0 | 1 |
| **Total of 2nd Sem** | | | **14** | **0** | **10** | **21** | **20** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Semester III | **Category Code** | **Course Name** | **Theory** | **Tutorial** | **Practical** | **Hr.** | **Credits** |
| | Project | Project Phase - I | 0 | 0 | 0 | | 17 |
| | Project | Summer Internship /IEP (6 Week) | | | | | 1 |
| | **Total of 3rd Sem** | | **0** | **0** | **0** | | **18** |
| Semester IV | | | | | | | |
| | **Category Code** | **Course Name** | **Theory** | **Tutorial** | **Practical** | **Hr.** | **Credits** |
| | Project | Project Phase - II and Dissertation (**in continuation of Phase 1**) | | | | | 22 |
| | | **Total of 4th Sem** | **0** | **0** | **0** | | **22** |
| | | | | | | **Total Credit** | **80** |

# Course Code

| Semester | Course Category* | Course Code | Course Name | Theory | Tutorial | Practical | Hrs. | Credits |
|---|---|---|---|---|---|---|---|---|
| Semester I | PCC | 24AI501T | Fundamentals of AI | 3 | 0 | 0 | 3 | 3 |
| | PCC | 24AI501P | Fundamentals of AI Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PCC | 24AI502T | Neural Networks and Deep Learning | 3 | 0 | 0 | 3 | 3 |
| | PCC | 24AI502P | Neural Networks and Deep Learning Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PCC | 24AI503T | Pattern Recognition and Machine Learning | 3 | 0 | 0 | 3 | 3 |
| | PCC | 24AI504T | Optimization Methods for AI/ML | 3 | 0 | 0 | 3 | 3 |
| | PCC | 24MA501T | Essential Mathematics for AI | 3 | 1 | 0 | 4 | 4 |
| | HSC | 24HS501T | Scientific Writing and Publication Ethics | 2 | 0 | 0 | 2 | 2 |
| | | | **Total** | **17** | **1** | **4** | **22** | **20** |
| Semester II | PCC | 24AI505T | AI for Energy and Environment | 3 | 0 | 0 | 3 | 3 |
| | PCC | 24AI506T | AI in Agriculture | 3 | 0 | 0 | 3 | 3 |
| | PCC | 24AI507P | Advance AI Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI531T | AI in Law, Governance, and Public Policies | 3 | 0 | 0 | 3 | 3 |
| | PEC | 24AI532T | AI in Space and Defense Applications | 3 | 0 | 0 | 3 | 3 |
| | PEC | 24AI533T | AI in Surveillance and National Security | 3 | 0 | 0 | 3 | 3 |
| | PEC | 24AI534T | Reinforcement Learning | 3 | 0 | 0 | 3 | 3 |
| | PEC | 24AI534P | Reinforcement Learning Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI535T | AI for IoT | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI535P | AI for IoT Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI536T | AI for Scientific Discovery | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI536P | AI for Scientific Discovery Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI537T | AI in Biometrics Systems and Security | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI537P | AI in Biometrics Systems and Security Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI538T | AI in Finance | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI538P | AI in Finance Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI539T | AI in Healthcare | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI539P | AI in Healthcare Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI540T | AI in Sports Analytics | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI540P | AI in Sports Analytics Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PEC | 24AI541T | Brain Computer Interface | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI541P | Brain Computer Interface Laboratory | 0 | 0 | 2 | 1 | 1 |
| | PEC | 24AI542T | Computer Vision | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI542P | Computer Vision Laboratory | 0 | 0 | 2 | 1 | 1 |
| | PEC | 24AI543T | Generative AI | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI543P | Generative AI Laboratory | 0 | 0 | 2 | 1 | 1 |
| | PEC | 24AI544T | Nature Inspired Computing | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI544P | Nature Inspired Computing Laboratory | 0 | 0 | 2 | 1 | 1 |
| | PEC | 24AI545T | NLP and Language Models | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI545P | NLP and Language Models Laboratory | 0 | 0 | 2 | 1 | 1 |
| | PEC | 24AI546T | Quantum AI/ML | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI546P | Quantum AI/ML Laboratory | 0 | 0 | 2 | 1 | 1 |
| | PEC | 24AI547T | Time series Analysis | 2 | 0 | 0 | 2 | 2 |
| | PEC | 24AI547P | Time Series Analysis Laboratory | 0 | 0 | 2 | 2 | 1 |
| | PRO | 24PRAI551 | Research Methodology | 2 | 0 | 0 | 2 | 2 |
| | PRO | 24PRAI552 | Seminar | 0 | 0 | 0 | 0 | 1 |
| | | | **Total** | **46** | **0** | **30** | **70** | **62** |
| Semester III | PRO | 24PRAI651 | Project Phase - I | 0 | 0 | 0 | 0 | 17 |
| | PRO | 24PRAI652 | Summer Internship / Industrial Exposure Program | 0 | 0 | 0 | 0 | 1 |
| | | | **Total** | **0** | **0** | **0** | **0** | **18** |
| Semester IV | PRO | 24PRAI653 | Project Phase - II and Dissertation | 0 | 0 | 0 | 0 | 16 |
| | | | **Total** | **0** | **0** | **0** | **0** | **22** |
| | | | **Total** | **0** | **0** | **0** | **0** | **122** |

# Elective bucket

| **Elective Track – 1: Advance topics in AI (With lab)** | **Elective Track – 2: AI based analytics. (With lab)** |
|---|---|
| 1. Computer Vision | 1. Time series Analysis |
| 2. Generative AI | 2. AI in sports analytics |
| 3. Nature Inspired Computing | |
| 4. Brain Computer Interface | |
| 5. NLP and Language Models | |
| 6. Quantum AI/ML | |
| | |
| **Elective Track – 3: Applications of AI (With lab)** | **Elective Track – 4: Advance Applications of AI (Without Lab)** |
| 1. AI in healthcare | 1. AI in agriculture |
| 2. AI for IoT | 2. AI in Law, governance, and public policies |
| 3. AI for Scientific discovery | 3. AI in surveillance and National security |
| 4. AI in Biometrics systems and security | 4. AI in space and Defense applications |
| 5. AI in finance | 5. AI for Energy and Environment |

The bucket will be modified as per progress in AI (with addition and deletion of subjects looking at progresses in AI)

# 1st Semester

| Course Code: 24AI501T | | | | | Fundamentals of AI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Understand the fundamental concepts of AI.
- Explain various methods of Artificial Intelligence
- Analyze and design various AI models.

| UNIT 1 Introduction to AI | 10Hrs. |
|---|---|
| History of AI, Nature of Intelligence, Biological Intelligence and their nature, development of AI and major milestones, present state of AI, Influence of AI in human society, advantages and risk of AI, ethics in AI, human centric AI. | |
| **UNIT 2: Knowledge** | **12 Hrs.** |
| Knowledge Representation, predicate logic, semantic nets, constraint propagation, representing knowledge using. rules, rules-based systems | |
| **UNIT 3: P PLANNING, LEARNING AND EXPERT SYSTEMS** | **15 Hrs.** |
| Classical planning, planning under uncertainty, value iteration and policy, planning algorithms, refinement planning, Learning from observation, Planning and decision making, Decision Theory, Expert systems, structure of expert systems | |
| **UNIT 4: Recent Trends in AI** | **5 Hrs.** |
| Various applications of AI, Generative models, Language Models and their applications | |

**Total: 42Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the concepts of AI.
CO2: Understand the fundamentals of AI.
CO3: Apply different AI algorithms.
CO4: Analyze the performance of various AI algorithms and models.
CO5: Evaluate the performance of various AI models.
CO6: Design a custom AI model.

**TEXT/REFERENCE BOOKS**


1. Cloud an Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016
2. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
3. Artificial Intelligence and Expert Systems Development by D W Rolston-Mc Graw hill.

| 24AI503T | | | | | Pattern Recognition and Machine Learning | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of pattern detection techniques.
- To understand regression and classification problems.
- To apply machine learning models for forecasting.

| **UNIT 1: Mathematical foundation for pattern recognition** | **11 Hrs.** |
|---|---|
| Introduction to Probability Theory, Basic concepts and definitions, Probability axioms, Conditional probability and independence, Bayesian Probability, Bayes' theorem, Probability distributions, Maximum likelihood estimation, Expectation and Variance, Properties of expectation and variance, Central Limit Theorem. | |
| **UNIT 2: Data pre-processing for machine learning** | **11 Hrs.** |
| Dealing with missing data, handling categorical data, training and test datasets, feature scaling, feature selection, feature importance, Compressing Data via Dimensionality Reduction. | |
| **UNIT 3: Model building** | **11 Hrs.** |
| Artificial neurons, perceptron, ADALINE, Modeling class probabilities via logistic regression, Support vector machines, kernel SVM, decision tree, k-nearest neighbor, model evaluation, hyper parameter tuning, k-fold cross-validation, performance evaluation metrics, Ensemble learning, clustering, linear regression, Multilayer ANN, RNN, GANs, | |
| **UNIT 4: Case studies and Applications** | **9 Hrs.** |
| Applications related to energy, environment, healthcare, smart infrastructures, transportation, communication and networking, VLSI chip design, finance, agriculture. | |

**Total: 42 Hrs**

**Course Outcomes:**

CO1: Remember characteristics of various patterns.
CO2: Understand pattern recognition techniques.
CO3: Apply machine learning models in forecasting.
CO4: Analyze models and results of forecasting.
CO5: Evaluate and compare performance of various machine learning models.
CO6: Develop a suitable application based on domain specific data.

**Text / Reference Books:**


1. R.O. Duda, P.E. Hart, and D.G. Stork. “Pattern Classification”, Wiley Interscience, ISBN: 0-13-022616-5, 2001.
2. C.M. Bishop. “Pattern Recognition and Machine Learning”, Springer, ISBN: 978-0387310732, 2011.
3. T. Hastie, et al. "The Elements of Statistical Learning”, Spinger, 2009.
4. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.

| 24AI504T | | | | | Optimization Techniques for AI/ML | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To learn the fundamentals of optimization techniques.
- To be able to understand, analyze, and solve constrained and unconstrained optimization problems encountered in AI/ML.
- To apply optimization techniques to solve diverse problems in the field of AL/ML.

| **UNIT I: INTRODUCTION AND CLASSICAL OPTIMIZATION METHODS** | **13 Hrs.** |
|---|---|
| Introduction to Engineering Optimization, Classification of Optimization Problems and Algorithms, Examples, Applications and Mathematical Formulations, Classical Optimization Methods: Mathematical Preliminaries, Unconstrained Non-linear Optimization: Uni-variate and Multi-variate, Optimality condition and methods, Gradient based and Gradient free algorithms, Nonlinear Optimization with Equality Constraints: Lagrange Multiplier, Nonlinear Optimization with Inequality Constraints: KKT Conditions, Algorithms for solving optimization problems with constraints. | |
| **UNIT II: CONVEX PROGRAMMING** | **10 Hrs.** |
| Convex Optimization Problems, Quadratic Programming, Sequential Quadratic Programming, Leas Square solution, Minimax optimization, Solution using KKT Conditions and Algorithms, Separable Programming Methods and Algorithms. | |
| **UNIT III: LINEAR AND INTEGER PROGRAMMING** | **09 Hrs.** |
| Linear Programming: Graphical Method, Simplex Algorithm, Duality, Integer Programming Methods. | |
| **UNIT IV: INTRODUCTION TO MULTI-OBJECTIVE OPTIMIZATION (MOO)** | **10 Hrs.** |
| General Problem, Classical MOO methods, Problems and Solutions, MOO algorithms: Introduction to Evolutionary, Nature inspired, and Physical property inspired algorithms, Applications to Machine Learning and Data Analytics. | |

**TOTAL HOURS: 42 Hrs.**

**COURSE OUTCOMES**

On completion of the course, student will be able to:

CO1 : Outline engineering problems into optimization framework.
CO2 : Understand efficient methodologies and algorithms to solve optimization problems.
CO3 : Apply concepts of mathematics to formulate and solve an optimization problem.
CO4 : Analyze performance measures for various optimization algorithms.
CO5 : Evaluate and compare performance of various optimization techniques.
CO6 : Design models for engineering optimization problems.

**TEXT/REFERENCE BOOKS**


1. Xin-She Yang, "Optimization Techniques and Applications with Examples", John Wiley & Sons Publication.
2. Xin-She Yang, "Engineering Optimization: An Introduction with Metaheuristic Applications", John Wiley & Sons Publication.
3. S.S. Rao, "Engineering Optimization: Theory and Practice", John Wiley & Sons Publication.
4. Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall India Learning Private Limited, 2012.
5. Jorge Nocedal, Stephen J. Wright, Numerical Optimization, Springer Series in Operations Research and Financial Engineering, Springer.
6. Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press

| 24AI502T | | | | | Neural Networks and Deep Learning | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Introduce concepts of artificial neural networks.
- Understand concepts and applications of deep learning using artificial neural networks.
- Understand concepts and requirements of adaptive learning techniques.

| UNIT 1: INTRODUCTION TO ARTIFICIAL NEURAL NETWORKs | 10 Hrs. |
|---|---|
| Introduction to Neural networks, Perceptron, McCulloch Pitts Neuron, Models of Neuron, Artificial Neural Network (ANN) Architectures, Classification of ANNs, ANN learning, analysis and applications, Single Layer & Multi-Layer Perceptron (MLP) Network, Optimization of neural networks (GD, SGD, Adagrad, Adadelta, RMSprop, Adam, NAG). Bias vs. variance trade-off, Regularization. | |
| **UNIT 2: CONVOLUTIONAL NEURAL NETWORKS** | **11 Hrs.** |
| Introduction to Deep Learning (DL) Techniques, Convolutional Neural Networks (CNN), Basic architecture, Convolutional Layers, Pooling Layers, Activation functions, Handling vanishing gradient problem, Dropout, Batch Normalization; Different CNN Models: LeNet, AlexNet, VGGNet, GoogleNet, ResNet, DenseNet, Training of Deep neural Networks, Hyper parameter tuning, transfer learning, Dataset augmentation. | |
| **UNIT 3: DEEP LEARNING NEURAL NETWORKS FOR TIME SERIES DATA** | **11 Hrs.** |
| Feedforward and Recurrent Neural Networks (RNN), Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Bidirectional RNNs, Deep RNN, Long Short-Term Memory Networks (LSTMs), Bidirectional LSTMs, Gated Recurrent Unit (GRU), Application of Deep Learning Networks in Various Forecasting Problems. | |
| **UNIT 4: NEURAL NETWORKS FOR SPECIAL APPLICATIONS** | **10 Hrs.** |
| Introduction to Encoder Decoder Models, Variational Autoencoders, GAN and Different Type of GAN's, Implementation on GAN's, Siamese network, Attention and Transformers, Types and Applications. | |

**Total: 42 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Define the basic concepts and terminology associated with neural networks, including neurons, activation functions, and network architectures.

CO2: Explain the fundamental principles underlying neural network operation, including forward and backward propagation, gradient descent, and optimization techniques.

CO3: Implement and train simple feedforward neural networks for tasks such as classification and apply appropriate preprocessing techniques and hyperparameter tuning to improve the performance of neural networks on real-world datasets.

CO4: Evaluate the strengths and weaknesses of different neural network architectures and activation functions for specific applications.

CO5: Evaluate the performance of advanced neural network architectures (e.g., convolutional neural networks, recurrent neural networks) on challenging tasks like image recognition, natural language processing, and time series prediction.

CO6: Design and implement novel neural network architectures or modifications to existing architectures to address specific challenges or improve performance on specialized tasks.

**TEXT/REFERENCE BOOKS**


1. Simon Haykin, "**Neural Networks and Learning Machines**", Third Edition, Paper Back, Pearson India.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, **"Deep Learning"**, MIT Press.
3. Josh Patterson and Adam Gibson, "**Deep Learning A Practitioner's Approach"**, O'Reilly Media, Inc.
4. Antonio Gulli, Sujit Pal, "**Deep Learning with Keras"**, Packt Publishing.
5. Christopher Bishop, **"Deep Learning: Foundations and Concepts"**, Springer.

| 24AI502P | | | | | Neural Networks and Deep Learning Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- Introduce concepts of artificial neural networks.
- Understand concepts and applications of deep learning using artificial neural networks.
- Understand concepts and requirements of adaptive learning techniques.

**List of Experiments: Following is the list of experiments, but it is not limited to it.**

1. To study the architecture of single layer perceptron.
2. To study the architecture of multi-layer perceptron.
3. To train and test deep neural networks.
4. To test various neural networks optimizers.
5. To study the applications of convolution neural network in image classification.
6. To study the hyper parameter tuning of convolutional neural network.
7. To study transfer learning using convolutional neural networks.
8. To study the architecture of LSTM network.
9. To study the architecture of Bidirectional LSTM network.
10. To study the architecture and implementation of GAN.
11. To study the architecture and implementation of Autoencoders.

**COURSE OUTCOMES:**

On completion of the course, student will be able to

CO1: Define the basic concepts and terminology associated with neural networks, including neurons, activation functions, and network architectures.

CO2: Explain the fundamental principles underlying neural network operation, including forward and backward propagation, gradient descent, and optimization techniques.

CO3: Implement and train simple feedforward neural networks for tasks such as classification and apply appropriate preprocessing techniques and hyperparameter tuning to improve the performance of neural networks on real-world datasets.

CO4: Evaluate the strengths and weaknesses of different neural network architectures and activation functions for specific applications.

CO5: Evaluate the performance of advanced neural network architectures (e.g., convolutional neural networks, recurrent neural networks) on challenging tasks like image recognition, natural language processing, and time series prediction.

CO6: Design and implement novel neural network architectures or modifications to existing architectures to address specific challenges or improve performance on specialized tasks.

**TEXT/REFERENCE BOOKS**


1. Simon Haykin, **"Neural Networks and Learning Machines"**, Third Edition, Paper Back, Pearson India.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, **"Deep Learning"**, MIT Press.
3. Josh Patterson and Adam Gibson, **"Deep Learning A Practitioner's Approach"**, O'Reilly Media, Inc.
4. Antonio Gulli, Sujit Pal, **"Deep Learning with Keras"**, Packt Publishing.
5. Christopher Bishop, **"Deep Learning: Foundations and Concepts"**, Springer.

| 24MA501T | | | | | Essential Mathematics for AI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 1 | 0 | 4 | 4 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To learn the fundamentals roles of computational linear algebra in Artificial Intelligence.
- To understand the fundamentals of calculus for multivariable and its role in Artificial Intelligence.
- To make the foundation of Fourier series.
- To understand basic foundations of some statistical test and distribution along with the probability distribution

**UNIT 1 COMPUTATIONAL LINEAR ALGEBRA** **10 Hrs**

Review of basic properties of matrices, review of diagonalizability of matrices, symmetric matrices, positive square root of positive semidefinite matrices, Generalized eigenvalue problem, the linear system Ax=b, Gaussian elimination, LU decomposition, Cholesky decomposition, Singular value decomposition (SVD), Eigenvalue problems.

**UNIT 2 CALCULUS FOR MULTIVARIABLE** **10 Hrs**

Limit and continuity of a function of two variables, Optimization, Maxima, and minima of a function of two variables, Lagrange multipliers, Double integral in rectangular and polar form, Triple integral in rectangular, Cylindrical and spherical coordinates.

**UNIT 3 FOURIER SERIES** **11 Hrs**

Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave, Euler's Formulae for Fourier Series, Fourier Series for functions of period $2\pi$, Fourier Series for functions of period $2\pi$, Dirichlet's conditions, Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series.

**UNIT 4 PROBABILITY AND STATISTICS** **11 Hrs**

Classical definition and its limitations. Axiomatic definition, Addition rule. Conditional probability & Independent events. Extension to more than 2 events (pair wise & mutual independence),
Definition of random variable, continuous and discrete random variables, probability density function & probability mass function for single variable, distribution function and its properties, definitions of expectation and variance, properties.
Some important discrete distributions: Binomial & Poisson distributions and related problems. Some important continuous distributions: Normal distributions and related problems.

**Max. 42 Hrs.**

**COURSE OUTCOMES**

On completion of the course, students will be able to
CO1: Recognise the fundamental concepts of computational linear algebra and its role in artificial intelligent.
CO2: Understand the concepts of calculus for multivariable and application for artificial intelligent.
CO3: Implementing knowledge Fourier series for the advanced study of artificial intelligent.
CO4: Design the statistical model for the random variables.
CO5: Apply the probability distribution for the artificial intelligent domain.
CO6: Design and create AI systems using the concepts of all mathematical analysis.

**TEXT/REFERENCE BOOKS**


1. Wendland, Holger. Numerical linear algebra. An introduction. Cambridge Texts in Applied Mathematics. Cambridge University Press, Cambridge.
2. Datta, Biswa Nath Numerical linear algebra and applications. Second edition. Society for Industrial and Applied Mathematics (SIAM), Philadelphia.
3. Demmel, James W. Applied numerical linear algebra. (English summary) Society for Industrial and Applied Mathematics (SIAM), Philadelphia.
4. SC Gupta and VK Kapoor. Fundamental of Mathematical Statistics (A Modern Approaches). S Chand Publications, Tenth Publication.
5. LAX P.D. Multivariable Calculus With Applications (Hb 2017). Springer Publication

| Course Code: 24AI501P | | | | | Fundamental of AI lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- Understand the fundamental concepts of AI.
- Explain various methods of Artificial Intelligence
- Analyze and design various AI models.

**List of Experiments: Following is the list of experiments of experiments, but it is not limited to it.**

1. Introduction to various frameworks/libraries for AI programming.
2. Play with data and their dimensions.
3. Implement various data preprocessing and feature engineering methods.
4. Implementation of various search algorithms (BFS, DFS, A*)
5. Implementation of various optimization algorithms.
6. Implementation of various boosting methods
7. Implementation of various regression algorithms
8. Implementation of various classification algorithms
9. Implementation of various clustering algorithms
10. Implementation of a Deep Neural Network.

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the concepts of AI.
CO2: Understand the fundamentals of AI.
CO3: Apply different AI algorithms.
CO4: Analyze the performance of various AI algorithms and models.
CO5: Evaluate the performance of various AI models.
CO6: Design a custom AI model.

**TEXT/REFERENCE BOOKS**


1. Cloud an Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016
2. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
3. Artificial Intelligence and Expert Systems Development by D W Rolston-Mc Graw hill.

| Course Code: 24HS501T | | | | | Scientific Writing and Publication Ethics | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

1. To comprehend the significance of scientific writing and to understand of the basic structure of a scientific paper.
2. To get familiarize with the process of selecting appropriate target journals and conferences.
3. To cultivate an awareness of publication ethics within the realm of scientific writing.
4. To get acquainted with the knowledge and tools necessary to identify, understand, and avoid plagiarism in scientific writing

| | |
|---|---|
| **UNIT-1: Introduction to Scientific Writing**<br>Importance of scientific writing in engineering, understanding the structure and components of a scientific paper, research paper writing style, referencing style | **07 Hrs.** |
| **UNIT 2: Selecting Target Journals and Conferences**<br>Types of journals and conferences in engineering, open access journals, journal impact factors, conference rankings, manuscript submission process, responding to reviewer comments | **07 Hrs.** |
| **UNIT 3: Publication Ethics**<br>Introduction and importance, publication misconduct, violation of publication ethics, falsification and/or fabrication of data, understanding of copyright form, collaboration issues (authorship), conflicts of interest issues, Committee on Publication Ethics (COPE) | **07 Hrs.** |
| **UNIT 4: Avoiding Plagiarism**<br><br>Plagiarism – definition, reasons for plagiarism, types of plagiarism, avoiding plagiarism | **07 Hrs.** |
| **TOTAL** | **28 Hrs** |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

CO1 - describe the importance of scientific writing in engineering and identifying its role in knowledge dissemination and academic integrity
CO2 - understand the structure and components of a scientific paper
CO3 - evaluate and select suitable journals and conferences to submit their research work
CO4 - understand publication ethics
CO5 - define plagiarism, identify its different types and reasons, and apply techniques to avoid plagiarism
CO6 - analyze and respond to reviewer comments for their research work

**TEXT/REFERENCE BOOKS**


4. Getting It Published: A Guide for Scholars and Anyone Else Serious about Serious Books by William Germano
5. Publish and Flourish: Become a Prolific Scholar by Tara Gray
6. Adil E. Shamoo, and David B. Resnik, Responsible Conduct of Research, Oxford University Press
7. Gary Comstock, Research Ethics: A Philosophical Guide to the Responsible Conduct of Research, Cambridge University Press
8. Tony Mayer, and Nicholas H. Steneck, Promoting Research Integrity in a Global Environment, World Scientific Publishing
9. Ethical Issues in Engineering Research, Publication, and Practice by Caroline Whitbeck

# 2nd Semester

| Course Code: 24AI534T | | | | | Reinforcement learning | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Understand the fundamental concepts of RL.
- Explain various methods of RL.
- Analyze and design various RL models.

| **UNIT 1 Introduction to RL** | **15 Hrs.** |
|---|---|
| Concepts in RL, concept of agent and the environment, concept of action and reward, states and observations, action spaces, policies, trajectories, different formulations of return, the RL optimization problem, value functions, The Optimal Q-Function and the Optimal Action, Formalism | |
| **UNIT 2: Key Concepts in RL Algorithms** | **12 Hrs.** |
| A Taxonomy of RL Algorithms, Model-Free vs Model-Based RL, Q-Learning, Trade-offs Between Policy Optimization and Q-Learning, model-predictive control, Deep Deterministic Policy Gradient, Deep Reinforcement Learning, Model-Based Deep Reinforcement Learning, | |
| **UNIT 3: Policy Optimization** | **10 Hrs.** |
| Intro to Policy Optimization, Deriving the Simple Policy Gradient, Baselines in Policy Gradients, Other Forms of the Policy Gradient, | |
| **UNIT 4: Advance topics in RL** | **5 Hrs.** |
| Asynchronous Methods for Deep Reinforcement Learning, Vanilla Policy Gradient, Deep Reinforcement Learning with Double Q-learning, | |

**Total: 42Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the concepts of RL.
CO2: Understand the fundamentals of RL.
CO3: Apply different RL algorithms.
CO4: Analyze the performance of various RL algorithms and models.
CO5: Evaluate the performance of various RL models.
CO6: Design a custom RL model.

**TEXT/REFERENCE BOOKS**

1. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

| Course Code: 24AI534P | | | | | Reinforcement learning Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- Understand the fundamental concepts of RL.
- Explain various methods of RL.
- Analyze and design various RL models.

**List of Experiments: Following is the list of experiments of experiments, but it is not limited to it.**

1. Introduction to tools for RL algorithm implementation
2. Introduction to Open AI Gym
3. Implement Gaussian Log-Likelihood.
4. Implement Policy for Proximal Policy Optimization (PPO)
5. Setting up a reinforce agent.
6. Train a Categorical agent on the Cartpole environment.
7. Implement a Multi-Armed Bandit problem (MAB)
8. Implement a Multi-Armed Bandits with Per-Arm

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the concepts of RL.
CO2: Understand the fundamentals of RL.
CO3: Apply different RL algorithms.
CO4: Analyze the performance of various RL algorithms and models.
CO5: Evaluate the performance of various RL models.
CO6: Design a custom RL model.

**TEXT/REFERENCE BOOKS**

1. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

| Course Code: 24AI507P | | | | | Advance AI lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- Understand the advanced concepts of AI.
- Explain various methods of Artificial Intelligence
- Analyze and design various advanced AI models.

**List of Experiments: Following is the list of experiments of experiments, but it is not limited to it.**

1. Hyper parameter tuning using grid search.
2. Implementation of ablation method in AI models.
3. Reduce AI models by pruning.
4. Study the effect of bit quantization in an AI model performance.
5. Deploy an AI model in hardware to automate a process.
6. Implementation of transfer learning and fine tuning of a model.
7. Build a docker image of an AI application and deploy a container of that image in cloud.
8. Apply federated learning to train an AI model.
9. Implement a variational autoencoder and study the distribution of the code layer/latent space Distribution.
10. Implement a deep generative AI model.
11. Case study/project work: Implement GNN based AI model.
12. Case study/ project work: Implement a Physics Informed Neural Network (PINN) to solve differential equations.

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the advanced concepts of AI.
CO2: Understand the advanced AI algorithms.
CO3: Apply different AI algorithms.
CO4: Analyze the performance of various AI algorithms and models.
CO5: Evaluate the performance of various AI models.
CO6: Design a custom AI model.

**TEXT/REFERENCE BOOKS**


10. Cloud an Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016
11. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
12. Artificial Intelligence and Expert Systems Development by D W Rolston-Mc Graw hill.

| Course Code: 24PRAI551T | | | | | Research Methodology | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

1. To understand the role of research in the field of engineering and get an overview of the research process.
2. To develop proficiency in literature review techniques.
3. To understand the process of formulating and solving research problems.
4. To understand different types of intellectual property rights.

| | |
|---|---|
| **UNIT I : Introduction to Research**<br>Role of research in engineering, research process overview, types of research, outcomes of research, characteristics of a researcher, research terminology | **06 Hrs.** |
| **UNIT II : Literature Review Techniques**<br>Searching for the existing literature, reviewing the selected literature, developing a theoretical framework, developing a conceptual framework | **06 Hrs.** |
| **UNIT III : Formulating and Solving a Research Problem**<br>Importance of formulating a research problem, sources of research problems, identifying a problem, formulation of research objectives and research questions, Need for research design, different research designs, experimental test-setups, data sampling, data collection, data analysis & interpretation | **08 Hrs.** |
| **UNIT VI: Intellectual Property Rights**<br>Introduction and significance of intellectual property rights, types of intellectual property rights, introduction to patents, patent drafting and filing, copyright, trademarks, industrial design, geographical indicators | **08 Hrs.** |
| **Total** | **28 Hrs.** |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

CO1 - **understand the role and significance of research in engineering.**
CO2 - develop understanding of the basic framework of research process and design
CO3 - identify technical gaps in the literature and formulate a problem.
CO4 - develop an understanding of various research designs and techniques.
CO5 - develop an understanding of the ethical dimensions of conducting applied research
**CO6 - evaluate and apply intellectual property rights concepts to the research outcomes.**

Reading Material


1. Stuart Melville, Wayne Goddard, Research Methodology: An Introduction for Science and Engineering Students, Juta & Co. Ltd.
2. David V. Thiel, Research Methods for Engineers, Cambridge University Press, UK
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, Pearson
4. CR Kothari, Research Methodology (Methods and Techniques), New age Publications

# Elective Track – 1: Advance topics in AI (With lab)

| 24AI542T | | | | | Computer Vision | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Introduce fundamental concepts of computer vision and its applications.
- Understand the principles and techniques of image processing and analysis.
- Develop skills to implement computer vision algorithms for solving real-world problems.

| **UNIT 1: Introduction to Computer Vision** | **5 Hrs.** |
|---|---|
| Image representation, digitization, image properties: histogram, entropy, image space, camera calibration. | |
| **UNIT 2: Mathematical foundation of image processing and analysis** | **9 Hrs.** |
| Discrete transforms, DCT, PCA, image processing: brightness and geometric transformations, image smoothing, edge detection, restoration, segmentation, shape analysis. | |
| **UNIT 3: Object Detection and Recognition** | **8 Hrs.** |
| Simple Object Detection and Tracking, Face recognition, implementations of Neural Style Transfer, YOLOv3, SSDs, Classification with CNNs, Transfer Learning and Fine Tuning, Generative Adversarial Networks, Autoencoders, deep segmentation, depth estimation, Working with Video Streams. | |
| **UNIT 4: Computer Vision Applications** | **6 Hrs.** |
| Medical image analysis, smart city systems, security systems, object retrieval, automation, remote sensing. | |

**Total: 28 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember image analysis fundamentals.
CO2: Understand pattern recognition techniques.
CO3: Apply machine learning models in image classification.
CO4: Analyze models and results of classification.
CO5: Evaluate and compare performance of various computer vision models.
CO6: Develop a suitable application based on domain specific data.

**TEXT/REFERENCE BOOKS:**

(1) Milan Sonka, et al. "Image processing, analysis and machine vision", Cengage, ISBN: 978-93-868-5814-6.
(2) Scott E Umbaugh. "Digital image processing and analysis", CRC press, ISBN: 978-1-4398-0205-2. (3) Abhinav Dadhich. "Practical Computer Vision", PacktPub, ISBN- 9781788294768 .
(4) E. R. Davies. "Computer Vision: Principles, Algorithms, Applications, Learning." Elsevier. ISBN: 9780128095751.
(5) Carsten Steger, Markus Ulrich, Christian Wiedemann. "Machine Vision Algorithms and Applications", Wiley. ISBN: 9783527413652.

| 24AI542P | | | | | Computer Vision Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**Course Objectives:**

- To impart basic knowledge of image analysis techniques.
- To understand pattern recognition and machine vision problems.
- To apply computer vision models for classification.

**List of Experiments:**

**Experiment Sessions would be based on following topics but not limited to:**

1. Introduction to tools, libraries for image analysis.
2. To read, write, edit a digital image.
3. To perform arithmetic and logic operations, spatial filters on an image.
4. To perform edge detection and segmentation on an image.
5. To perform various digital image transforms such as Fourier transform, DCT etc.
6. To perform feature extraction and analysis of specific object in an image.
7. To perform CNN based image classification.
8. To perform GANs based image transformations.
9. To perform standard pre-trained deep neural models for object detection.
10. To perform machine vision system implementation for topic of interest.

**Course Outcomes:**

CO1: Remember image analysis fundamentals.
CO2: Understand pattern recognition techniques.
CO3: Apply machine learning models in image classification.
CO4: Analyze models and results of classification.
CO5: Evaluate and compare performance of various computer vision models.
CO6: Develop a suitable application based on domain specific data.

| 24AI543T | | | | | Generative AI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To learn the fundamentals of the Generative AI
- To be able to understand and analyze the various Generative models.
- To apply various Generative AI models

| UNIT 1: INTRODUCTION TO GENERATIVE AI | 6 Hrs. |
|---|---|
| Definition and overview of Generative AI, history of the development of gen AI, Applications and use-cases of Generative AI, Ethical concerns of Gen AI, | |
| **UNIT 2: GENERATIVE MODELS** | **8 Hrs.** |
| Introduction to variational autoencoder (VAE), Mathematical foundation of VAE, Introduction Generative Adversarial Networks (GANs), Mathematical formulation of GANs, Conditional VAEs and GANs, Disentangled representations. | |
| **UNIT 3: ETHICAL CONSIDERATION OF GENERATIVE AI** | **8 Hrs.** |
| Bias and Fairness in Generative AI, Misuse of Generative AI, Regulation and Policy for Generative AI, Techniques for bias detection and mitigation in Generative AI | |
| **UNIT 4: ADVANCED TOPICS IN GENERATIVE AI** | **6 Hrs.** |
| Large Language Models (LLMs), Generative Pretrained Transformers (GPTs), Prompt Engineering, Generative AI in Drug and Chip Design, Generative AI in Material Science Development | |

**Total: 28 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the concepts generative AI.
CO2: Understand the fundamentals concepts of Generative AI.
CO3: Apply various Generative AI algorithms.
CO4: Analyze the performance of various Generative AI algorithms and models.
CO5: Evaluate the performance of various Generative AI models.
CO6: Design a custom Generative model.

**TEXT/REFERENCE BOOKS**


1. Generative Deep Learning, by David Foster, O'Reilly Media, Inc., ISBN: 9781098134181.
2. Generative AI with Python and TensorFlow 2, By Joseph Babcock, Raghav Bali, Packt publication

| Course Code: 24AI543P | | | | | Generative AI Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- To learn the fundamentals of the Generative AI
- To be able to understand and analyze the various Generative models.
- To apply various Generative AI models

**List of Experiments: Following is the list of experiments of experiments, but it is not limited to it.**

1. Implement traditional Autoencoder.
2. Implement Variational Autoencoder (VAE)
3. Implement VAE for denoising signals/images.
4. Implement Generative Adversarial Networks (GANs)
5. Implement GAN for a real-world application.
6. Implement a Transformer architecture.
7. Implement a Diffusion model.
8. Study the application of GAN in image and video editing

**COURSE OUTCOMES**

On completion of the course, student will be able to
CO1: Remember the concepts generative AI.
CO2: Understand the fundamentals concepts of Generative AI.
CO3: Apply various Generative AI algorithms.
CO4: Analyze the performance of various Generative AI algorithms and models.
CO5: Evaluate the performance of various Generative AI models.
CO6: Design a custom Generative model.

**TEXT/REFERENCE BOOKS**


1. Generative Deep Learning, by David Foster, O'Reilly Media, Inc., ISBN: 9781098134181.
2. Generative AI with Python and TensorFlow 2, By Joseph Babcock, Raghav Bali, Packt publication

| 24AI544T | | | | | Nature Inspired Computing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of natural computing systems.
- To understand the concepts of natural systems and its applications.
- To understand natural design considerations.

| UNIT I: INTRODUCTION AND GENETIC ALGORITHMS | 07 Hrs. |
|---|---|
| From Nature to Nature Computing, Individuals, Entities and agents, Evolutionary Computing, Hill Climbing and Simulated Annealing, Genetics Principles, Standard Evolutionary Algorithm -Genetic Algorithms, Reproduction-Crossover, Mutation, Evolutionary Programming, Genetic Programming. | |
| **UNIT II: - SWARM INTELLIGENCE** | **07 Hrs.** |
| Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, SACO and scope of ACO algorithms, Ant Colony Algorithm (ACA), Swarm Robotics, Foraging for food, Social Adaptation of Knowledge, Particle Swarm Optimization (PSO). | |
| **UNIT III: IMMUNOCOMPUTING** | **07 Hrs.** |
| Introduction- Immune System, Physiology and main components, Pattern Recognition and Binding, Immune Network Theory- Danger Theory, Evaluation Interaction Immune Algorithms, Bone Marrow Models, Forest's Algorithm, Artificial Immune Networks. | |
| **UNIT IV: COMPUTING WITH NEW NATURAL MATERIALS** | **07 Hrs.** |
| DNA Computing: Motivation, DNA Molecule, Adleman's experiment, Test tube programming language, Universal DNA Computers , PAM Model , Splicing Systems , Lipton's Solution to SAT Problem , Scope of DNA Computing , From Classical to DNA Computing, Future trends. | |
| **TOTAL HOURS: 28 Hrs.** | |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Remember characteristics of natural computing system |
| CO2 | : | Understand nature inspired computing algorithms |
| CO3 | : | Apply nature inspired computing algorithms to solve engineering problems |
| CO4 | : | Analyze nature inspired computing algorithms |
| CO5 | : | Evaluate performance of nature inspired computing algorithms |
| CO6 | : | Develop nature inspired computing algorithms |

**TEXT/REFERENCE BOOKS**


1. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group.
2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA.
3. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.
4. Marco Dorrigo, Thomas Stutzle," Ant Colony Optimization", PHI,2005.

| 24AI544P | | | | | Nature Inspired Computing Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | -- | -- | -- | 50 | 50 | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of natural computing systems.
- To understand the concepts of natural systems and its applications.
- To understand natural design considerations.

**LIST OF EXPERIMENTS**

1 Study and simulation of Genetic Algorithms
2 Study and simulation of Simulated Annealing Algorithms
3 Study and simulation of Differential Evolutionary Algorithms
4 Study and simulation of Ant Colony Optimization Algorithms
5 Study and simulation of Particle Swarm Optimization Algorithms
6 Study and simulation of immuno-computing algorithms
7 Study and simulation of Forest's algorithm
8 Study and simulation of Evaluation Interaction Immune Algorithms
9 Study and simulation of DNA computing algorithms
10 Study and simulation of Fire fly algorithm

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Remember characteristics of natural computing system |
| CO2 | : | Understand nature inspired computing algorithms |
| CO3 | : | Apply nature inspired computing algorithms to solve engineering problems |
| CO4 | : | Analyze nature inspired computing algorithms |
| CO5 | : | Evaluate performance of nature inspired computing algorithms |
| CO6 | : | Develop nature inspired computing algorithms |

**TEXT/REFERENCE BOOKS**


1. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group.
2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA.
3. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.
4. Marco Dorrigo, Thomas Stutzle," Ant Colony Optimization", PHI,2005.

| 24AI541T | | | | | Brain Computer Interface | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Introduce students to the principles of signal processing techniques and their application to biomedical signals.
- Understanding methods and tools for extracting information from biomedical signals.
- Understand the analysis of biomedical signals.

| **UNIT I: INTRODUCTION TO BCI** | 7 Hrs. |
|---|---|
| Introduction - Brain structure and function, Brain Computer Interface Types – Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI. | |
| **UNIT II: BRAIN ACTIVATION** | 7 Hrs. |
| Brain activation patterns - Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement potential rhythms, motor imagery, Stimulus related potentials -Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks. | |
| **UNIT III: FEATURE EXTRACTION METHODS** | 7 Hrs. |
| Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering - Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artifacts reduction, Feature Extraction - Phase synchronization and coherence. | |
| **UNIT IV: MACHINE LEARNING METHODS FOR BCI** | 7 Hrs. |
| Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial,RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis | |
| **TOTAL HOURS: 28 Hrs.** | |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Understand different types of biomedical signals and their properties. |
| CO2 | : | Understand different artifacts in biomedical signals and the process of removing it |
| CO3 | : | Understand EEG signal and its analysis |
| CO4 | : | Apply advanced methods to extract relevant information from biomedical signal measurements. |
| CO5 | : | Assess Biomedical signal processing techniques for various problems and evaluate the effectiveness of techniques. |
| CO6 | : | Design concepts of allocating functions appropriately to the human and the machine. |

**TEXT/REFERENCE BOOKS**


1. Rajesh.P.N.Rao, "**Brain-Computer Interfacing: An Introduction**", Cambridge University Press, First edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "**Brain Computer Interfaces: Principles and practice"**, Oxford University Press, USA, Edition 1, January 2012.

| 24AI541P | | | | | Brain Computer Interface Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | -- | -- | -- | 50 | 50 | 100 |

**COURSE OBJECTIVES**

- To introduce the basic concepts of brain computer interface.
- To study the various signal acquisition methods.
- To study the signal processing methods used in BCI.

| LIST OF EXPERIMENTS | |
|---|---|
| 1 | To study the Brain signal acquisition. |
| 2 | To study the different types of signal-preprocessing techniques |
| 3 | To Study artifact removal in bio-signals |
| 4 | To Study waveform analysis and feature extraction from bio-signals. |
| 5 | To Study the pattern classification in bio-signals |
| 6 | To study the role of EEG signal analysis in healthcare |
| 7 | To study the data-driven multichannel brain and biomedical signal processing |
| 8 | To study the correlation between Sleep & brain |
| 9 | To study the Brain correlates of creativity and dementia |
| 10 | To study the AI and deep learning applications to brainwave processing/classification |

**COURSE OUTCOMES**

On completion of the course, students will be able to:

| | | |
|---|---|---|
| CO1 | : | Understand the basic physiological, perceptual, and cognitive components of human learning and memory |
| CO2 | : | Understand theoretical knowledge of and practical experience in the fundamental aspects of designing and implementing user interfaces |
| CO3 | : | To analyze interaction problems from a technical, cognitive, and functional perspective |
| CO4 | : | To develop an awareness of the range of general human-computer interaction issues that must be considered when designing information systems |
| CO5 | : | To design multimodal displays for conveying and presenting information |
| CO6 | : | To deploy variety of simple methods for designing and evaluating the quality of user interfaces and spatial displays |

**TEXT/REFERENCE BOOKS**


1. Arnon Kohen, "**Biomedical Signal Processing**", Vol I and II, CRC Press Inc, Boca Rato,
2. TorstenFelzer, "**On the possibility of Developing a Brain Computer Interface**", Technical Report, Technical University of Darmstadt, Germany,2001.
3. Wolpaw J.R, N.Birbaumer et al, "**Brain control interface for Communication and control**", Clinical Neurophysiology, 113, 2002.

| 24AI545T | | | | | NLP and Language Models | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/ Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Comprehend core principles of Natural Language Processing (NLP), including text preprocessing, tokenization, and text representation methods.
- Investigate advanced NLP techniques such as Named Entity Recognition (NER) and sentiment analysis, exploring their applications in domains like machine translation and language understanding.
- Assess the architecture and effectiveness of large language models (LLMs) like GPT and BERT, while considering ethical implications such as bias and privacy.

| **UNIT 1: Introduction** | **5 Hrs.** |
|---|---|
| Introduction to NLP, Basic Text Preprocessing Techniques, Tokenization and Part-of-Speech Tagging, Text Representation: Bag-of-Words, TF-IDF, Word Embeddings: Word2Vec, GloVe, Overview of Large Language Models: GPT, BERT, Transformer architecture. | |
| **UNIT 2: Advanced techniques** | **9 Hrs.** |
| Advanced Text Processing Techniques, Named Entity Recognition (NER) and Entity Linking, Sentiment Analysis and Opinion Mining, Text Classification: Naive Bayes, Support Vector Machines, Neural Networks , Machine Translation and Language Understanding, Case Studies and Applications of NLP in Industry. | |
| **UNIT 3: Evaluation of Models** | **8 Hrs.** |
| Evaluation Metrics for NLP Tasks: Precision, Recall, F1 Score, Cross-Validation and Model Selection, Introduction to Large Language Models (LLMs), Understanding Model Architecture: Transformer, Attention Mechanism, Fine-tuning LLMs for Specific Tasks, Ethical Considerations in NLP. | |
| **UNIT 4: Generation and applications** | **6 Hrs.** |
| Text Generation with Large Language Models, Summarization and Abstractive Text Generation, Dialogue Systems and Conversational Agents, Recent Advances in NLP Research, Future Directions in NLP and Large Language Models | |

**Total: 28 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Recall basic concepts of NLP, such as tokenization and text representation methods.

CO2: Memorize the characteristics of prominent large language models (LLMs) like GPT and BERT.

CO3: Explain the significance of advanced NLP techniques like Named Entity Recognition (NER) and sentiment analysis in various applications.

CO4: Understand the underlying principles of LLMs and their impact on improving NLP tasks.

CO5: Apply text preprocessing techniques and tokenization methods to prepare text data for analysis.

CO6: Implement pre-trained LLMs and fine-tuning methods to customize models for specific NLP tasks.

**TEXT/REFERENCE BOOKS:**


(1) Eisenstein, Jacob. Introduction to natural language processing. MIT press.

(2) Paaß, Gerhard, and Sven Giesselbach. Foundation Models for Natural Language Processing: Pre-trained Language Models Integrating Media. Springer Nature.

(3) Zhang, Yue, and Zhiyang Teng. Natural language processing: a machine learning perspective. Cambridge University Press.

| 24AI545P | | | | | NLP and Language Model Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | -- | -- | -- | 50 | 50 | 100 |

**Course Objectives:**

- To ddevelop practical skills in implementing NLP algorithms and large language models (LLMs) through hands-on programming and experimentation.
- To aapply theoretical concepts to real-world scenarios by fine-tuning pre-trained LLMs and evaluating their performance in tasks like text classification and sentiment analysis.
- To uutilize project-based learning to create NLP solutions for practical problems using real-world datasets and communicate findings effectively through presentations and reports.

**List of Experiments:**

**Experiment Sessions would be based on following topics but not limited to:**

1. Text Preprocessing Techniques: Implementing and Comparing Tokenization Methods
2. Named Entity Recognition (NER) System Development using Python and NLTK
3. Sentiment Analysis of Twitter Data: Building a Classifier with Scikit-learn
4. Fine-tuning Pre-trained Language Models for Text Classification Tasks
5. Text Generation with GPT-3: Exploring OpenAI's Language Model
6. Evaluating Bias in Large Language Models: Analyzing Gender and Ethnicity Biases
7. Dialogue Systems Development: Building a Simple Chatbot with Transformers
8. Abstractive Text Summarization using Pre-trained Models: A Comparative Study

**Course Outcomes**:

CO1: Recall basic concepts of NLP, such as tokenization and text representation methods.

CO2: Memorize the characteristics of prominent large language models (LLMs) like GPT and BERT.

CO3: Explain the significance of advanced NLP techniques like Named Entity Recognition (NER) and sentiment analysis in various applications.

CO4: Understand the underlying principles of LLMs and their impact on improving NLP tasks.

CO5: Apply text preprocessing techniques and tokenization methods to prepare text data for analysis.

CO6: Implement pre-trained LLMs and fine-tuning methods to customize models for specific NLP tasks.

| 24AI546T | | | | | Quantum AI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To learn the fundamentals concept of quantum computing
- To be able to understand the concepts of quantum AI.
- To apply various Quantum AI algorithms.

| **UNIT 1: INTRODUCTION TO QUNTUM TECHNOLOGY** | **6 Hrs.** |
|---|---|
| Introduction to quantum mechanics, Overview of Quantum Technology, Introduction to quantum computing, different between the traditional and quantum computing, applications of quantum computing. | |
| **UNIT 2: QUANTUM COMPUTING METHODS** | **8 Hrs.** |
| Quantum error correction, Quantum fault tolerance, Quantum cryptography, Simon's algorithm, The prime factorization algorithm, Grover's search algorithm. | |
| **UNIT 3: QUANTUM AI** | **8 Hrs.** |
| Introduction to quantum neural networks, utilizing quantum algorithms to make the transition from classical AI to quantum AI, Understanding the differences and advantages of quantum AI, | |
| **UNIT 4: APPLICATIONS OF QUANTUM AI** | **6 Hrs.** |
| Applications of Quantum AI for Optimization Problems, Quantum AI for complex scientific simulations, Quantum AI for drug discovery, Quantum AI for Data Security. | |

**Total: 28 Hrs.**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the concepts Quantum AI.
CO2: Understand the fundamentals concepts of quantum mechanics.
CO3: Apply various quantum AI algorithms.
CO4: Analyze the performance of various quantum AI algorithms and models.
CO5: Evaluate the performance of various quantum AI models.
CO6: Design applications using quantum AI.

**TEXT/REFERENCE BOOKS**

1. Quantum Computation and Quantum Information. Cambridge, UK: Cambridge University Press, September 2000. ISBN: 9780521635035.

| Course Code: 24AI546P | | | | | Quantum AI Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- To learn the fundamentals of the Generative AI
- To be able to understand and analyze the various Generative models.
- To apply various Generative AI models

**List of Experiments: Following is the list of experiments of experiments, but it is not limited to it.**

1. Parameterized quantum circuits
2. Data encoding for quantum machine learning.
3. Training parameterized quantum circuits
4. Implement variational quantum classifier.
5. Study the quantum feature maps and kernels.
6. Implement quantum unsupervised learning.
7. Implement quantum GAN.

**COURSE OUTCOMES**

On completion of the course, student will be able to
CO1: Remember the concepts generative AI.
CO2: Understand the fundamentals concepts of Generative AI.
CO3: Apply various Generative AI algorithms.
CO4: Analyze the performance of various Generative AI algorithms and models.
CO5: Evaluate the performance of various Generative AI models.
CO6: Design a custom Generative model.

**TEXT/REFERENCE BOOKS**

1. Qiskit Textbook, https://github.com/Qiskit/textbook

# Elective Track – 2: AI based analytics (With lab)

| 24AI547T | | | | | Time Series Analysis | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of time series data analysis methods.
- To understand univariate and multivariate time series data analysis.
- To apply of time series models for forecasting.

| **UNIT I: UNIVARIATE TIME SERIES MODELS** | **08 Hrs.** |
|---|---|
| Characteristics of Time Series, Statistical Parameters and Functions for Time Series Data, Linear Models: MA, AR, ARMA, Integrated Processes, Unit root test, Stationarity test, Forecasting using linear models, Estimations, modeling stochastic processes, Handling structural breaks. | |
| **UNIT II: - MODELS OF VOLATILITY** | **07 Hrs.** |
| Specification and Interpretation, The ARCH and GARCH models, Tests for Heteroskedasticity, Estimation of GARCH model. | |
| **UNIT III: MULTIVARIATE TIME SERIES MODELS** | **06 Hrs.** |
| Introduction to Basic Multivariate Time Series Analysis Models, VAR and VARMA models | |
| **UNIT IV: STATE SPACE TIME SERIES MODELS** | **07 Hrs.** |
| State Space Models, State Space Models with Correlated Errors, Filtering and Smoothing, Kalman Filter, Estimation of State Space Models | |
| **TOTAL HOURS: 28 Hrs.** | |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Remember characteristics of various time series models. |
| CO2 | : | Understand univariate and multivariate time series analysis techniques. |
| CO3 | : | Apply time series models in forecasting. |
| CO4 | : | Analyze models and results of forecasting. |
| CO5 | : | Evaluate and compare performance of various time series analysis models. |
| CO6 | : | Develop a suitable model based on characteristics of time series data |

**TEXT/REFERENCE BOOKS**


1. George Box, Gwilym Jenkins, Gregory Reinsel, Greta Ljung “Time Series Analysis: Forecasting and Control”, Wiley.
2. Robert H. Shumway, David S. Stoffer, “Time Series Analysis and its Applications”, Springer.
3. Tucker S. McElroy and Dimitris N. Politis “Time Series: A First Course with Bootstrap Starter”, CRC Press.
4. Klaus Neusser, “Time Series Econometrics”, Springer.
5. Raquel Prado, Marco A. R. Ferreira, Mike West, “Time Series: Modeling, Computation and Inference”, CRC Press.
6. Wayne A. Woodward, Henry L. Gray, Alan C. Elliott, “Applied Time Series Analysis with R”, CRC Press.

| 24AI547P | | | | | Time Series Analysis Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | -- | -- | -- | 50 | 50 | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of time series data analysis methods.
- To understand univariate and multivariate time series data analysis.
- To apply of time series models for forecasting.

| LIST OF EXPERIMENTS | |
|---|---|
| 1 | Introduction to Programming Tool and Libraries for Time Series Analysis |
| 2 | Time Series Primer, Getting time series plots |
| 3 | Getting ACF plots for various time series data. |
| 4 | Preparing data set from real world data and getting plots and ACF. |
| 5 | Stationarity test on time series data and estimation of statistical parameters. |
| 6 | Preparation of linear models and forecasting (MA, AR and ARMA models) |
| 7 | Models for non-stationary data (ARIMA and SARIMA models) |
| 8 | Filtering of time series data. |
| 9 | Performance evaluation of time series linear models. |
| 10 | ARCH and GARCH Modeling for volatility |
| 11 | VAR and VARMA Modeling for multivariate time series |
| 12 | State space modeling of time series data |
| 13 | Kalman filtering model of time series data |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Remember characteristics of various time series models. |
| CO2 | : | Understand univariate and multivariate time series analysis techniques. |
| CO3 | : | Apply time series models in forecasting. |
| CO4 | : | Analyze models and results of forecasting. |
| CO5 | : | Evaluate and compare performance of various time series analysis models. |
| CO6 | : | Develop a suitable model based on characteristics of time series data |

**TEXT/REFERENCE BOOKS**


1. George Box, Gwilym Jenkins, Gregory Reinsel, Greta Ljung “Time Series Analysis: Forecasting and Control”, Wiley.
2. Robert H. Shumway, David S. Stoffer, “Time Series Analysis and its Applications”, Springer.
3. Tucker S. McElroy and Dimitris N. Politis “Time Series: A First Course with Bootstrap Starter”, CRC Press.
4. Klaus Neusser, “Time Series Econometrics”, Springer.
5. Raquel Prado, Marco A. R. Ferreira, Mike West, “Time Series: Modeling, Computation and Inference”, CRC Press.
6. Wayne A. Woodward, Henry L. Gray, Alan C. Elliott, “Applied Time Series Analysis with R”, CRC Press.

| 24AI540T | | | | | AI in Sports Analytics | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| | | | | | Theory | | | Practical | | Total Marks |
| L | T | P | C | Hrs/Week | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Understand challenges and opportunities in sports 2.0.
- Analyze time-series data from sports matches, training sessions, practice sessions, and coaches.
- Develop and test predictive models using real-world sports data.
- Communicate findings effectively using visualization techniques by building a dashboard integrated with ML models.

| **UNIT 1: INTRODUCTION, DATA ACQUISITION AND PREPROCESSING** | **6 Hrs.** |
|---|---|
| **Introduction:** Overview of sports analytics, importance, and applications. **Data Acquisition and Management in Sports:** Sources of sports data, acquisition software and hardware, data quality issues, preprocessing techniques | |
| **UNIT 2: STATISTICAL AND MACHINE LEARNING MODELS** | **8 Hrs.** |
| **Statistical Methods for Sports Analytics**: Review applicable statistical methods. **Machine Learning Models in Sports:** Supervised and unsupervised learning in sports analytics for game performance, injury risk assessment | |
| **UNIT 3: TIME SERIES AND VIDEO ANALYTICS IN SPORTS** | **8 Hrs.** |
| **Time-Series Analysis in Sports:** Time-series and video analysis techniques for monitoring game data and athlete performance. **Injury Prediction and Prevention:** Video analytics for predicting and preventing injuries. | |
| **UNIT 4: Visualization Techniques in Sports Analytics** | **6 Hrs.** |
| **Techniques for effectively visualizing sports data**: Exploring Visualization tools and developing dashboards for use by the trainers and coaches. | |

**Total: 28 Hrs**

**COURSE OUTCOMES**

On completion of the course, students will be able to
CO1: Remember the key terms of the sports science.
CO2: Understand the different statistical methods.
CO3: Apply various ML algorithms to predict performance and injury risk.
CO4: Analyze patterns and trends for informed decision-making by the coaches.
CO5: Evaluate the effectiveness of visualization techniques.
CO6: Design a comprehensive sports analytics project.

**TEXT/REFERENCE BOOKS**


1. Fried, Gil, and Ceyda Mumcu, eds. Sport analytics: A data-driven approach to sport business and management. Taylor & Francis, 2016.
2. Alamar, Benjamin C. *Sports analytics: A guide for coaches, managers, and other decision makers*. Columbia University Press, 2013.

| Course Code: 24AI540P | | | | | AI in sports analytics Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/ Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- To learn the techniques of data collection, preprocessing, sports analytics, and data interpretation.
- To be able to understand statistical and ML models.
- To apply various software and analytical methods to handle real-world sports dataset

**List of Experiments: The following is the list of experiments of experiments, but it is not limited to it.**

1. Setting up the environment and discovering datasets.
2. Handling data quality, data cleaning and preprocessing
3. Applying statistical tests to sports data.
4. Building and evaluating prediction models for performance and injury risks.
5. Project Proposal (ten weeks project) – Outlining problems, dataset and deciding analytical methods.
6. Analyzing time series data from games.
7. Developing models for injury risk prediction.
8. Using software tools to create data visualization.
9. Final project presentation – Project, methods, results and insights.

**COURSE OUTCOMES**

On completion of the course, student will be able to
CO1: Remember the primary software tools, sports science terms and relevant libraries and framework.
CO2: Understand data flow in sports analytics.
CO3: Apply statistical and ML models to solve predefined problem in performance prediction and injury risks.
CO4: Analyse complex sports datasets and identify patterns.
CO5: Evaluate outcomes of sports analytics model.
CO6: Design a comprehensive project in sports analytics.

**TEXT/REFERENCE BOOKS**


1. Fried, Gil, and Ceyda Mumcu, eds. Sport analytics: A data-driven approach to sport business and management. Taylor & Francis, 2016.
2. Alamar, Benjamin C. *Sports analytics: A guide for coaches, managers, and other decision makers*. Columbia University Press, 2013
3. Severini, Thomas A. Analytic methods in sports: Using mathematics and statistics to understand data from baseball, football, basketball, and other sports. Chapman and Hall/CRC, 2020.

# Elective Track – 3: Applications of AI (With lab)

| 24AI539T | | | | | AI in Healthcare | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To introduce the basic concepts of AI in healthcare
- To study the various AI methods in healthcare
- To study the potential of AI in crucial decision making related to health

| | |
|---|---|
| **UNIT I: INTRODUCTION TO AI IN HEALTHCARE** | 07 Hrs. |
| Introduction of concepts, methods, and potential of intelligent systems in medicine: History and status quo, and decision support system. Application on any specific area of interest, Risk stratification, Data acquisition and pre-processing. | |
| **UNIT II: AI IN MEDICAL DIAGNOSTICS** | 07 Hrs. |
| Importance of AI in diagnostics, AI in medical image diagnostics (X-RAY, MRI, ultrasound, CT), Digital Imaging and Communications in Medicine (DICOM), AI in EEG, EMG, ECG, and multimedia-based diagnostics, prognosis, and overall survival prediction. Explainable AI in healthcare. | |
| **UNIT III: CLINICAL DECISION SUPPORT SYSTEMS** | 07 Hrs. |
| Feature identification and extraction, Model selection and implementation, Model validation and evaluation with performance metrics, visualization, and interpretability. Introduction to neural networks and applications in healthcare. Deep neural networks, Convolutional neural networks, ARIMA for time series forecasting, SHAP analysis for feature analysis and selection | |
| **UNIT IV: ETHICAL AND LEGAL CONSIDERATIONS** | 07 Hrs. |
| Patient privacy and data security in AI-driven healthcare, Regulatory landscape, and compliance (e.g., HIPAA, GDPR), Bias, fairness, and transparency in AI algorithms | |
| **TOTAL HOURS: 28 Hrs.** | |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Recognize the fundamental of AI in healthcare. |
| CO2 | : | Explore the applications of AI in healthcare, including medical imaging analysis, clinical decision support, and personalized medicine |
| CO3 | : | Examine the challenges and opportunities associated with integrating AI into healthcare systems. |
| CO4 | : | Implement AI models and algorithms for diagnostics. |
| CO5 | : | Analyze ethical, legal, and regulatory issues surrounding AI in healthcare |
| CO6 | : | Develop critical thinking skills to evaluate AI technologies and their impact on patient care and healthcare delivery |

**TEXT/REFERENCE BOOKS**


1. Arjun Panesar, “Machine Learning and AI for Healthcare Data for Improved Health Outcomes”, A Press, Second Edition, 2021
2. Ankur Saxena, Shivani Chandra. “Artificial Intelligence and Machine Learning in Healthcare”, First edition, Springer, 2021
3. Pradeep N, Sandeep Kautish, Sheng-Lung Peng. “Demystifying Big Data, Machine Learning, and Deep Learning for Healthcare Analytics”, Elsevier Academic Press, 2021

| 24AI539P | | | | | AI in Healthcare Laboratory | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | -- | -- | -- | 50 | 50 | 100 |

**COURSE OBJECTIVES**

- To introduce the basic concepts of AI in healthcare
- To study the various AI methods in healthcare
- To study the potential of AI in crucial decision making related to health

| LIST OF EXPERIMENTS | |
|---|---|
| 1 | To Study artifact removal in bio-signals |
| 2 | To Study waveform analysis and feature extraction from bio-signals. |
| 3 | Implementation of the pattern classification in bio-signals |
| 4 | To study the role of ECG/EMG/ EEG signal analysis in healthcare |
| 5 | Implementation of Brain Tumor Segmentation in MRI |
| 6 | Implementation of Lung cancer segmentation from MRI/ XRAY |
| 7 | Study of AI in Histopathology |
| 8 | Implementation of saliency map to find important features in MRI for a cancer/tumor cell |
| 9 | Study of AI in drug discovery and its comparison with In-silico methods |
| 10 | AI in protean folding |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Recognize the fundamental of AI in healthcare. |
| CO2 | : | Explore the applications of AI in healthcare, including medical imaging analysis, clinical decision support, and personalized medicine |
| CO3 | : | Examine the challenges and opportunities associated with integrating AI into healthcare systems. |
| CO4 | : | Implement AI models and algorithms for diagnostics. |
| CO5 | : | Analyze ethical, legal, and regulatory issues surrounding AI in healthcare |
| CO6 | : | Develop critical thinking skills to evaluate AI technologies and their impact on patient care and healthcare delivery |

TEXT/REFERENCE BOOKS


4. Arjun Panesar, “Machine Learning and AI for Healthcare Data for Improved Health Outcomes”, A Press, Second Edition, 2021
5. Ankur Saxena, Shivani Chandra. “Artificial Intelligence and Machine Learning in Healthcare”, First edition, Springer, 2021
6. Pradeep N, Sandeep Kautish, Sheng-Lung Peng. “Demystifying Big Data, Machine Learning, and Deep Learning for Healthcare Analytics”, Elsevier Academic Press, 2021

| 24AI535T | | | | | AI for IoT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Learn the fundamentals of Artificial Intelligence and IoT.
- Learn to role of AIoT in a distributed environment.
- Know the various implements of Artificial Intelligence and their working for IoT.
- Study the basic AioT applications.

| **UNIT 1 Artificial Intelligence and IoT Fundamentals** | **7 Hrs.** |
|---|---|
| Introduction to IoT: IoT applications, sensor systems, IoT, sensing techniques, IoT networking, IoT Data analytics, IoT Platforms and Systems, Intelligent Agents and Environments, Role of supervised learning, unsupervised learning, Reinforcement learning for IoT | |
| **UNIT 2 Architectures and Implements** | **7 Hrs.** |
| Introduction to Artificial Intelligence for IoT (AioT): AioT concepts and issues, Technologies behind AioT, AioT application segments, Technical architecture of AioT, Smart sensors, and devices; Wearables; Smart object and human, sensing, Challenges of AI in networks for IoT, AI for IoT data analytics and automation | |
| **UNIT 3 AI for Edge and Distributed Environments** | **7 Hrs.** |
| Distributed intelligence of IoT systems, Edge-Computing-Powered Artificial Intelligence of Things, On-device Machine Learning with IoT Devices, Advantages and disadvantages of using AI at the edge, | |
| **UNIT 4 AI Applications and Use Cases for IoT** | **7 Hrs.** |
| Use of AI implements in different IoT domains such as Autonomous Vehicles, Surveillance Systems, Smart Homes, Smart Buildings, Smart Cities, Industrial Automation, and Intelligent Transportation Systems, etc. | |

**Max 28 Hrs.**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Understand the fundamental concepts, technical challenges, and state-of-the-art technology of AioT

CO2: Learn the architectures and platforms for sensing, networking, and data analytics in AioT systems

CO3: Implementing learning techniques for AioT

CO4: Analyze the AioT at the Edge and in the distributed environment

CO5: Evaluate the performance of AIOT architecture and implements

CO6: Design and create AioT applications

**TEXT/REFERENCE BOOKS**


1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
2. AioT Innovation, ed. Fadi AI-Turjman. Publisher: Springer. 2020
3. Hands-On Artificial Intelligence for IoT: Expert machine learning and deep learning techniques for developing smarter IoT systems", by Amita Kapoor. Publisher: Packt Publishing Ltd. 2018.
4. Dieter Uckelmann et.al, Architecting the Internet of Things, Springer

| 24AI535P | | | | | AI for IoT Laboratory | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Learn the fundamentals of Artificial Intelligence and IoT.
- Learn to role of AIoT in a distributed environment.
- Know the various implements of Artificial Intelligence and their working for IoT.
- Study the basic AIoT applications.

**The experiments could be based upon the following topics.**

1. Sensors and actuators for AI-enabled IoT
2. Microcontrollers and microprocessors for AI-enabled IoT
3. Communication and networking protocols for AI-enabled IoT
4. Using basic AI implements in IoT systems.
5. Deploying ML and CV based techniques in IoT.
6. AI methods for IoT data analytics
7. Distributed intelligence of IoT systems,
8. Edge-Computing-Powered Artificial Intelligence of Things,
9. On-device Machine Learning with IoT Devices, Advantages, and disadvantages of using AI at the edge.

**COURSE OUTCOMES**

On completion of the course, student will be able to

| | | |
|---|---|---|
| CO1 | : | Understand the fundamental concepts, technical challenges, and state-of-the-art technology of AIIoT |
| CO2 | : | Learn the architectures and platforms for sensing, networking, and data analytics in AIIoT systems |
| CO3 | : | Implementing learning techniques for AIIoT |
| CO4 | : | Analyze the AIIoT at the Edge and in the distributed environment |
| CO5 | : | Evaluate the performance of AIOT architecture and implements |
| CO6 | : | Design and create AIIoT applications |

**TEXT/REFERENCE BOOKS**


5. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
6. AIoT Innovation, ed. Fadi AI-Turjman. Publisher: Springer. 2020
7. Hands-On Artificial Intelligence for IoT: Expert machine learning and deep learning techniques for developing smarter IoT systems", by Amita Kapoor. Publisher: Packt Publishing Ltd. 2018.
8. Dieter Uckelmann et.al, Architecting the Internet of Things, Springer

| 24AI536T | | | | | AI for Scientific discovery | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/ Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Introduce fundamental concepts of artificial intelligence (AI) as applied to scientific discovery,
- Understand the principles and applications of AI techniques in discovery of scientific solutions addressing a range of user defined specifications,
- Develop skills to implement AI algorithms for mapping the design space with the respective behavioral space.

| **UNIT 1: Introduction to solution space for discovery** | **08 Hrs.** |
|---|---|
| Solution space for discovery, Modelling the solution space, Bounds and constraints, Objective function, Objective function for constrained search, Nature-inspired optimization techniques in scientific discovery, Discovery in fault/perturbation prone solution space, Robust design discovery | |
| **UNIT 2: Discovery space mapping using neural networks** | **08 Hrs.** |
| Surrogate modelling: Introduction to the concept of surrogate models, Design of surrogate models using Neural networks, Case study of surrogates on hardware design, Challenge of non-uniqueness, addressing non-uniqueness with representation learning, the challenge of vanishing gradients, Network architectures to address vanishing gradients. | |
| **UNIT 3: Sampling strategies for scientific discovery** | **07 Hrs.** |
| Dataset generation for knowledge discovery, Sampling the discovery space, Probability sampling – Simple, stratified, systematic and cluster sampling, Nonprobability sampling, Latent space sampling, Clustering for dataset generation | |
| **UNIT 4: Scientific Machine Learning** | **05 Hrs.** |
| Physics based loss functions- Residual derivatives, DNN based derivatives, Physics driven neural networks, Reducing numerical error with learning | |

**Total: 28 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1 – Identify the aspects of solution space in scientific discovery.

CO2 – Understand the techniques to traverse in the solution space.

CO3 – Apply appropriate tool/method to map the solution space.

CO4 – Analyze the obtained solution in context with its accuracy and robustness.

CO5 – Appraise formulations to informatively sample the space for discovery.

CO6 – Evaluate and design loss functions based on the physics of the discovery.

**TEXT/REFERENCE BOOKS**


1. Slawomir Koziel, Leifur Leifsson, Surrogate-Based Modeling and Optimization: Application in Engineering, 1st Edition, Springer-Verlag New York Inc (2013)
2. Jiang P, Zhou Q, Shao X, Jiang P, Zhou Q, Shao X. Surrogate-model-based design and optimization. Springer Singapore (2020)

| 24AI536P | | | | | AI for Scientific Discovery Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 50 | 50 | 100 |

**COURSE OBJECTIVES:**

- To learn the fundamentals of the biometrics systems and their performance metrics
- To be able to understand and analyze the various properties of a biometric system.
- To apply various authentication algorithms in biometrics.

**List of Experiments: Following is the list of experiments, but it is not limited to it.**

1. To define a bounded solution space and implementing constraints.
2. To explore the solution space using evolution based and swarm-based search algorithm.
3. To exploit the of solution space for best solutions.
4. To build DNN-based surrogate model from an available dataset.
5. To address vanishing gradient in scientific data with skip layers.
6. To implement surrogate assisted optimization.
7. To visualize latent representation of scientific data using auto-encoders.
8. To sample a design space using random/Latin Hypercube sampling and training a model with it.
9. To sample a design space using greedy sampling and clustering and training a model with it.
10. To design a machine learning model with a loss function driven from the physics of scientific data.

**COURSE OUTCOMES:**

On completion of the course, student will be able to

CO1 – Identify the aspects of solution space in scientific discovery.
CO2 – Understand the techniques to traverse in the solution space.
CO3 – Apply appropriate tool/method to map the solution space.
CO4 – Analyze the obtained solution in context with its accuracy and robustness.
CO5 – Appraise formulations to informatively sample the space for discovery.
CO6 – Evaluate and design loss functions based on the physics of the discovery.

**TEXT/REFERENCE BOOKS**

1. Molnar, C. (2022). Interpretable Machine Learning, Second Edition, Molnar C. Interpretable machine learning 2020, Lulu Publishers.

| 24AI537T | | | | | AI in Biometrics Systems and Security | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To learn the fundamentals of the biometrics systems and their performance metrics
- To be able to understand and analyze the various properties of a biometric system
- To apply various authentication algorithms in biometrics.

| **UNIT 1: INTRODUCTION TO BIOMETRICS SYSTEMS** | **8 Hrs.** |
|---|---|
| Introduction – Biometric systems, modes of operation, performance measures, Choosing a threshold, False acceptance, false rejection, equal error rate, accuracy, CMC curve, ROC curve, Area under ROC curve, d' index, design cycle of biometric systems, physiological and behavioral biometrics. Biometric databases: constrained and unconstrained. | |
| **UNIT 2: BIOMETRIC AUTHENTICATION TECHNIQUES** | **7 Hrs.** |
| Face Recognition, Face detection, alignment, and feature extraction, Deep learning models for face recognition, Case studies: FaceNet, VGGFace, Fingerprint and Iris Recognition, Minutiae-based fingerprint matching, Iris segmentation and feature extraction, Deep learning approaches for fingerprint and iris recognition. | |
| **UNIT 3 : SECURITY CHALLENGES AND COUNTERMEASURES** | **7 Hrs.** |
| Spoofing Attack Detection, Types of spoofing attacks (presentation attacks), Anti-spoofing techniques using CNNs and LSTMs, Cancelable Biometrics and Template Protection, Cancelable biometric systems, Cryptographic techniques for template protection, Privacy-preserving approaches. | |
| **UNIT 4 : ADVANCED TOPICS IN BIOMETRICS** | **6 Hrs.** |
| Multimodal Biometrics, Fusion of multiple biometric traits, Score-level and decision-level fusion, Deep learning-based multimodal systems, Biometric Presentation Attack Detection. | |

**Total: 28 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Define biometrics and list common biometric traits.

CO2: Understand the significance of biometrics in security and gain foundational knowledge of AI techniques.

CO3: Apply deep learning techniques to various biometric modalities and compare different deep learning approaches for biometric authentication.

CO4: Analyze different deep learning approaches for biometric authentication.

CO5: Evaluate the strengths and limitations of existing biometric security solutions and critically assess the impact of multimodal authentication on security.

CO6: Develop novel approaches for biometrics authentication.

TEXT/REFERENCE BOOKS


1. Anil K. Jain, Arun Ross, and Karthik Nandakumar, “Introduction to Biometrics”, 2011, First Edition, Springer, ISBN number: 978-0-387-77326-1.
2. Mayank Vatsa, Richa Singh, and Angshul Majumdar, “Deep learning in Biometrics”, 2018, CRC Press, Taylor & Francis Group, ISBN number: 978-1-138-57823-4
3. Bir Bhanu and Ajay Kumar, “Deep learning for Biometrics”, 2017, Springer International Publishing, ISBN number: 978-3-319-61656-8
4. Guodong Guo and Harry Wechsler, “Mobile Biometrics”, 2017, Institution of Engineering and Technology (IET), London, ISBN number: 978-1-78561-095-0

| 24AI537P | | | | | AI in Biometrics Systems and Security Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Teaching Scheme** | | | | | **Examination Scheme** | | | | | |
| **L** | **T** | **P** | **C** | **Hrs/Week** | **Theory** | | | **Practical** | | **Total Marks** |
| | | | | | **MS** | **ES** | **IA** | **LW** | **LE/Viva** | |
| **0** | **0** | **2** | **1** | **2** | **0** | **0** | **0** | **50** | **50** | **100** |

**COURSE OBJECTIVES:**

- To learn the fundamentals of the biometrics systems and their performance metrics
- To be able to understand and analyze the various properties of a biometric system
- To apply various authentication algorithms in biometrics.

**List of Experiments: Following is the list of experiments, but it is not limited to it.**

1. Localization of iris from the eye image.
2. Localization of palmprint region from hand image.
3. Study of performance measures for a biometric systems in verification mode.
4. Study of performance measures for a biometric systems in identification mode.
5. Implementing a full biometric system with public iris dataset.
6. Implementing a full biometric system with public palmprint dataset.
7. To study and implement PAD algorithms.
8. Realization of fingerprint identification through COTS matchers.
9. To implement multimodal biometrics system using feature-level fusion.
10. To implement multimodal biometrics system using score-level fusion.

**COURSE OUTCOMES:**

On completion of the course, student will be able to

CO1: Define biometrics and list common biometric traits.

CO2: Understand the significance of biometrics in security and gain foundational knowledge of AI techniques.

CO3: Apply deep learning techniques to various biometric modalities and compare different deep learning approaches for biometric authentication.

CO4: Analyze different deep learning approaches for biometric authentication.

CO5: Evaluate the strengths and limitations of existing biometric security solutions and critically assess the impact of multimodal authentication on security.

CO6: Develop novel approaches for biometrics authentication.

**TEXT/REFERENCE BOOKS**


1. Anil K. Jain, Arun Ross, and Karthik Nandakumar, “Introduction to Biometrics”, 2011, First Edition, Springer, ISBN number: 978-0-387-77326-1.
2. Mayank Vatsa, Richa Singh, and Angshul Majumdar, “Deep learning in Biometrics”, 2018, CRC Press, Taylor & Francis Group, ISBN number: 978-1-138-57823-4
3. Bir Bhanu and Ajay Kumar, “Deep learning for Biometrics”, 2017, Springer International Publishing, ISBN number: 978-3-319-61656-8
4. Guodong Guo and Harry Wechsler, “Mobile Biometrics”, 2017, Institution of Engineering and Technology (IET), London, ISBN number: 978-1-78561-095-0

| 24AI538T | | | | | AI in Finance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 2 | 0 | 0 | 2 | 2 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of AI in financial technologies.
- To understand financial system modeling using AI techniques.
- To apply AI techniques to financial systems.

| **UNIT I: AI AND NORMATIVE FINANCE** | **09 Hrs.** |
|---|---|
| Introduction to Financial Markets and Instruments, AI's role in financial technology, Current trends and challenges, AI algorithms, Machine learning and deep learning models for financial applications, Modelling of Risk, Return, Markowitz's Mean-Variance Portfolio Theory, Portfolio Optimization, Capital Asset Pricing Model (CAPM), Performance Analysis, Modelling return generating process, Modelling investors, Utility Theory, Indifference curves, Arbitrage Pricing Model. | |
| **UNIT II: IMPORTANT APPLICATIONS OF AI IN FINANCE: CASE STUDIES (IMPLEMENTATION THROUGH LAB SESSIONS)** | **04 Hrs.** |
| AI in wealth and asset management, Investment strategies and trading, Overview, working, approaches and applications of recommendation engines in finance, Insurance, Product development and behavioral pricing, Customer experience and personalization, Claims management and fraud detection, Customer services, Robotics Process Automation, Credit Scoring. | |
| **UNIT III: FUNDAMENTAL AND TECHNICAL ANALYSIS FOR INVESTMENT AND TRADING DECISIONS** | **08 Hrs.** |
| Economic analysis, Sector analysis, Company analysis, understanding data in Financial Statements, Intrinsic valuation models. Technical analysis: Introduction, Various Price and Volume indicators and Charting Tools, Efficient market hypothesis, Implications on trading and investment decisions. | |
| **UNIT IV: INTRODUCTION TO ALGORITHMIC TRADING (IMPLEMENTATION THROUGH LAB SESSIONS)** | **07 Hrs.** |
| Introduction, Architecture of Algorithmic trading system, API, Order types and execution, Limitations, managing historical data, Vectorized back testing, Predicting movements, Building classes for event based back-testing, Automating trading operations, Cloud deployments, Ethics in Algorithmic Trading, Future trends. | |
| **TOTAL HOURS: 28 Hrs.** | |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

CO1 : Define characteristics of intelligent financial systems.
CO2 : Understand representation of financial models using AI.
CO3 : Apply AI models to solve problems of financial industries.
CO4 : Analyze financial system models.
CO5 : Evaluate and compare performance of various financial models.
CO6 : Develop a suitable model based on characteristics of financial data

**TEXT/REFERENCE BOOKS**


1. Hariom Tatsat, Sahil Puri & Brad Lookabaugh "Machine Learning & Data Science Blueprints for Finance", O'Reilly.
2. J. C. Francis, D. Kim, "Modern portfolio theory: Foundations, analysis, and new developments". John Wiley & Sons.
3. Stefan Jansen, "Machine Learning for Algorithmic Trading: Predictive Models to Extract Signals from Market and Alternative Data for Systematic Trading Strategies with Python".
4. Yves Hilpisch "Python for Algorithmic Trading", O'Reilly.

| 24AI538P | | | | | AI in Finance Lab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 0 | 0 | 2 | 1 | 2 | -- | -- | -- | 50 | 50 | 100 |

**COURSE OBJECTIVES**

- To impart basic knowledge of AI in financial technologies.
- To understand financial system modeling using AI techniques.
- To apply AI techniques to financial systems.

| LIST OF EXPERIMENTS<br>Case Studies to be developed in Python/Any other suitable computer language | |
|---|---|
| 1 | Risk - return analysis and building efficient frontier portfolio analysis and portfolio optimization using historical data of financial securities |
| 2 | Portfolio management and performance evaluation |
| 3 | Capital asset pricing model (CAPM) for portfolio management and optimization |
| 4 | Clustering Investors using ML-DL techniques |
| 5 | Clustering Financial Assets and Instruments using ML-DL techniques |
| 6 | Predicting future values of financial time series data using ML-DL and time series models |
| 7 | Using Deep Learning for Movement Prediction |
| 8 | Fraud Detection using ML-DL techniques |
| 9 | Loan Default Probability using ML-DL techniques |
| 10 | Various technical indicators and charting on multi-time frames |
| 11 | Algorithmic trading strategies using ML-DL techniques and technical indicators |
| 12 | Working with Real Time Data, API and Sockets for Algorithmic Trading |
| 13 | Sentiment analysis using AI tools |
| 14 | Automated Portfolio Recommender |
| 15 | Credit Scoring Modelling |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Define characteristics of intelligent financial systems. |
| CO2 | : | Understand representation of financial models using AI. |
| CO3 | : | Apply AI models to solve problems of financial industries. |
| CO4 | : | Analyze financial system models. |
| CO5 | : | Evaluate and compare performance of various financial models. |
| CO6 | : | Develop a suitable model based on characteristics of financial data |

**TEXT/REFERENCE BOOKS**


1. Hariom Tatsat, Sahil Puri & Brad Lookabaugh “Machine Learning & Data Science Blueprints for Finance”, O’Reilly.
2. J. C. Francis, D. Kim, “Modern portfolio theory: Foundations, analysis, and new developments”. John Wiley & Sons.
3. Stefan Jansen, “Machine Learning for Algorithmic Trading: Predictive Models to Extract Signals from Market and Alternative Data for Systematic Trading Strategies with Python”.
4. Yves Hilpisch “Python for Algorithmic Trading”, O’Reilly.

# Elective Track – 4: Advance Applications of AI (Without Lab)

| 24AI506T | | | | | AI in Agriculture | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Introduce fundamental concepts of artificial intelligence (AI) as applied to agriculture.
- Understand the principles and applications of AI techniques in agricultural systems.
- Develop skills to implement AI algorithms for solving agricultural problems.

| **UNIT 1: Introduction To AI in Agriculture** | **11 Hrs.** |
|---|---|
| Overview of artificial intelligence in agriculture, Introduction to machine learning and deep learning in agriculture, Applications of AI in crop monitoring, yield prediction, disease detection, and precision agriculture, Challenges and opportunities in applying AI to agricultural systems. | |
| **UNIT 2: Machine Learning Techniques for Agricultural Data** | **11 Hrs.** |
| Introduction to machine learning algorithms for agricultural data analysis, such as decision trees, random forests, and support vector machines, Preprocessing techniques for agricultural datasets, including feature scaling and data normalization, Model evaluation and performance metrics for agricultural applications, Case studies and practical examples of machine learning in agriculture. | |
| **UNIT 3: Deep Learning for Image Analysis in Agriculture** | **11 Hrs.** |
| Introduction to convolutional neural networks (CNNs) for image analysis in agriculture, Transfer learning and fine-tuning pretrained CNN models for agricultural image classification, Applications of deep learning in plant disease detection, weed identification, and crop monitoring using satellite imagery, Hands-on exercises and projects using deep learning frameworks for agricultural image analysis. | |
| **UNIT 4: AI for Precision Farming and Smart Agriculture** | **9 Hrs.** |
| Introduction to precision farming and smart agriculture technologies, Sensor-based data collection and IoT devices for agricultural monitoring, Implementation of AI algorithms for real-time decision-making in precision agriculture, Integration of AI with robotics and drones for autonomous farming operations. | |

**Total: 42 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Define the fundamental concepts and terminology associated with artificial intelligence and its applications in agriculture.
CO2: Explain the principles and techniques of machine learning and deep learning as applied to agricultural data analysis and decision-making.
CO3: Evaluate machine learning algorithms for solving agricultural problems, including crop yield prediction, disease detection, and pest control.
CO4: Analyze and interpret the performance of deep learning models for image analysis in agriculture, such as plant disease identification and crop monitoring.
CO5: Design and develop AI-based solutions for precision farming and smart agriculture applications, considering real-world constraints and challenges.
CO6: Evaluate the ethical, environmental, and social implications of deploying AI technologies in agriculture and propose strategies for responsible and sustainable adoption.

**TEXT/REFERENCE BOOKS**


1. Camps-Valls, Gustau, Devis Tuia, Xiao Xiang Zhu, and Markus Reichstein, eds. Deep learning for the Earth Sciences: A comprehensive approach to remote sensing, climate science and geosciences. John Wiley & Sons.
2. Satapathy, Suchismita, Debesh Mishra, and Arturo Realyvásquez Vargas. Innovation in Agriculture with IoT and AI. Springer.
3. Pantazi, Xanthoula-Eirini, Dimitrios Moshou, and Dionysis Bochtis. Intelligent data mining and fusion systems in agriculture. Academic Press.
4. Khan, Mohammad Ayoub, Rijwan Khan, and Mohammad Aslam Ansari, eds. Application of Machine Learning in Agriculture. Academic Press.

| 24AI531T | | | | | AI in Law, governance, and public policies | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs./Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 1 | 0 | 4 | 4 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

1. To gain the knowledge of emergence of AI ethics in law and public policy, examining the norms, values, and political strategies involved in the consensus-building processes that shape the
2. To understand in critical analysis of AI policy documents and delve into core principles such as fairness, accountability, and transparency,
3. To gain a series of design thinking workshops that will challenge students to debate over the responsible use of AI in real-world case studies.

| **UNIT I: INTEGRITY AND TRANSPARENCY** | **12 Hrs.** |
|---|---|
| The challenges of evaluating AI-augmented knowledge; the value of intellectual property in the age of knowledge extractivism; and the relevance of academic traditions in emerging knowledge landscapes. The use of technology for professional judgment in critical decision-making processes; the potential for deceptive outputs of machine learning algorithms; and the essential role of human oversight in mitigating the limitations of AI. | |
| **UNIT II: DEMOCRACY AND INTEROPERABILITY** | **12 Hrs.** |
| The emergence of AI-based communication systems; the responsibilities of tech companies vs. governmental bodies in regulating content; and the potential impacts on public opinion and values. The global context of AI governance; the feasibility of harmonizing policies between nations with fundamentally different norms and values; and the potential for creating standards that respect both technological progress and cultural diplomacy. | |
| **UNIT III: ACCOUNTABILITY AND FAIRNESS** | **12 Hrs.** |
| The ethical challenges of programming moral decisions into machines; the principles that should guide such decisions; and the legal and ethical frameworks for accountability when those decisions lead to harm. The trade-offs between technological efficiency and fairness; the ethical obligations to prevent bias in technological deployments; and the broader societal impacts of relying on flawed systems. | |
| **UNIT IV: CONTROL AND SUSTAINABILITY** | **08 Hrs.** |
| The balance between using technology for collective governance and the potential risks to personal liberty; the impact of algorithmic bias on such systems; and the meaning of user-centric data agency. The environmental costs and benefits of deploying AI systems; and the ethical implications in aligning them with sustainable development goals. | |
| | **TOTAL HOURS: 42 Hrs.** |

**COURSE OUTCOMES**

On completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | : | Identify and remember core principles, challenges, and developments in AI governance, including essential policy milestones and landmark case studies |
| CO2 | : | Understand the complex interplay of AI development and regulatory practices, comprehending how emerging technologies influence and are influenced by public norms and values. |
| CO3 | : | Apply interdisciplinary approaches integrating knowledge from the humanities, social sciences, and public policy to evaluate the social impact of emerging AI applications in real-world scenarios. |
| CO4 | : | Analyze emerging AI governance strategies, critically assessing their origins, applications, and effectiveness for responsible AI management and regulation. |
| CO5 | : | Exercise leadership and communication skills necessary for advocating ethical decision-making and public interest in AI governance, considering both global impact and specific community needs. |
| CO6 | : | Design an original project around a specific challenge that demonstrates critical thinking and innovation in promoting the strategic use of AI for the public good |

TEXT/REFERENCE BOOKS

1. Costanza-Chock, Sasha. “Design Sites: Hackerspaces, Fablabs, Hackathons, and DiscoTechs.” Design Justice: Community-led Practices to Build the Worlds We Need, 135-172. Cambridge, MA: The MIT Press,2020.
2. Gal, Danit. "Perspectives and Approaches in AI Ethics: East Asia." In Markus D. Dubber, Frank Pasquale,and Sunit Das (eds). The Oxford Handbook of Ethics of AI, 607-625. New York: Oxford University Press,2020
3. Eubanks, Virginia. “Automating Eligibility in the Heartland.” In Automating Inequality: How High-tech Tools Profile, Police, and Punish the Poor, 39-84. New York, NY: St. Martin's Press, 2018.

| 24AI533T | | | | | AI in surveillance and National security | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- To understand role of artificial intelligence (AI) technologies in modern surveillance systems and national security efforts.
- To be able to understand and analyze key components and architectures of surveillance systems, including sensors, data processing, and analytics.
- To assess the ethical and legal considerations associated with the use of AI in surveillance and national security, including privacy rights and data protection.

| UNIT 1: INTRODUCTION TO SURVEILLANCE | 10 Hrs. |
|---|---|
| Overview of Surveillance Studies Brief history, key developments leading to current surveillance technologies; public controversy and accountability. Visual surveillance; audio surveillance; aerial surveillance; Biometrics; pros and cons of surveillance technologies. | |
| **UNIT 2: AI TECHNIQUES FOR SURVEILLANCE** | **10 Hrs.** |
| Video analytics: motion detection, object detection (human, vehicles, attributes), YOLO, anomaly detection, Behavioral analytics: activity recognition, crowd analysis, scene understanding, gait analysis | |
| **UNIT 3 : CASE STUDIES AND REAL-WORLD APPLICATIONS** | **11 Hrs.** |
| Analysis of case studies illustrating the deployment of AI in surveillance and national security operations. Examples from various domains, including border security, counterterrorism, law enforcement, and cybersecurity. | |
| **UNIT 4 : PRIVACY AND ETHICAL CONSIDERATIONS** | **11 Hrs.** |
| Ethical considerations and legal frameworks governing the use of AI in surveillance and national security. Legal and ethical implications of surveillance video analytics. Privacy-preserving techniques such as anonymization and encryption. Compliance with regulations such as GDPR (General Data Protection Regulation). | |

**Total: 42 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Define key concepts related to AI in surveillance and national security.
CO2: Explain the principles behind AI algorithms used in surveillance applications.
CO3: Apply AI techniques to analyze surveillance data for video analytics.
CO4: Evaluate the effectiveness of AI algorithms in detecting and mitigating security risks.
CO5: Design AI-based solutions for addressing specific national security challenges, such as border control or counterterrorism.
CO6: Evaluate the societal impact and ethical implications of AI-driven surveillance practices.

**TEXT/REFERENCE BOOKS**


1. Maheshkumar H Kolekar, “Intelligent Video Surveillance Systems”, 2018, CRC Press, ISBN number: 978-1498767118.
2. Kerstin Denecke, “Event-Driven Surveillance: Possibilities and Challenges”, 2012, Springer.

| 24AI532T | | | | | AI in Defence & Space Applications | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Introduce fundamental concepts of artificial intelligence (AI) as applied to space and defense applications,
- Understand the principles and applications of AI techniques in space exploration and defense systems,
- Develop skills to implement AI algorithms for solving challenges in space and defense domains.

| **UNIT 1: Introduction to AI in Space and Defense** | **11 Hrs.** |
|---|---|
| Overview of artificial intelligence in space and defense applications, Introduction to machine learning and deep learning in space exploration and defense systems, Applications of AI in satellite communication, space debris tracking, and defense surveillance, Challenges and opportunities in applying AI to space and defense domains. | |
| **UNIT 2: Machine Learning Techniques for Space and Defense Data** | **11 Hrs.** |
| Introduction to machine learning algorithms for space and defense data analysis, such as decision trees, random forests, and support vector machines, Preprocessing techniques for space and defense datasets, including feature scaling and data normalization, Model evaluation and performance metrics for space and defense applications, Case studies and practical examples of machine learning in space exploration and defense systems. | |
| **UNIT 3: Deep Learning for Image Analysis in Space and Defense** | **10 Hrs.** |
| Introduction to advanced neural networks for image analysis in space and defense applications, Transfer learning and fine-tuning pretrained CNN models for satellite image classification and object detection, Applications of deep learning in satellite imagery analysis, target recognition, and military intelligence, Hands-on exercises and projects using deep learning frameworks for space and defense image analysis. | |
| **UNIT 4:AI for Autonomous Systems and Cybersecurity** | **10 Hrs.** |
| Introduction to AI for autonomous space systems and unmanned aerial vehicles (UAVs), Implementation of AI algorithms for autonomous navigation, obstacle avoidance, and mission planning in space and defense contexts, AI techniques for cybersecurity and threat detection in defense systems, Integration of AI with unmanned platforms and cybersecurity measures for defense applications. | |

**Total: 42 Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Define the fundamental concepts and terminology associated with artificial intelligence and its applications in space and defense domains.

CO2: Explain the principles and techniques of machine learning and deep learning as applied to space exploration and defense systems.

CO3: Evaluate machine learning algorithms for solving challenges in space and defense data analysis, including satellite imagery interpretation and threat detection.

CO4: Analyze the performance of deep learning models for image analysis in space and defense applications, such as object recognition and target tracking.

CO5: Design AI-based solutions for autonomous systems and cybersecurity in space and defense contexts.

CO6: Evaluate the ethical, legal, and security implications of deploying AI technologies in space and defense applications and propose strategies for responsible and secure adoption.

**TEXT/REFERENCE BOOKS**


1. Masakowski, Yvonne R., ed. Artificial intelligence and global security: future trends, threats and considerations. Emerald Publishing Limited.
2. Daugherty, Paul R., and H. James Wilson. Human+ machine: Reimagining work in the age of AI. Harvard Business Press.
3. Murphy, Robin R. Introduction to AI robotics. MIT press.

| Course Code: 24AI505T | | | | | AI for Energy and Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Teaching Scheme | | | | | Examination Scheme | | | | | |
| L | T | P | C | Hrs/Week | Theory | | | Practical | | Total Marks |
| | | | | | MS | ES | IA | LW | LE/Viva | |
| 3 | 0 | 0 | 3 | 3 | 25 | 50 | 25 | -- | -- | 100 |

**COURSE OBJECTIVES**

- Understand the importance of AI in Energy and Environmental issues.
- Explain various AI methods for Energy and environment.
- Analyze and design various AI models for Energy and environment applications.

| **UNIT 1 Introduction to AI in Energy and Environment** | **10Hrs.** |
|---|---|
| Understanding how AI is used in energy systems, AI applications in energy production, scheduling, and optimization, Understanding the role of AI in renewable energy system, Understanding the role of AI in environment protection and sustainable development. | |
| **UNIT 2: Various applications of AI in Energy and Environmental research** | **12 Hrs.** |
| AI in Energy material engineering, AI in renewable energy research, AI climate change study, AI in sustainable Development, AI in Environment management, AI in ocean and coastal environment research, AI in biodiversity conservation. | |
| **UNIT 3: AI and its impact in Energy and environment** | **15 Hrs.** |
| Impact of AI training in energy and environment, Increasing Energy Demand due to use of AI, Adding Electronic Waste due to increase in data centers, Increasing Carbon Emissions, Growing Plants Using Less Natural Resources, maintaining Artificial Climate for agriculture and green house management. | |
| **UNIT 4: Ethical Concern in applications of AI in energy and environment** | **5 Hrs.** |
| Bias in Decision-Making, energy requirements of AI compute and the growing need for rare-earth materials, Failure to secure equitable access to these physical requirements for successful AI development, risks fueling geopolitical instability as the more AI developed countries seek to secure cheap energy supplies and protect the supply chains for key raw materials. | |

**Total: 42Hrs**

**COURSE OUTCOMES**

On completion of the course, student will be able to

CO1: Remember the uses of AI in Energy and Environment

CO2: Understand the impact of AI in Energy and Environment

CO3: Apply various AI algorithms for energy and environmental study.

CO4: Analyze the performance of various AI algorithms for energy and environment.

CO5: Evaluate the performance of various AI models for energy and environment research.

CO6: Design a custom AI model for energy and environment.

**TEXT/REFERENCE BOOKS**


1. Artificial Intelligence Methods in the Environmental Sciences, By Sue Ellen Haupt, Antonello Pasini, Caren Marzban 2009, Springer Netherlands