Roll No.:…………….

National Institute of Technology, Hamirpur (HP)

Name of the Examination: B.Tech.

Branch :Electrical Engineering **Semester :7th**

Course Name :Modern Control Systems **Course Code : EED-412**

Time: 2 Hours **Maximum Marks: 50**

Note :

1. **All Questions are compulsory**
2. **Draw the relevant diagrams/figures**
3. **Assume data wherever required**
4. **Wherever applicable, students with odd Roll No.will attempt (a) part while those with even Roll No. will attempt (b) part.**

Q1) (a)Discuss the stability analysis approach using describing function. Determine the describing function for the non-linearity given in Figure 1.

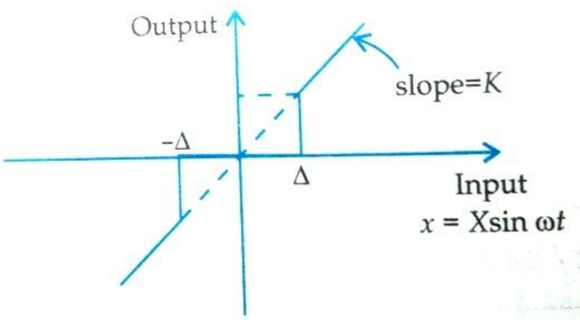

Figure 1

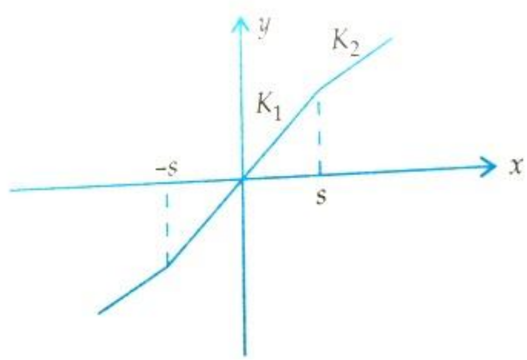

Figure 2

(b) Discuss the assumptions and limitations of the describing function approach. Determine the describing function for the non-linearity given in Figure 2. **(3+7)**

Q2) (a) Consider a linear system described by the transfer function

$$\frac{Y(s)}{X(s)} = \frac{10}{s(s+1)(s+2)}$$

Design a feedback controller with a state feedback so that the closed loop poles are placed at -2,-1±j1.

(b) A single-input system is described by the following state equation.

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 1 & -2 & 0 \\ 2 & 1 & -3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 10 \\ 1 \\ 0 \end{bmatrix} U$$

Design a state feedback controller which will give closed-loop poles at -1±j2,-6. **(10)**

P.T.O.

Q3) (a)For a certain systemsay, 'A', represented by state equation $\dot{X}(t) = AX(t)$. The response is $X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ and $X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$.Determine the system matrix A and the state transition matrix.

(b) For a certain system, say, 'B', represented by state equation $\dot{X}(t) = AX(t)$. The response is $X(t) = \begin{bmatrix} e^{-3t} \\ -3e^{-3t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$ and $X(t) = \begin{bmatrix} e^{t} \\ e^{t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$.Determine the system matrix A and the state transition matrix. **(10)**

Q4) Consider a nonlinear system described by following equations

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

$$\dot{x}_2 = -x_2 - x_1^3$$

Investigate the system's stability using Lyapunov method. **(10)**

Q5) Check the stability of the sampled data control systems represented by the following characteristic equation using both Jury's stability test and bilinear transformation method.

$$z^3 - 0.2z^2 - 0.25z + 0.05 = 0$$ **(10)**