SREENIVASAINSTITUTEOFTECHNOLOGYANDMANAGEMENTSTUDIES
(Autonomous)

Minor - PROGRAMMING & COMPUTATIONAL INTELLIGENCE - Offered by CSE Department

S.No	Course Code	CourseTitle	Scheme of Instructions HoursperWeek				Scheme ofExaminationMaximumMarks		
			L	T	P	C	I	E	Total
1	23MRPCI1	Python for AI & Data Science	3	-	-	3	30	70	100
2	23MRPCI2	Data Structures & Algorithms for AI	3	-	-	3	30	70	100
3	23MRPCI3	Reinforcement Learning	3	-	-	3	30	70	100
4	23MRPCI4	Quantum Computing for AI	3	-	-	3	30	70	100
5	23MRPCI5	Edge AI &IoT	3	-	-	3	30	70	100
6	23MRPCI6	Python & DS Lab	-	-	3	1.5	30	70	100
7	23MRPCI7	RL & Quantum AI Lab	-	-	3	1.5	30	70	100

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CSE Department

Minor- PROGRAMMING &
COMPUTATIONAL INTELLIGENCE

23MRPCI1	PYTHON FOR AI & DATA SCIENCE	L	T	P	C
	(Common to Branches)	3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

1. Understand the fundamentals of Python programming relevant to AI and Data Science.
2. Learn to handle, process, and visualize data using Python libraries.
3. Apply Python-based techniques to build AI and machine learning models.
4. Explore advanced AI concepts and implement them using Python.
5. Develop skills to work with real-world datasets and AI applications using Python.

UNIT –1: Python Programming Fundamentals for AI & Data Science (9)
Introduction to Python: Features and Setup, Data Types and Variables, Control Structures: Conditional Statements and Loops, Functions and Modules, Exception Handling, File Handling in Python, Introduction to Object-Oriented Programming, Introduction to Python IDEs and Notebooks

UNIT –2: Data Handling and Preprocessing Using Python Libraries (9)
Introduction to NumPy: Arrays and Operations, Pandas for Data Manipulation: Series and DataFrames, Handling Missing Data, Data Cleaning and Transformation, Data Aggregation and Grouping, Working with Dates and Time in Pandas, Data Input/Output: CSV, Excel, JSON, Introduction to Data Preprocessing Techniques

UNIT –3: Data Visualization Techniques in Python (9)
Introduction to Matplotlib: Basic Plotting, Customizing Plots and Graphs, Seaborn for Statistical Visualizations, Plotting Categorical Data, Plotting Time Series Data, Pairplots, Heatmaps, and Correlation Plots, Interactive Visualizations with Plotly, Visualizing Distributions and Outliers

UNIT –4: Machine Learning Basics with Python (9)
Introduction to Scikit-learn, Supervised Learning Algorithms: Linear Regression, Logistic Regression, Unsupervised Learning: K-Means Clustering, Model Evaluation Metrics: Accuracy, Precision, Recall, F1-score, Cross-validation and Hyperparameter Tuning, Feature Selection and Engineering, Overfitting and Underfitting Concepts, Introduction to Pipeline and Model Persistence

UNIT –5: Advanced AI Applications with Python (9)
Introduction to Neural Networks with Keras and TensorFlow, Building and Training Deep Learning Models, Natural Language Processing with Python (NLTK, SpaCy), Computer Vision Basics with OpenCV, Reinforcement Learning Overview, Transfer Learning and Pretrained Models, Deploying AI Models with Flask API, Ethical Considerations and Best Practices in AI

Total Hours: 45

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COURSE OUTCOMES:

On successful completion of the course, students will be able to		Pos
CO1	Understand Python programming basics and syntax for AI and Data Science applications.	Understand (L2)
CO2	Apply Python libraries for data manipulation and visualization.	Apply (L3)
CO3	Analyze data sets and extract meaningful insights using Python tools.	Analyze (L4)
CO4	Evaluate machine learning models implemented with Python.	Evaluate (L5)
CO5	Design and implement AI solutions using Python programming.	Create (L6)

TEXT BOOKS:

1. **Jake VanderPlas**, *Python Data Science Handbook*, O'Reilly, 2016.
2. **Sebastian Raschka, VahidMirjalili**, *Python Machine Learning*, Packt, 2019.
3. **AurélienGéron**, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly, 2019.

REFERENCE BOOKS:

1. **Wes McKinney**, *Python for Data Analysis*, O'Reilly, 2017.
2. **Joel Grus**, *Data Science from Scratch: First Principles with Python*, O'Reilly, 2019.
3. **Francois Chollet**, *Deep Learning with Python*, Manning, 2018.

REFERENCE WEBSITE:

Platform	Course Title & Link
Coursera	Applied Data Science with Python Specialization – University of Michigan

SREENIVASAINSTITUTEOFTECHNOLOGYANDMANAGEMENTSTUDIES
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23MRPCI2	DATA STRUCTURES & ALGORITHMS FOR AI	L	T	P	C
	(Common to Branches)	3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

- Understand fundamental data structures and algorithms relevant to AI applications.
- Learn how to implement and analyze algorithms for efficient data processing in AI systems.
- Apply data structures and algorithms to solve AI problems such as search, optimization, and learning.
- Analyze algorithmic complexity and optimize AI solutions for performance.
- Develop skills to design AI algorithms using appropriate data structures.

UNIT –1: Fundamentals of Data Structures for AI (9)

Introduction to Data Structures and Algorithms, Arrays and Linked Lists, Stacks and Queues, Trees: Basic Terminology and Binary Trees, Graphs: Representation and Terminologies, Hashing and Hash Tables, Recursion and Recursive Algorithms, Complexity Analysis: Big-O Notation

UNIT –2: Searching and Sorting Algorithms in AI (9)

Linear Search and Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Merge Sort and Quick Sort, Heap Sort and Counting Sort, Search Algorithms in Graphs: DFS and BFS, Heuristic Search: A* Algorithm, Algorithm Design Techniques: Divide and Conquer, Performance Analysis of Sorting and Searching Algorithms

UNIT –3: Advanced Data Structures and Their Applications in AI (9)

Balanced Trees: AVL Trees and Red-Black Trees, B-Trees and B+ Trees, Trie and Suffix Trees, Priority Queues and Heaps, Disjoint Set Union (Union-Find), Graph Algorithms: Minimum Spanning Tree (Kruskal, Prim), Shortest Path Algorithms (Dijkstra, Bellman-Ford), Application of Advanced Data Structures in AI

UNIT –4: Algorithms for AI Problem Solving (9)

Backtracking Algorithms, Branch and Bound Technique, Dynamic Programming and Memoization, Greedy Algorithms and their applications, Optimization Algorithms in AI, Local Search Algorithms, Evolutionary Algorithms and Genetic Algorithms, Complexity Classes: P, NP, NP-Complete, NP-Hard

UNIT –5: Designing AI Algorithms with Data Structures (9)

Designing Efficient Search Algorithms for AI, Data Structures for Knowledge Representation, Graph-based Algorithms for Social Network Analysis, Tree-based Algorithms in Decision Making (Decision Trees), Algorithms for Natural Language Processing, Algorithms for Computer Vision Tasks, Parallel and Distributed Algorithms in AI, Case Studies: Implementing AI Algorithms using Data Structures.

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Total Hours: 45

COURSE OUTCOMES:

On successful completion of the course, students will be able to		**Pos**
CO1	Understand basic and advanced data structures used in AI applications.	**PO1, PO2, P03, PO4**
CO2	Implement and apply fundamental algorithms for problem-solving in AI.	**PO1, PO2, P03, PO4**
CO3	Analyze the time and space complexity of algorithms.	**PO1, PO2, P03, PO4**
CO4	Evaluate different algorithmic approaches and choose appropriate ones for AI problems.	**PO1, PO2, P03, PO4**
CO5	Design efficient algorithms and data structures for AI systems.	**PO1, PO2, P03, PO4**

TEXT BOOKS:

1. **Mark Allen Weiss**, *Data Structures and Algorithm Analysis in C++*, Pearson.
2. **Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein**, *Introduction to Algorithms*, MIT Press.
3. **Nils J. Nilsson**, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann (for AI algorithm context).

REFERENCE BOOKS:

1. **Richard E. Neapolitan, KumarssNaimipour**, *Foundations of Algorithms*, Jones & Bartlett Publishers.
2. **R. S. Salaria**, *Data Structures and Algorithms*, Khanna Publishing House.
3. **Stuart Russell, Peter Norvig**, *Artificial Intelligence: A Modern Approach*, Pearson.

REFERENCE WEBSITE:

Platform	**Course Title & Link**
Coursera	Algorithms Specialization – Stanford University

SREENIVASAINSTITUTEOFTECHNOLOGYANDMANAGEMENTSTUDIES
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23MRPCI3	REINFORCEMENT LEARNING	L	T	P	C
	(Common to Branches)	3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

- Understand the fundamental concepts and principles of reinforcement learning (RL).
- Learn various RL algorithms including model-free and model-based methods.
- Analyze the mathematical foundations and performance of RL algorithms.
- Apply reinforcement learning techniques to real-world problems and AI applications.
- Develop skills to design, implement, and evaluate RL systems effectively.

UNIT –1: Introduction and Foundations of Reinforcement Learning (9)

Overview of Reinforcement Learning, Key Elements: Agent, Environment, States, Actions, Rewards, Markov Decision Process (MDP) - Definition and Properties, Policies and Value Functions, Bellman Equations for State and Action Values, Concept of Return and Discount Factor, Exploration vs Exploitation dilemma, Examples of RL in Real World.

UNIT –2: Dynamic Programming and Monte Carlo Methods (9)

Policy Evaluation with Dynamic Programming, Policy Improvement and Policy Iteration, Value Iteration Algorithm, Monte Carlo Prediction and Control, First-visit and Every-visit MC Methods, On-policy vs Off-policy MC Methods, Importance Sampling in Monte Carlo, Applications of Dynamic Programming and Monte Carlo in RL.

UNIT –3: Temporal Difference Learning (9)

Introduction to Temporal Difference (TD) Learning, TD(0) Algorithm and its Properties, TD Prediction and Control Methods, SARSA Algorithm (On-policy TD Control), Q-Learning Algorithm (Off-policy TD Control), Eligibility Traces and TD(λ), Function Approximation in TD Learning, Convergence and Stability Analysis.

UNIT –4: Policy Gradient and Advanced Methods (9)

Policy Gradient Theorem, REINFORCE Algorithm, Actor-Critic Methods, Deep Reinforcement Learning (DRL) Overview, Deep Q Networks (DQN), Trust Region Policy Optimization (TRPO), Proximal Policy Optimization (PPO), Exploration Strategies (ε-greedy, Boltzmann, UCB).

UNIT –5: Applications and Recent Advances in Reinforcement Learning (9)

Multi-agent Reinforcement Learning, Hierarchical Reinforcement Learning, Inverse Reinforcement Learning, RL in Robotics and Autonomous Systems, RL for Game Playing (Chess, Go, Atari), Safety and Ethics in RL, Transfer Learning and Meta-RL, Case Studies and Research Trends

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Total Hours: 45

COURSE OUTCOMES:

On successful completion of the course, students will be able to		**Pos**
CO1	Understand core concepts such as Markov Decision Processes, policies, and rewards in RL.	Understand (L2)
CO2	Implement fundamental RL algorithms like Dynamic Programming, Monte Carlo, and Temporal Difference.	Apply (L3)
CO3	Analyze convergence, stability, and exploration-exploitation trade-offs in RL algorithms.	Analyze (L4)
CO4	Evaluate the effectiveness of different RL algorithms on benchmark tasks.	Evaluate (L5)
CO5	Design and develop advanced RL solutions for complex environments.	Create (L6)

TEXT BOOKS:

1. **Richard S. Sutton and Andrew G. Barto**, *Reinforcement Learning: An Introduction*, 2nd Edition, MIT Press, 2018.
2. **CsabaSzepesvári**, *Algorithms for Reinforcement Learning*, Morgan & Claypool Publishers, 2010

REFERENCE BOOKS:

1. **Marco Wiering and Martijn van Otterlo (Editors)**, *Reinforcement Learning: State-of-the-Art*, Springer, 2012.
2. **Deep Reinforcement Learning Hands-On** by Maxim Lapan, Packt Publishing, 2018.
3. **David Silver's Lecture Notes and Videos** on Reinforcement Learning (available online).

REFERENCE WEBSITE:

https://nptel.ac.in/courses/113105100

Platform	**Course Title & Link**
Coursera	Reinforcement Learning Specialization – University of Alberta

CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO.1												
CO.2												
CO.3												
CO.4												
CO.5												
CO*												

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23MRPCI4	QUANTUM COMPUTING FOR AI	L	T	P	C
	(Common to Branches)	3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

- Understand foundational concepts of quantum computing and its significance in Artificial Intelligence (AI).
- Explore quantum algorithms relevant to AI applications.
- Analyze the advantages and challenges of applying quantum computing in AI.
- Develop skills to implement basic quantum algorithms for AI tasks.
- Investigate emerging trends and research in Quantum AI.

UNIT –1: Introduction to Quantum Computing and AI (9)

Classical Computing vs Quantum Computing, Qubits and Quantum States, Quantum Superposition and Entanglement, Quantum Gates and Circuits, Measurement in Quantum Systems, Basic Quantum Algorithms Overview, Introduction to Artificial Intelligence, Intersection of Quantum Computing and AI

UNIT –2: Quantum Algorithms for AI (9)

Quantum Search Algorithm (Grover's Algorithm), Quantum Fourier Transform, Quantum Amplitude Amplification, Quantum Phase Estimation, Variational Quantum Algorithms (VQA), Quantum Annealing and Optimization, Quantum Approximate Optimization Algorithm (QAOA), Quantum Machine Learning Overview

UNIT –3: Quantum Machine Learning (QML) Fundamentals (9)

Quantum Data Encoding and State Preparation, Quantum Support Vector Machines (QSVM), Quantum Neural Networks (QNN), Quantum Clustering Algorithms, Quantum Principal Component Analysis (QPCA), Hybrid Quantum-Classical Models, Quantum Kernel Methods, Challenges in QML

UNIT –4: Quantum AI Applications and Implementations (9)

Quantum Reinforcement Learning Basics, Quantum Natural Language Processing (QNLP), Quantum Image Processing, Quantum Optimization for AI Problems, Error Correction and Noise in Quantum AI Systems, Quantum Hardware for AI (Qubits technologies), Performance Evaluation of Quantum AI Algorithms, Case Studies of Quantum AI Applications

UNIT –5: Advanced Topics and Future Directions (9)

Designing Quantum Circuits for AI Tasks, Quantum AI Programming Frameworks (Qiskit, Cirq, etc.), Scalability and Resource Management in Quantum AI, Ethical and Security Implications of Quantum AI, Quantum AI Research Trends, Integration of Quantum AI with Classical AI, Quantum AI for Big Data Analytics, Emerging Quantum Technologies and AI

Total Hours: 45

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COURSE OUTCOMES:

On successful completion of the course, students will be able to		Pos
CO1	Understand principles of quantum computing and their implications for AI.	Understand (L2)
CO2	Explain key quantum algorithms used in AI applications.	Understand (L2)
CO3	Apply quantum computing techniques to solve basic AI problems.	Apply (L3)
CO4	Analyze the benefits and limitations of quantum computing in AI contexts.	Analyze (L4)
CO5	Design and implement quantum algorithms for AI applications.	Create (L6)

TEXT BOOKS:

1. **Richard S. Sutton and Andrew G. Barto**, *Reinforcement Learning: An Introduction*, 2nd Edition, MIT Press, 2018.
2. **CsabaSzepesvári**, *Algorithms for Reinforcement Learning*, Morgan & Claypool Publishers, 2010.

REFERENCE BOOKS:

1. **Marco Wiering and Martijn van Otterlo (Editors)**, *Reinforcement Learning: State-of-the-Art*, Springer, 2012.
2. **Deep Reinforcement Learning Hands-On** by Maxim Lapan, Packt Publishing, 2018.
3. **David Silver's Lecture Notes and Videos** on Reinforcement Learning (available online).

REFERENCE WEBSITE:

Platform	**Course Title & Link**
Coursera	Reinforcement Learning Specialization – University of Alberta
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23MRPCI5	EDGE AI &IOT	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

- To introduce the concept of Edge Computing and its integration with AI and IoT.
- To explore AI model deployment on edge devices.
- To understand IoT protocols, architectures, and security issues.
- To apply Edge AI techniques for real-time decision-making.
- To analyze case studies of Edge AI applications in smart systems.

UNIT –1: Introduction to Edge Computing and IoT (9)

Introduction to IoT: Definition, architecture, components, IoTvs Edge Computing, Edge, Fog, and Cloud Computing – Differences, Edge AI Overview – Concept and Applications, Characteristics and Benefits of Edge AI, Edge Devices: Microcontrollers, SBCs, Smart Cameras, Industry 4.0 and Smart Systems, Use Cases: Smart Home, Healthcare, Industry

UNIT –2: IoT and Edge AI Architectures & Communication Protocols (9)

IoT Architectures: 3-Layer, 5-Layer, Middleware, Edge AI Pipeline Architecture, MQTT, CoAP, HTTP, and AMQP Protocols, Data Collection and Preprocessing at the Edge, Real-time Data Transmission and Synchronization, Sensor Networks and Wireless Protocols (BLE, Zigbee, LoRaWAN), Communication Challenges in IoT, Interoperability and Integration Frameworks

UNIT –3: AI and ML for Edge Devices (9)

AI/ML Workflow Overview: Training vs Inference, Model Compression Techniques (Quantization, Pruning), Knowledge Distillation for Edge AI, TinyML and Lightweight Model Deployment, Edge ML Frameworks: TensorFlowLite, ONNX, PyTorch Mobile, Case Study: Deploying a CNN on Raspberry Pi, Energy and Latency Considerations, Model Evaluation Metrics for Edge AI

UNIT –4: Edge AI System Design and Optimization (9)

Hardware Selection: MCU, MPU, FPGA, ASIC, Power Consumption and Thermal Constraints, Model Accuracy vs Performance Tradeoffs, Data Management and Storage on Edge Devices, Federated Learning at the Edge, Edge-to-Cloud Integration Patterns, Edge AI Application Lifecycle, Security and Privacy at the Edge

UNIT –5: Applications and Case Studies of Edge AI &IoT (9)

Smart City Applications: Traffic, Waste, Lighting, Healthcare Monitoring Systems using Edge AI, Industrial Automation with Edge-enabled Sensors, Agriculture: Soil Health, Irrigation, Crop Monitoring, Surveillance & Real-time Video Analytics, Edge AI for Predictive Maintenance, AI on Drones and Autonomous Vehicles, Building Scalable Edge AI Solutions

Total Hours: 45

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COURSE OUTCOMES:

On successful completion of the course, students will be able to		Pos
CO1	Understand the fundamentals of Edge Computing and IoT systems.	Understand (L2)
CO2	Explain the architecture and protocols used in IoT and Edge AI.	Understand (L2)
CO3	Apply machine learning models to edge devices for real-time inference.	Apply (L3)
CO4	Analyze the constraints and trade-offs in deploying AI models on edge devices.	Analyze (L4)
CO5	Design and evaluate edge-based AI systems for real-world applications.	Create (L6)

TEXT BOOKS:

1. **"Edge AI: Convergence of Edge Computing and Artificial Intelligence"** – Xiaofei Wang, Springer, 2020.
2. **"Internet of Things: Principles and Paradigms"** – RajkumarBuyya, Amir VahidDastjerdi, Elsevier, 2016.
3. **"TinyML: Machine Learning with TensorFlowLite on Arduino and Ultra-Low-Power Microcontrollers"** – Pete Warden, Daniel Situnayake, O'Reilly Media, 2019.

REFERENCE BOOKS:

1. **"Architecting the Internet of Things"** – Dieter Uckelmann, Springer.
2. **"Hands-On Edge Analytics with Azure IoT"** – ArvindRavulavaru, Packt Publishing.
3. Research papers from **IEEE IoT Journal**, **ACM Transactions on IoT**, **Nature Electronics (Edge AI)**.

REFERENCE WEBSITE:

- **Platform** **Course Title & Link**
  Coursera AI for Edge Computing – IBM
-

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23MRPCI6	PYTHON & DS LAB	L	T	P	C
		-	-	3	1.5

PRE-REQUISITES: Nil.

COURSE EDUCATIONAL OBJECTIVES:

- To strengthen programming and DS skills for AI.

COURSE OUTCOMES:

- Apply Python for solving AI-related problems.
- Use appropriate data structures in solutions.

EXPERIMENTS:

1. Python basics and data types
2. Functions and recursion
3. Lists, Tuples, Sets
4. Dictionaries and comprehension
5. Stacks and Queues
6. Linked Lists implementation
7. Searching and Sorting
8. Tree traversals
9. Graph representation and DFS/BFS
10. Recursion with memoization
11. Implement AI heuristic search (A*)

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23MRPCI7	RL & QUANTUM AI LAB	L	T	P	C
		-	-	3	1.5

PRE-REQUISITES: Nil.

COURSE EDUCATIONAL OBJECTIVES:

- To introduce RL and Quantum concepts in AI.

COURSE OUTCOMES:

- Apply RL to solve simple tasks.
- Demonstrate basics of quantum circuits.

EXPERIMENTS:

1. Intro to OpenAI Gym
2. RL environment setup
3. Q-learning implementation
4. Policy gradient methods
5. CartPole balancing with RL
6. Quantum computing basics (Qiskit)
7. Quantum circuits & gates
8. Superposition and entanglement
9. Quantum teleportation simulation
10. Quantum ML (VQC intro)
11. Reinforcement learning with function approximation
12. RL/Quantum hybrid demo

TEXT BOOKS: