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QUESTION BANK (DESCRIPTIVE)

Subject with Code :OPTIMAL CONTROL THEORY (16EE7510)**Course & Branch**: CS - EEE
Year &Sem: I-M.Tech& II-Sem **Regulation:** R16

UNIT-I

1. What are the techniques available for solving constrained and unconstrained problems of optimization? Explain each of them in detail. L1[12M]
2. (a) What is an optimization problem? Explain with an example. L2[6M]
   (b) What are the constrained problems of optimization? Explain. L2[6M]
3. What is a convex optimization problem? Explain about (i) convex set (ii) convex function. L1[12M]
4. (a) What is meant by quadratic problem? Explain L2[6M]
   (b) What are the necessary conditions for quadratic programming problem? Explain. L2[6M]
5. Explain the classification of optimization problems with suitable examples. L1[12M]
6. (a) Find the domain for which following functions are convex cosx, sinx function. L2[6M]
   (b) Minimize $f(x,y)=(x-10)^2$ subject to $g1=x+y-12\leq 0$, $g2=x-8<0$ use KKT conditions. L2[6M]
7. Explain the necessary conditions of optimality for a general constrained problem. L1[12M]
8. Check the convexity of a problem: Minimize $f(x_1, x_2)=2x_1+3x_2-x_1^3-2x_2^2$ subject to $x_1+3x_2\leq 6$, $5x_1+2x_2\leq 10$, $x_1,x_2\geq 0$. L1[12M]
9. Explain KKT necessary and sufficient conditions for quadratic programming problem. L1[12M]
10. Explain constrained and unconstrained problems and their solutions using different techniques. L1[12M]

UNIT-II

1. How interior method is useful for convex optimization? Explain. L1[12M]
2. What is meant by performance index? Explain in detail different types of performance indices. L1[12M]
3. Explain in detail primal and dual problems. L1[12M]
4. Considering the following problem: Maximize $Z_p=5x_1 – 2x_2$ subjected to $2x_1+x_2\leq 9$;$x_1-2x_2\leq 2$; $-3x_1+2x_2\leq 3$; $x_1,x_2\geq 0$ salve the primal & dual problem and study their final table. L1[12M]
5. (a) Explain the concept of duality in a linear programming problem. L2[6M]
   (b) Consider the program: Maximize $3x_1+2x_2+x_3$ Subject to $x_1\geq 0$, $x_2\geq 0$, $x_3\geq 0$ and $x_1-x_2+x_3\leq 4$, $2x_1+x_2+3x_3\leq 6$; $-x_1+2x_3\leq 3$ and $x_1+x_2+x_3\leq 8$ state the dual problem. L2[6M]
6. Using simplex method, solve the following optimization problem. Maximize $5x_1+2x_2+x_3$ subject to $x_1\geq 0$, $x_2\geq 0$, $x_3\geq 0$, $x_1+3x_2-x_3\leq 6$, $x_2+x_3\leq 4$ and $3x_1+x_2\leq 7$. L1[12M]
7. Consider the following problem in two variables: Minimize $f=-x_1x_2$ subjected to $(x1-3)^2+x_2^2=5$ obtain the solution for dual problem. L1[12M]
8. Explain different types of performance indices. L1[12M]
9. Derive Euler Lagrange Equation L1[12M]
10. Explain the basic concepts of Multi-Objective optimization problem. L1[12M]

UNIT-III

1. Find an external for the functional:
2. $J(x) = \int_0^{\frac{\pi}{4}} \left[x_1^2(t) + \dot{x}_1(t) + \dot{x}_2(t) + \dot{x}_2^2(t) \right] dt$ The functionsx_1 and x_2 are independent and boundary conditions are: $x_1(0)=1$; $x_1(\pi/4)=2$;; $x_2(0)=3/2$; $x_2(\pi/4)$=free.L1[12M]
3. (a) What are the necessary conditions for optimal control problems? Explain in detail. L1[6M]
   (b) Explain how calculus of variation method can be used to find the stationary values of functions. L1[6M]
4. Find the optimal feedback control law for the plant $\dot{x}_1(t) = x_2(t)u(t)$; $\dot{x}_2(t) = x_1(t) - x_2(t) + u(t)$and the cost function $J = \int_0^{\infty} \left[2x_1^2(t) + 4x_2^2(t) + 0.5u^2(t)\right] dt$ L1[12M]
5. A second order system described by $\dot{x}_1(t) = x_2(t)$, $\dot{x}_2(t) = -2x_1(t) - 3x_2(t) + 5u(t)$ and cost function is $J = \int_0^{\infty} \left(x_1^2(t) + u^2(t)\right) dt$. Find t optimal control when x(0)=3 and $x_2(0)=2$. L1[12M]
6. For the first-order system $\dot{x}(t) = -x(t) + u(t)$, find the optimal control $u^*(t)$to minimize the following cost function $J = \int_0^{t_f} \left(x^2(t) + u^2(t)\right) dt$ where t_f is not specified and x(0)=5 and $x(t_f)=0$.Alsofind t_f. L1[12M]
7. (a) Explain the necessary conditions for optimal control. L2[5M]
   (b) State and explain the fundamental theorem of the calculus of variations. L2[5M]
8. Explain in details about linear regulator problem. L1[12M]
9. Explain about calculus of variation to optimal control problem. L1[12M]
10. Explain the functional involving several independent functions L1[12M]

UNIT-IV

1. Derive continuous time AlgebricRiccati Equation that satisfies linear quadratic optimal regulator for LTI systems L1[12M]
2. Explain about frequency domain interpretation of linear quadratic regulator? L1[12M]
3. Define and Explain about linear quadratic regulator L1[12M]
4. Explain Define about remarks on weighting matricesL1[12M]
5. Define time optimal control and derive the expression? L1[12M]
6. Explain about the simplest variational problems? L1[12M]
7. Analize the solution of Riccati equations? L1[12M]
8. Derive the expressions for the linear quadratic regulator? L1[12M]
9. Derive the expression for linear quadratic regulator? L1[12M]
10. Explain bout interpretation of LQR in frequency domain robust studies L1[12M]

UNIT-V

1. Using frequency domain method, design an optimal controller for the following systems $\dot{x}1(t) = x2(t), \dot{x}2(t) = u(t)$ that minimizes the performance index
   J=1/2 $\int_0^\infty (x_1^2(t) + x_2^2(t) + u^{2(t)}$)dt.L1[12M]
2. Explain about Pontrygin's minimum principle? L1[12M]
3. Determine the smooth curve of smallest length connecting the point x(0)=1 to the line t=5, It can be shown that length of a curve lying the t-x(t) plane, witht$_0$=0and t$_f$=5 L1[12M]
4. Derive the expressions for pontrygin's minimum principle? L1[12M]
5. For the first order systems $\dot{x}(t)$ =-x(t)+u(t), find the optimal control u^*(t) to minimize the following cost function J=$\int_0^{tf}(x^2(t)+u^2$(t)) dt where t$_f$ is not specified and x(0)=5 and x(t$_f$) =0 also find t$_f$ L1[12M]
6. Using the dynamic programming method, minimize the following functional.
   J= $x_1^2(k_f) + 2x_2^2(k_f) + \int_{k=0}^{k_f-1}$ {(0.5 $x_1^2(k)$ +0.5 x_2^2(k)+0.5 u^2(k))} for the second order systems
   X_1 (k+1)= 0.8 x_1 (k) +x_2 (k)+u(k); x_2(k+1)=0.6x_2 (k)+0.5u(k) subjected to the initial conditions. X_1(k_0=0) =5; x_2(k_0=0) =3 ; X(k_f) is free ,and k$_f$=10 ? L1[12M]
7. Using the frequency domain results determine the optimal feedback coefficients and the closed loop optimal control for the MIMO system. $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} u(t)$ and the cost function $J = \int_0^\infty \left[4x_1{}^2(t) + 4x_2{}^2(t) + 0.5u_1{}^2(t) + u_2{}^2(t) \right] dt$ L1[12M]
8. Explain in details various steps for the development of solution of the Time-optimal control L1[12M]
9. (a) Explain time optimal control problem with an example L1[6M]
   (b) Discuss about system and signal norms L1[6M]
10. (a) Explain the computational procedure of dynamic programming. L1[6M]
    (b) Explain the statement of problems and its solution. L1[6M]