

**INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI**  
**PROFORMA FOR NEW COURSE**

1.	Title of the Course	Optimal Control
2.	Course Number	EE5105
3.	Status of the Course	Elective
4.	Structure of Credits	3-0-0-3
5.	Offered to	PG
6.	New Course/ Modification to	New Course
7.	To be offered by	Dr. P S Saikrishna
8.	To take effect from	July 2018
9.	Prerequisite	Control Engineering, Calculus and Differential Equations
10.	Whether approved by the Program	Yes
11.	<p>Course Objective: (Max 70 words)</p> <p>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.</p>	
12.	<p>Course Content: (Max 100 words)</p> <p>Review of state-space representation of systems, Introduction to Optimization- Unconstrained 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, free-endpoint 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.</p>	
13.	<p>Text Books:</p> <ol style="list-style-type: none"> <li>1. Naidu D S, <i>Optimal Control Systems</i>, CRC press, 2002.</li> <li>2. Pinch E R, <i>Optimal Control and the Calculus of Variations</i>, Oxford University Press, 1995.</li> </ol>	
14.	<p>References:</p> <ol style="list-style-type: none"> <li>1. Mike M G, <i>A Primer on The Calculus of Variations and Optimal Control Theory</i>, American Mathematical Society, First Indian Edition, 2012.</li> <li>2. Daniel L, <i>Calculus of Variations and Optimal Control Theory - A Concise Introduction</i>, Princeton University Press, 2012.</li> </ol>	