Syllabus

Course Name: Machine Learning **[2:0:2=3]**

Course Content:

Introduction to Machine Learning. Essential Libraries and Tools (SciPy, NumPy, Pandas, Graphviz, Seaborn, matplotlib Packages). Types of learning - supervised and unsupervised learning. Types of problems - Regression, Classification and Clustering; Applications of machine learning. Discussion on the key concepts such as the cost function, optimization - Gradient Descent algorithm. Sampling, decision boundary, Under-fitting and Overfitting of models and Bias-Variance tradeoff, Cost-sensitive models, inductive bias. Bayesian Learning: Basics of Probability, Bayes Rule, Generative vs. Discriminative Models, Bayes Rule - Parameter Estimation, Maximum Likelihood. Supervised Learning: Solving Regression Problems - Linear Regression, Regularization - Ridge and Lasso. Solving Classification Problems - Logistic Regression, SVM, Decision Tree. Ensemble - Decision Forest, Bagging and Boosting. Unsupervised Learning: Clustering - DBScan and BIRCH. Anomaly Detection - Density Estimation. Introduction to Reinforcement Learning. Dimension Reduction with Principal Components Analysis, Kernel Principal Components Analysis. Introduction to Artificial Neural Networks. Model validation and selection: Accuracy, confidence interval, Confusion Matrix, Precision, Recall and other metrics, Hyper-parameter tuning, Cross Validation, Bootstrap and ROC curves, R-squared etc. Model Deployment - deploying the machine learning model in a cloud-based server.

Course Outcomes:

CO1: Understand different types of machine learning techniques and their applications.

CO2: Apply different machine learning algorithms for solving classification, and regression using feature engineering and feature selection.

CO3: Analyse real-world problems and design appropriate machine learning models.

Textbook:

1) Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2) Ethem Alpaydın, Introduction to Machine Learning (Adaptive Computation and Machine Learning), MIT Press, 2004.
3) Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc, 2022

Reference Book:

1) Gareth James, Daniela Witten, Trevor Hastie, Robert, Tibshirani, and Jonathan Taylor, Introduction to Statistical Learning with Applications in Python, Springer, 2023.

2) Raschka, Sebastian, and Vahid Mirjalili, Python machine learning: Machine learning and deep learning with Python, scikit-learn, and TensorFlow 2, Packt Publishing Ltd, 2019.

Course Name: Computer Organization & Architecture **[2:1:0=3]**

Course Content:

Introduction: Function and structure of a computer, Functional components of a computer, Interconnection of components, Performance of a computer. Instruction Set Architecture: Representation of Instructions: Machine instructions, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures, Processing Unit: Organization of a processor - Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Microprogrammed control unit, Introduction to parallel processing systems, Flynn's classifications, pipeline processing, Instruction pipelining, pipeline stages and Pipeline hazards.

Memory Subsystem: Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Error correction memories, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Address translation, Hardware support for memory management.

Course Outcomes:

CO1: Understand the functional units of the processors and corresponding instruction set architecture

CO2: Design the computer systems consisting of processing unit, I/O devices and memory subsystem for solving realistic problems.

CO3: Analyze the performance of given systems in terms of data transfer rate, processing speed, density, cost etc.

Text Book:

1) William Stallings, "Computer Organization and Architecture – Designing for Performance", Latest edition.
2) Hennessy, J. L., and D. A. Patterson. Computer Architecture: A Quantitative Approach, 3rd ed. San Mateo, CA: Morgan Kaufman, 2002.
3) M Morris Mano and Rajib Mall, "Computer System Architecture", Third Revised Edition, Pearson.

Reference Book:

1) John P. Hayes, "Computer Architecture and Organization", Third Edition, Tata McGraw Hill, Latest edition.

Course Name: Digital Image Processing **[2:0:2=3]**

Course Content:

Introduction: Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Representing Digital Images, Spatial and Intensity Resolution. Transformation and Enhancement of images: Gray level transformations and processing in spatial domain, Enhancement using arithmetic/logic operations, Image derivatives, filtering- smoothing, sharpening, convolution and correlation. Histogram processing – stretching, equalization and matching. Image interpolation. Fourier transformation and processing in frequency domain – DFT, FFT, Inverse Fourier transformation, Filtering: smoothing and sharpening in frequency domain, convolution. Image Restoration: Noise models, restoration in spatial domain, periodic noise reduction using frequency domain filtering, Inverse filtering. Colour models and transformations, Smoothing and sharpening and segmentation. Morphological operations: Dilation, Erosion, Opening, Closing, Boundary extraction, Thinning. Image compression fundamentals, Lossless compressions and Lossy compression Techniques. Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region-based segmentation, Segmentation using morphology. Introduction to Image Representation and Description: - Chain code, Polynomial approximation, Signatures, Skeletons; Regional description – Texture -- gray-level-cooccurrence matrix.

Course Outcomes:

CO1: Understand fundamental concepts and principles of digital image processing.

CO2: Apply and demonstrate different image pre-processing and enhancement techniques in the spatial and frequency domains.

CO3: Analyse various state of art algorithms to process images for various applications.

CO4: Design framework to solve real-life and societal problems using appropriate methods, interpreting results, and reporting.

Text Book:

1) Rafael C. Gonzalez, Richard E. Woods; Digital Image Processing; 3rd Ed., Pearson, ISBN: 978-0131687288

Reference Book:

1) Anil K. Jain; Fundamentals of Digital Image Processing, 1st Ed., Prentice Hall, ISBN: 978-0133361650
2) William K. Pratt; Digital Image Processing; 4th Ed., Wiley India Private Limited, ISBN: 978-1482216691
3) Kenneth R. Castleman; Digital Image Processing; 1st Ed., Pearson Education, ISBN: 978-0132114677
4) Mark Nixon, Alberto S. Aguado; Feature Extraction & Image Processing, 2nd Ed., Academic Press Inc. ISBN: 978-0-12372-538-7
5) Digital Image Processing – 2nd edition, By S. Sridhar, Publisher: OXFORD University Press

Course Name: Artificial Intelligence **[3:0:0=3]**

Course Content:

Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, and Applications. State-space search, Uninformed search – BFA, DFA, Iterative deepening search; Heuristic searching techniques – A* algorithm, optimality of A*, Game Playing – Min-Max algorithm, Alpha-Beta pruning, Constraint Satisfaction Problems, Knowledge Representation & Reasoning: Propositional logic and First-order logic, Inference in First order logic, Forward & Backward Chaining, Resolution refutation, Intelligent Agents – components and types of agents, environments, Planning – search vs. planning, partial-order planning, Introduction to Expert Systems – knowledge representation with rule-based systems, MYCIN, Handling imprecision in data: Introduction to Fuzzy Logic and inference, Optimization and search with Genetic Algorithms.

Course Outcomes:

CO1: Understand theories and concepts necessary for building an artificially intelligent system.

CO2: Apply heuristics to develop a better searching algorithm, logic, and resolution to make logical inferences.

CO3: Analyze data to be able to deal with uncertainty by applying approximate reasoning and building simple intelligent agents.

Textbooks:

1) Stuart Russel and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Perason.
2) Elaine Rich, Kevin Knight and Shivshankar B Nair, “Artificial Intelligence”, McGraw Hill.

Reference Books:

1. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson

2. David L. Poole and Alan K. Mackworth, Python code for Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press.