Program: B Tech/MBA Tech [Data Science, Artificial Intelligence, B Tech [AI and ML, AI and DS] B Tech Integrated [Computer Engineering]				**Semester :** VII/VIII/ V-VII/ XII	
Course: Reinforcement Learning				**Code:** 702DB0E014	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100)**
2	2	0	3	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite: Foundations of Machine Learning, Applications of Machine Learning					

Course Objective

The aim of the course is to give an introduction to the basic aspects of reinforcement learning and its distinguishing features. It will provide information on the core challenges and approaches including generalization and exploration in the field of reinforcement learning. It will also educate students with the concept of function approximation and policy gradient methods

Course Outcomes

After completion of the course, students will be able to –

1. Apply the basics of Reinforcement Learning (RL) to compare with traditional control design
2. Correlate how RL relates and fits into the broader umbrella of machine learning, deep learning
3. Recommend value functions and appropriate algorithms for optimal decision-making
4. Design a dynamic programming approach to an industrial control problem

Detailed Syllabus

Unit	Description	Duration
1.	**Introduction to RL** Introduction to RL terminology, Elements of RL, RL framework and applications, Immediate RL	**03**
2.	**Multi-arm Bandits** An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Non-stationary Problem, Optimistic Initial Values, Upper-Confidence-Bound	**04**
3.	**Markov Process and Optimality Proofs** Markov property, Markov chains, Markov reward process (MRP), Markov Decision Process (MDP) Modelling, Bellman equation, state and action value functions, Bellman optimality equation, Cauchy sequence & Green's equation	**05**
4.	**Prediction and Control by Dynamic Programing** Overview of dynamic programing for MDP, definition and formulation of planning in MDPs, Banach fixed point theorem, Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Efficiency of Dynamic Programming	**05**

Signature
(Head of the Department)

5.	**Monte Carlo Methods for Model Free Prediction and Control** Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Off-policy Prediction via Importance Sampling, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Return	**05**
6.	**Temporal-Difference (TD) Learning and Function Approximation Methods** Overview TD(0), TD(1) and TD(λ), k-step estimators, TD Control methods - SARSA, Q-Learning and their variants, Eligibility traces, Introduction to Function approximation, Least squares, Memory-based and Kernel-based Function Approximation	**04**
7.	**Policy Gradients Methods** Policy Approximation and its Advantages, Log-derivative trick, Naive Reinforce algorithm, bias and variance in RL, Reinforce with baselines, Actor-Critic methods	**04**
Total		**30**

Text Books

1. Laura Graesser and Wah Loon Keng, *Foundations of Deep Reinforcement Learning: Theory and Practice in Python*, 1st Edition, Pearson India/Padmavati Publisher, 2022.
2. Richard Sutton and Andrew Barto, *Reinforcement Learning: An Introduction*, 2nd Edition, MIT Press, 2018.
3. Abhishek Nandy and Manisha Biswas, *Reinforcement Learning: With Open AI, TensorFlow and Keras Using Python*, 1st Edition, Apress Publisher, 2017.

Reference Books

1. Nimish Sanghi, *Deep Reinforcement Learning with Python: With PyTorch, TensorFlow and OpenAI*, 2nd edition, Apress Publisher, 2021.
2. Alexander Zai and Brandon Brown, *Deep Reinforcement Learning in Action*, 1st Edition, Manning Publisher, 2020.
3. Csaba Szepesvari, *Algorithms for Reinforcement Learning*, 3rd Edition, Morgan & Claypool Publisher, 2019.

Laboratory Work

8 to 10 programming exercises (and a practicum) based on the syllabus

Signature
(Head of the Department)