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Total No. of Pages : 02

Total No. of Questions : 08

M.Tech. (EE) (2018 Batch) (Sem.-2)

**ROBUST CONTROL**

Subject Code : MTEE-204B-18

M.Code : 76107

Time : 3 Hrs.

Max. Marks : 60

**INSTRUCTIONS TO CANDIDATES :**

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

1. Check definiteness of the scalar function applying Sylvester's criterion-

$$V(x) = 4x_1^2 + 5x_2^2 + x_3^2 - 8x_1x_2 + 4x_1x_3 - 4x_2x_3.$$

2. Apply the vectorization method to solve the Lyapunov equation.

$$A^T P + P A = -I$$

With

$$A = \begin{bmatrix} 0 & 1 & -1 \\ 2 & -5 & -1 \\ 3 & 1 & -2 \end{bmatrix}$$

3. Determine the optimum input using Riccati equation when the performance index is :

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

Where M is the input and the system equation is :  $\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} X + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} M$ .

4. Given the system with state-space matrices :

$$A = \begin{bmatrix} 0 & 1 \\ 3 & -2 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; C = \begin{bmatrix} -1 & 1 \end{bmatrix}$$

Design the linear quadratic regulator with  $Q = C^T C$  and  $r = 5$ .

5. Distinguish between  $H_2$  and  $H_{\infty}$  control.

Given the system

$$\begin{cases} \dot{x}_1 = x_1 + u + 2w \\ y = x_1 + w \\ z = 2x_1 + 2u \end{cases}$$

Calculate analytically the compensator  $C(s)$  with the  $H_{\infty}$  control technique.

6. Using the LMI approach, find the control law that stabilizes simultaneously the two systems :

$$A_1 = \begin{bmatrix} -2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 5 \end{bmatrix}; B_1 = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} \text{ e } A_2 = \begin{bmatrix} -5 & 0 & 0 \\ 0 & -6 & 0 \\ 0 & 0 & 3 \end{bmatrix}; B_2 = \begin{bmatrix} 0 \\ 1 \\ 3 \end{bmatrix}$$

7. Give the system with transfer function  $G(s) = \frac{4}{s-3}$  determine the coprime factorization. Then determine the class of stabilizing compensators with unit step response equal to 1. Finally, calculate the energy associated to the impulse response for the closed-loop system.
8. Given the continuous-time system with transfer function  $G(s) = \frac{\alpha}{s^3 + s^2 + 4s + 4}$  calculate for which values of  $\alpha$  is the system bounded real.

**NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.**