ONE TIME EXIT SCHEME

USN | | | | | | | | | | |

10EE55

Fifth Semester B.E. Degree Examination, April 2018

Modern Control Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the terms: i) State ii) State variable iii) State space iv) State vector. **(04 Marks)**

b. For the network shown below, obtain the state model choosing $i_1(t) = x_1(t)$ and $i_2(t) = x_2(t)$ as state variables. **(08 Marks)**

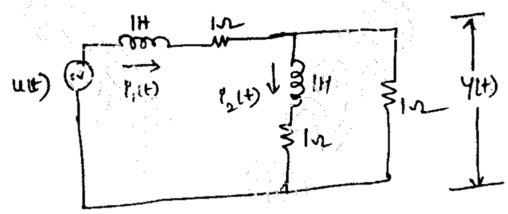

Fig Q1(b)

c. Obtain the state space representation for the system with transfer function

$$\frac{y(s)}{u(s)} = \frac{25}{s^3 + 11s^2 + 25s + 73}$$

Also draw to state diagram. **(08 Marks)**

2 a. A feedback system is characterized by the closed loop transfer function

$T(s) = \frac{s^2 + 3s + 3}{s^3 + 2s^2 + 3s + 1}$. Draw a suitable signal flow graph and obtain state model. **(06 Marks)**

b. Obtain the state model of a system whose transfer function is

$\frac{y(s)}{u(s)} = \frac{s^3 + 3s^2 + 2s}{s^3 + 12s^2 + 47s + 60}$ in canonical form. **(08 Marks)**

c. Derive the General expression for transfer function $C[SI - A]^{-1} B + D$ from state model in standard form. **(06 Marks)**

3 a. Find eigen values, eigen vector and modal matrix for

$$A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$$ **(06 Marks)**

b. Convert the following state model into canonical form (diagonal form) using a suitable transformation matrix.

$$\dot{x} = \begin{bmatrix} 1 & -4 \\ 3 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ -1 \end{bmatrix} u, \quad y = [1 \quad 0]x.$$ **(08 Marks)**

c. Define State Transition Matrix. Explain the procedure to obtain State Transition Matrix using any one method. **(06 Marks)**

4 a. Obtain State Transition Matrix using Cayley – Hamilton method for the system $A = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix}$. (05 Marks)

b. For the system represented by $\dot{x}(t) = A\,x(t)$, the response is $x(t) = \begin{bmatrix} 2e^{-4t} \\ e^{-4t} \end{bmatrix}$ when $x(0) = \begin{bmatrix} [illegible] \\ 1 \end{bmatrix}$ and $x(t) = \begin{bmatrix} 4e^{-2t} \\ e^{-2t} \end{bmatrix}$ when $x(0) = \begin{bmatrix} 4 \\ 1 \end{bmatrix}$. Determine system matrix 'A' and state transition matrix. (10 Marks)

c. Evaluate controllability of the system represented by $\dot{x} = Ax + Bu$ where

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix} \quad B = \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix}$$

Using KALMANS TEST. (05 Marks)

PART – B

5 a. Consider a system described by the state model $\dot{x} = Ax,\ y = Cx$ where $A = \begin{bmatrix} -1 & 1 \\ 1 & 2 \end{bmatrix}$, $C = [1 \quad 0]$. Determine the state observer gain matrix 'G' if the desired eigen values are placed at $\mu_1 = \mu_2 = -5$ using
   (i) Ackermann's formula
   (ii) Direct substitution method. (12 Marks)

b. Consider the system represented by $\dot{x} = Ax + Bu$, where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

Determine the state feedback gain matrix 'K' if the closed loop poles are located $s = -2 \pm j4$ and $s = -10$ using direct substitution method. (08 Marks)

6 a. Write a short note on P, PI and PID controllers. (06 Marks)

b. List any six properties of nonlinear systems. (06 Marks)

c. Discuss the following with respect to nonlinear system
   i) Dead zone
   ii) Friction. (08 Marks)

7 a. What are singular points? Explain the following with respect to singular points.
   i) Stable focus ii) Saddle point. (06 Marks)

b. Discuss the limit cycles with respect to nonlinear systems. (04 Marks)

c. Draw to phase trajectory for the following system using isoclines method;
   $\ddot{x} + \dot{x} + x = 0$, with initial conditions as (0, 6). (10 Marks)

8 a. Define the terms
   i) Stability ii) Asymptotic stability iii) Asymptotic stability in large. (06 Marks)

b. Explain Krasovskii's method of constructing Liapunov's functions for nonlinear systems. (08 Marks)

c. Determine the stability of the system described by the following equation.

$\dot{x} = Ax$ where $A = \begin{bmatrix} -1 & 1 \\ -2 & -4 \end{bmatrix}$. (06 Marks)