GANPAT UNIVERSITY

M.TECH SEM.1ST ELECTRICAL ENGINEERING

REGULAR EXAMINATION JAN 2013

3EE103: ADVANCED CONTROL SYSTEM

TIME:-3 HOURS **TOTAL MARKS-70**

INSTRUCTION:-
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

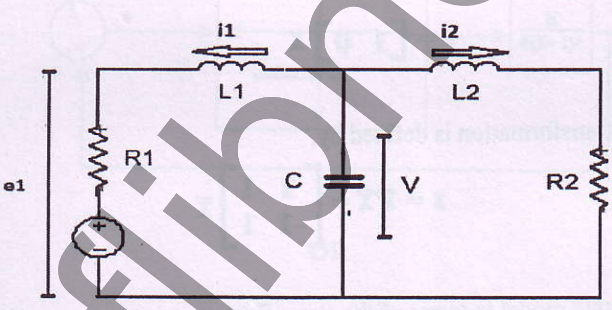
Section-I

Q-1 **(A)** Given a single input single output state variable model, **(6)**

$$\dot{X} = AX + BU$$
$$Y = CX$$

Prove that transfer function of the system $G(s) = C(sI - A)^{-1}B$.

(B) Find the state space representation of given electrical network. **(6)**



Take $v(t)$, $i_1(t)$, $i_2(t)$ as state variables.

OR

Q-1 **(A)** Consider the linear time invariant system shown by following state equation, **(5)**

$$\begin{bmatrix} \dot{x}1 \\ \dot{x}2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \end{bmatrix}$$

Compute the solution of the homogeneous equation, assuming the initial condition,

$$X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

(B) Derive the solution of state equations, both homogeneous and non-homogeneous. **(7)**

Q-2 **(A)** Define the state controllability of system and derive the condition for system to be completely state controllable. **(7)**

(B) Check for the controllability and observability of the systems. **(4)**

(a) $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u \; ; \; y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$

(b) $\dot{x} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \; ; \; y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$

OR

Q-2 **(A)** Consider the system, **(5)**

$$\dot{x} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

A similarity transformation is defined by,

$$x = P\bar{x} = \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} \bar{x}$$

Express the state model in terms of the states $\bar{x}$ (t).

(B) Solve the state equation for given initial conditions. **(6)**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$$

(i) $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, (ii) $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

Q-3 Construct the state model for the following transfer functions. Obtain diagonal or Jordan canonical form for each system. **(12)**

(i) $\dfrac{s+3}{s^2+3s+2}$ (ii) $\dfrac{5}{(s+1)^2(s+2)}$ (iii) $\dfrac{s^3+8s^2+17s+8}{(s+1)(s+2)(s+3)}$

Section-II

Q-4 **(A)** What is the singular point? Explain various types of singular points. **(9)**

(B) Define the following terms. **(3)**

(1) Uniform stability,

(2) Asymptotic stability,

(3) Exponential stability.

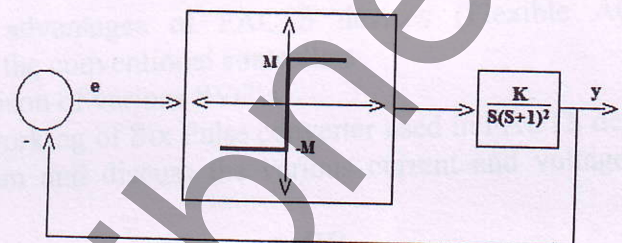
OR

Q-4 **(A)** Explain the method of isoclines for drawing the phase trajectories with example. **(8)**

(B) Draw the figure for stable and unstable limit cycles in terms of describing function. **(4)**

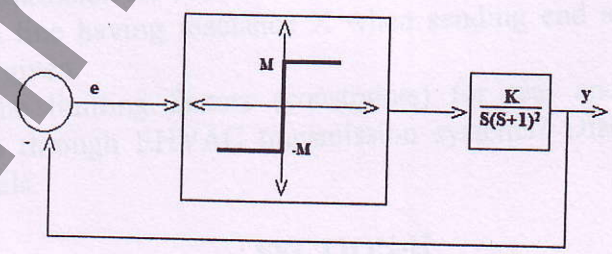
Q-5 **(A)** Define the phase trajectory and phase portrait of the system. What is the importance of it, in case of stability analysis? **(2)**

(B) Consider the system shown in figure, and draw the phase trajectory of the system. From that analyse the limit cycle stability of the system, for $K = 1$. **(9)**



OR

Q-5 **(A)** Consider the system shown in figure, and using the describing function analysis show that a stable limit cycle exists for all values of $K > 0$. Find the amplitude and frequency of the limit cycle when the $K = 4$. **(9)**



(B) How to find linear approximation of nonlinear function? **(2)**

Q-6 Derive the describing function for following elements. **(12)**

a. Saturating element.

b. On-off switch with dead zone.

END OF PAPER