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Printed Pages : 7

TEE-13

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0205

Roll No.

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B. Tech.**(SEM. VII) EXAMINATION, 2007-08****ADVANCE CONTROL SYSTEMS***Time : 3 Hours/**[Total Marks : 100]*

- 1 Attempt any **four** parts from the following question. Each part of the question is of 5 marks :

- (a) Consider a system given by following equation :

$$\frac{d^3 y}{dt} + 9 \frac{d^2 y}{dt} + 26 \frac{dy}{dt} + 24y = 6u$$

Find the phase variable form of the state variable representation of the system using partial fraction expansion method.

- (b) Obtain the time response of the following system :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 3 \\ -2 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$$

where $u(t)$ is a unit step function occurring at $t = 0$.

- (c) Obtain the transfer function of the system whose governing equations are



Form the Lyapunov function and find the range of k for the system to be stable.

- (c) Consider the non-linear system described by the equations

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -(1 - |x_1|)x_2 - x_1$$

Find the region in the state plane for which the equilibrium state of the system is asymptotically stable.

- 4 Attempt any **four** parts from the following question. Each part of the question is of 5 marks :

- (a) Obtain the optimal value of the parameter k_2 that

minimize the performance index $J = \int (\theta_r - \theta)^2 dt$ for

a unit-step input θ_r of the system described by following state equation

$$\dot{\underline{x}} = \underline{A} \underline{x} + \underline{b} u; \quad \underline{x}(0) = \underline{0}$$

$$\underline{y} = \underline{C} \underline{x}$$

with

$$\underline{A} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}; \quad \underline{b} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; \quad \underline{C} = [1 \ 0]$$

$$u = -k_1(x_1 - \theta_r) - k_2(x_2); \quad x_1 = \theta; \quad x_2 = \dot{\theta}$$

with the constraint $k_1 = 1$.

- (b) Derive optimal state regulator design through the Matrix Riccati equation. Also give the design steps.
- (c) For the system described in (a) part minimize the performance index $J = \int [(\theta_r - \theta)^2 + u^2] dt$ in terms of shifted state variables $x_1 = x_1 - \theta_r; x_2 = x_2$.
- (d) Use Lyapunov equation for designing a regulator for a liquid level system described by state equation

$$\dot{Y} = -Y + U; \quad Y(0) = 1$$

Where

$Y = h$ = deviation of liquid head from steady-state;

$U = q$ = rate of liquid inflow.

that minimizes the performance index

$$J = \int (y^2 + u^2) dt$$

- (e) For the system shown in the block diagram shown in Fig. 1



The feedback control law is

$$u = -k_1(x_1 - \theta_r) - k_2(x_2); \quad x_1 = \theta; \quad x_2 = \dot{\theta}$$

with the constraint $k_1 = 1$.

- (b) Derive optimal state regulator design through the Matrix Riccati equation. Also give the design steps.
- (c) For the system described in (a) part minimize the performance index $J = \int_0^\infty [(\theta_r - \theta)^2 + u^2] dt$ in terms of shifted state variables $x_1 = x_1 - \theta_r; x_2 = x_2$.
- (d) Use Lyapunov equation for designing a regulator for a liquid level system described by state equation

$$\dot{Y} = -Y + U; \quad Y(0) = 1$$

Where

$Y = h$ = deviation of liquid head from steady-state;

$U = q$ = rate of liquid inflow.

that minimizes the performance index

$$J = \int_0^\infty (y^2 + u^2) dt$$

- (e) For the system shown in the block diagram shown in Fig. 1



