Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

**End Semester Examination – April/May– 2017**

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| **Sub. Code:** | **14EI3008** | **Duration :** | **3hrs** |
| **Sub.Name:** | **OPTIMAL CONTROL THEORY** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| Q. No. | Sub Div. | Questions | Course  Outcome | Marks |
| 1. | a. | Explain the various performance measures for optimal control problems. | CO1 | 15 |
| b. | Define the principle of Optimality. | CO1 | 5 |
| (OR) | | | | |
| 2. | a. | With an example explain the requirements of an optimal control problem. | CO1 | 3 |
| b. | Consider a first order system x (k+1)=x(k)+u(k) and the performance  criterion to be optimizedas J=1/2 x2(kf) +1/2[x2(k) +u2 (k)]  Take kf=2. Let the constraints and the quantization values on the control be  -1.0≤u (k) ≤+1.0, k=0, 1, 2 or x(k)=-1.0, -0.5,0,+0.5,+1.0  and on the state be 0≤x(k)≤+2.0, k=0,1 or  x(k)=0, 0.5,1.0, 1.5,2.0 | CO2 | 17 |
| 3. | a. | With block diagram, explain how a performance measure can be selected? | CO1 | 5 |
| b. | Derive the optimal control law for linear continuous regulator problem. | CO1 | 15 |
| (OR) | | | | |
| 4. | a. | Find an extremal for the functional ;  the boundary conditions are x(1)=4, x(tf)=4, and tf> 1 is free. | CO2 | 10 |
|  | b. | Discuss how is a functional of a single function minimized using calculus of variations in (t - x)-plane with the assumption that both ends are fixed. Obtain Euler-Lagrange equation in this case and comment on its type. | CO2 | 10 |
| 5. | a. | Find a necessary condition that must be satisfied by an extremal of the functional  where t0, x(to)=x0, and  x(tf) =xf are specified and tf is free. | CO2 | 10 |
|  | b. | Determine the curve with minimum arc length between the point x(0) = 1 and the line t1= 5 in (t-x)-plane. Comment on the result obtained. | CO2 | 10 |
| (OR) | | | | |
| 6. | a. | Investigate the use of H-J-B equation as a means of solving the general form of the continuous linear regulator problem. | CO2 | 10 |
|  | b. | Find an extremal for the functional  the boundary conditions are x(1)=4, x(tf)=4, and tf> 1 is free. | CO2 | 10 |
| 7. |  | Discuss Pontryagin’s minimum principle for minimization of a selected performance index of an optimal control problem. Also comment on its success. | CO3 | 20 |
| (OR) | | | | |
| 8. |  | Consider the system described by its state equation      with initialconditions x(t0)=x0. The performance measure to be minimized is  tf is specified, and the final state x(tf) is free.   1. Find necessary conditions for an unconstrained control to minimize J. 2. Find necessary conditions for optimal control if | CO3 | 20 |
|  | | **Compulsory:** |  |  |
| 9. | a. | Derive ARE (Algebraic Riccati Equation) for linear tracking problem. | CO3 | 10 |
|  | b. | Write the steepest Descent Algorithm. | CO3 | 10 |

ALL THE BEST