

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NECD512	Online Prediction and Learning Algorithms	3	0	0	3

Course Objective

The objective of this course is to introduce the students to the field of online prediction and learning algorithms. These are frequently used for decision making and control in various fields ranging from weather prediction, online marketing, content delivery networks, resource allocation in wireless communications, medical test design and many more. Through this course, the students will be well equipped to address online decision-making problems in diverse areas in modern communication and computing systems.

Prerequisites

Familiarity with probability, analysis, calculus and linear algebra is required, which are all covered in the course Mathematics for Communication Theory (ECC501). Some knowledge of machine learning is useful but not essential.

Learning Outcomes

Upon successful completion of this course, students will:

- acquire a broad understanding of the algorithms used for online decision making.
- be able to design and analyze algorithms for solving several real-world online decision-making problems.
- be prepared to venture into more advanced areas of online learning practice and research.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: the online learning setup, classifications, basic notions of static regret, prediction and learning with expert advice	7	Familiarity with basic notions of online learning and experts learning problem
2	Online convex optimization: follow-the-leader, follow-the-regularized-leader (FTRL), online gradient descent, online mirror descent, optimistic FTRL	7	Introduction to OCO and its variants and their usage
3	Online combinatorial learning: follow-the-perturbed-leader (FTPL), optimistic FTPL, SAmpled HedGE (SAGE)	7	Familiarity with structured and high dimensional online learning and relevant algorithms
4	Multi-Armed-Bandits (MAB): setting, adversarial and stochastic MAB, explore-then-exploit, UCB, optimism-in-the-face-of-uncertainty, Exp3	7	Understanding of MABs and their variants and fundamental principles for solutions
5	Contextual MAB: setting, LinUCB, Exp4, Exp2, bandit convex optimization	7	Understanding of contextual MABs and solution approaches
6	Other topics: Bayesian MABs, Thompson Sampling, online reinforcement learning, Markov decision processes	7	Excursion to other topics using the knowledge of previous units

Text Book:

1. "Introduction to Online Convex Optimization" by E. Hazan, MIT Press, 2021
2. "Bandit Algorithms" by T. Lattimore and C. Szepesvari, Cambridge Univ. Press, 2020

Reference Books:

4. "Online Learning and Online Convex Optimization" by Shai Shalev-Shwartz, Foundations and Trends® in Machine Learning, 2012
5. "Prediction, Learning, and Games" by Nicolo Cesa-Bianchi and Gabor Lugosi, Cambridge university press, 2006.