(5)

Printed Pages : 7 TEE-13

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

PAPER ID : 0205 Roll No. | | | | | | | | | | |

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 :

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

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

 aktuonline.com

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

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

$$\dot{x}_1 = -\left(1-|x_1|\right)x_2 - x_1$$

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

$$\dot{\underline{x}} = A\,\underline{x} + bu; \;\; x(0) = 0$$
$$\underline{y} = C\,\underline{x}$$

with

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

aktuonline.com

The feedback control law is

$$u = -k_1(x_1 - \theta_r) - k_2(x_2);\ \ x_1 = \theta;\ \ x_2 = \theta$$

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 $J = \int\left[(\theta_r - \theta)^2 + u^2\right]dt$ 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

$$Y = -y + u;\quad y(0) = 1$$

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

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

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 $J = \int \left[(\theta_r - \theta)^2 + u^2\right] dt$ 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

$$Y = -y + u; \quad y(0) = 1$$

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**