1.	Title of the course	Optimal Control
2.	Course number	EE505L
3.	Structure of credits	3-0-0-3
4.	Offered to	PG
5.	New course/modification to	Modification To EE5105/2
6.	To be offered by	Department of Electrical Engineering
7.	To take effect from	July 2022
8.	Prerequisite	Nil
9.	**Course Objective(s):** To introduce optimal control theory using tools from Calculus of variations for finding extremals that minimize/maximize cost functionals, and derive optimal control using Pontryagins maximum principle. The course will also introduce numerical methods for solving problems related to practical applications.	
10.	**Course Content:** Review of state-space representation of systems, Introduction to OptimizationUnconstrained and constrained optimization, Karush-Kuhn-Tucker (KKT) conditions. Calculus of Variations-Examples of variational problems, Cost functionals, extremals, Weak and strong extrema, First-order necessary conditions for weak extrema--Euler-Lagrange equations, Hamiltonian formalism and mechanics, Variational problems with constraints, Second-order Conditions-Legendre's condition, Weierstrass-Erdmann corner conditions, Weierstrass excess function ; Optimal control problem formulations- Variational approach to the fixed-time, freeendpoint problem; Pontryagin maximum principle- Proof of the maximum principle, Time-optimal control of double integrator, Bang-bang control; Hamiltonian-Jacobi Bellman (HJB) equation-principle of optimality, Sufficient condition for optimality ; Linear quadratic regulator (LQR) problem- candidate optimal feedback law, Riccati differential equation, proof of sufficiency using HJB equation ; Numerical methods for optimal control problems- Evaluation of parameter-dependent functionals and their gradients, Indirect methods, Direct methods. Applications- Time-optimal control of linear systems, Singular control, Optimal control to target curves.	
11.	**Textbook(s):** 1. Naidu D S, *Optimal Control Systems*, CRC press (2002). 2. Pinch E R, *Optimal Control and the Calculus of Variations*, Oxford University Press (1995).	
12.	**Reference(s):** 1. Mike M G,A Primer on The Calculus of Variations and Optimal Control Theory, 1st Edition, American Mathematical Society (2012). 2. Daniel L, *Calculus of Variations and Optimal Control Theory - A Concise Introduction*, Princeton University Press (2012).	