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Fifth Semester B.E. Degree Examination, June / July 08
Modern Control Theory

Time: 3 hrs. Max. Marks:100

Note : *Answer any FIVE full questions.*

1 a. Explain P, PI, PID controllers. **(08 Marks)**

b. Construct the state model using phase –variables for the following equation and draw the state diagram:

$$\frac{d^3y}{dt^3}+4\frac{d^2y}{dt^2}+7\frac{dy}{dt}+2y=5u.$$ **(12 Marks)**

2 a. Explain the terms with an example:
i) State ii) State variables iii) State vector iv) State space. **(08 Marks)**

b. Obtain - i)First companion and ii) Second companion form, for the equation

$$G(s)=\frac{s+3}{s^3+9s^2+24s+20}$$

Draw the signal flow graphs. **(12 Marks)**

3 a. Define state transition matrix. List out its properties. **(08 Marks)**

b. Obtain state transition matrix by
i) Laplace transformation and
ii) Cayley-Hamilton theorem
for the following system.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$ **(12 Marks)**

4 a. Find the time-response of the following system

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 1\end{bmatrix}u(t)$$

where u(t) is the unit step occurring at t = 0 and $x^T(0)=[1\quad 0]$ **(10 Marks)**

b. Obtain the transfer functions of the systems having the state models

i) $\dot{x}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}X+\begin{bmatrix}1\\ 0\end{bmatrix}u$ and $Y=[1\quad 0]X$

ii) $\dot{x}=\begin{bmatrix}-5 & -1\\ 3 & -1\end{bmatrix}X+\begin{bmatrix}2\\ 5\end{bmatrix}u$ and $Y=[1\quad 2]X$ **(10 Marks)**

5 a. Explain the common physical non linearities. **(10 Marks)**

b. What is the significance of phase-plane plot? Explain the various steps of plotting phase-plane trajectories by either phase-plane method or isocline method. **(10 Marks)**

6 a. What are singular points? Explain the different singular points with respect to stability of non-linear systems. **(10 Marks)**

b. Consider the system described by

$$A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -5 & -6\end{bmatrix}\qquad B=\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$$

Using state feedback control u = – kx, it is desired to have the closed loop poles at s = –1 ± j2, s = –10. Find the state feedback matrix using Ackermann's formula. **(10 Marks)**

7 a. Determine whether or not the following quadratic form is negative definite.

$$Q = -x_1^2 - 3x_2^2 - 11x_3^2 + 2x_1x_2 - 4x_2x_3 - 2x_1x_3$$ **(10 Mar**

b. Obtain the Liapunov candidate for the following system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$ **(10 Mar**

8 a. Using Krasovskii's theorem, find the stability region of the equilibrium state at x = 0 the following

$$\dot{x}_1 = -x_1$$

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$ **(10 Mar**

b. Explain the concept of complete state controllability. Obtain the conditions on a, b an for complete state controllability for

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} \lambda_1 & 1 & 0 \\ 0 & \lambda_1 & 1 \\ 0 & 0 & \lambda_1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} a \\ b \\ c \end{bmatrix} [u]$$ **(10 Mar**

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