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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-

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

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

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

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_{inf} 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_∞ control technique.

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

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

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 α 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.