<table>
<tr><th>Course code</th><th>Course name</th><th>L-T-P-Credits</th><th>Year of Introduction</th></tr>
<tr><td>AE462</td><td>OPTIMAL CONTROL SYSTEM</td><td>3-0-0-3</td><td>2016</td></tr>
<tr><td colspan="4">Prerequisite : Nil</td></tr>
<tr><td colspan="4">Course Objectives
• To formulate various types of optimal control problems
• To learn calculus of variations and dynamic programming for solving optimal control problems</td></tr>
<tr><td colspan="4">Syllabus
Optimal control problem formulation. Dynamic optimization- Unconstrained Problems - Calculus of Variations. Continuous time and Discrete time Linear Quadratic regulator and Tracking problems-LQG Problems. Constrained Problems- Pontryagin's Minimum Principle- Dynamic Programming-Constrained Problems.</td></tr>
<tr><td colspan="4">Expected outcome
The students will be able to
i. Understand the concepts related to calculus of variations and optimal control theory
ii. Apply the optimal control concepts to formulate and solve various types of control problems</td></tr>
<tr><td colspan="4">Text Books:
1. Donald E. Kirk, Optimal Control Theory: An Introduction, Prentice-Hall networks series, 1970
2. M.Gopal, "Modern Control System Theory", Wiley Eastern, New Delhi, second Edition, 1993</td></tr>
<tr><td colspan="4">References:
1. Brian D O Anderson and John B Moore, "Optimal Control - Linear Quadratic Methods", Prentice Hall of India, 1991
2. Desineni Subbaram Naidu, Optimal Control System, CRC press
3. Sage.A.P & White.C.C, Optimum Systems Control, Prentice Hall</td></tr>
<tr><td colspan="4">Course Plan</td></tr>
<tr><th>Module</th><th>Contents</th><th>Hours</th><th>Semester Exam Marks</th></tr>
<tr><td>I</td><td>Optimal control problem - Problem formulation – Mathematical model – Physical constraints – Performance measure – Optimal control problem – Form of optimal control – Performance measures for optimal control problem – Selection of performance measure -Open loop and closed loop form of optimal control. Performance measures for optimal control problems – General form of performance measure</td><td>4</td><td>15%</td></tr>
<tr><td>II</td><td>Fundamental concepts and theorems of calculus of variations – Euler - Lagrange equation and extremal of functionals - the variational approach to solving optimal control problems - Hamiltonian and different boundary conditions for optimal control problem</td><td>6</td><td>15%</td></tr>
<tr><td colspan="4">FIRST INTERNAL EXAMINATION</td></tr>
<tr><td>III</td><td>LINEAR QUADRATIC OPTIMAL CONTROLSYSTEM - Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case-</td><td>8</td><td>15%</td></tr>
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	Time-invariant case – Stability issues of Time-invariant regulator, Linear Quadratic Tracking system: Finite time case and Infinite time case— Optimal solution of LQR problem. - Different techniques for solution of algebraic Riccati equation-- LQG Problem		
IV	DISCRETE TIME OPTIMAL CONTROL SYSTEMS Variational calculus for Discrete time systems – Discrete time optimal control systems:-Fixed final state and open-loop optimal control and Free-final state and open-loop optimal control, Closed loop optimal control matrix difference Riccati equation – optimal cost function Discrete time linear state regulator system – Steady state regulator system	8	20%
SECOND INTERNAL EXAMINATION			
V	Dynamic Programming:- Principle of optimality, optimal control using Dynamic Programming –Interpolation-A recurrence relation of dynamic programming-Computational procedure for solving Control problems-Discrete linear regulator problems, Hamilton Jacobi-Bellman Equation – Continuous linear regulator problems	9	20%
VI	CONSTRAINED OPTIMAL CONTROL SYSTEMS – Pontryagin's minimum principle and sate inequality constraints –Minimum Time optimal problems Minimum control effort Problems – Optimal Control problems with State Constraints	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100 Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)