Roll No. ☐☐☐☐☐☐☐☐☐☐☐☐ **Total No. of Pages : 02**

Total No. of Questions : 08

M.Tech (EE) EI-II (2018 Batch) (Sem.-1)

OPTIMAL AND ADAPTIVE CONTROL

Subject Code : MTEE-104D

Paper ID : [75224]

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. **Attempt any FIVE questions out of EIGHT questions.**
2. **Each question carries TWELVE marks.**

Q1. Determine the optimum input when the performance index is :

$$\int_0^{\infty} X^T \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} X + M^T \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} M dt$$

Where M is the input and the system equation is $\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} X + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} M$. Also explain the advantage of the Matrix Riccati equation developed from the Hamilton- Jacobi approach.

Q2. For a system described as $\dot{X} = u$, the performance index is given as $J = \int_0^{t_1} (X + 2u)\, dt, t_1 = 5\text{sec}$. The boundary conditions are : X_0=5 and $X_f = 2$. The constraints are : X ≥ 1 and -2 ≤ u ≤ 2. Using Dynamic Programming determine the minimum performance index.

Q3. Derive the Euler's Equation.

Q4. The performance index of the system is $J = \int_0^{3} (x_1^2 + u^2)\, dt$. The system is described by $\dot{X}_1 = u - X_1,\ X_1(0) = 1$. Find $u(t)$ to minimize the system considering the two point boundary problem.

Q5. Explain Pontryagin's max/min principle.

Q6. Determine the stability range for the gain m of the system shown below using Liapunov's method :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -2 & 1 \\ -m & 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ m \end{bmatrix} u$$

Where u is the input.

Q7. Derive the expression for the Matrix Riccati equation and optimal control for the linear regulator problem.

Q8. Optimize the following performance index :

$$J = \int_0^3 \left(\frac{d^2\phi}{dt^2} \right) dt$$

When the equality constraints are $\phi(0) = 1, \quad \phi(3) = 0$
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