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Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Modern Control Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Compare the classical control theory with the modern control theory. (atleast – comparisons). **(06 Marks)**

b. What are the advantages and disadvantages of phase variables and canonical variables? **(06 Marks)**

c. For the electric circuit shown in Fig.Q1(c), obtain the state model and also draw the state diagram.

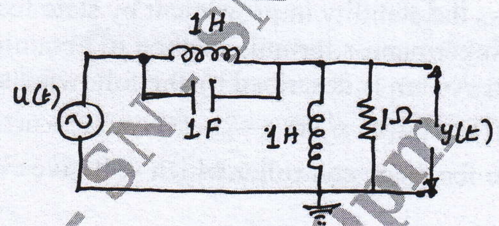

Fig.Q1(c) **(08 Marks)**

2 a. Consider the following system shown in Fig.Q2(a), obtain two different state models.

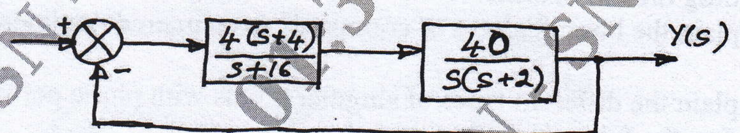

Fig.Q2(a) **(12 Marks)**

b. Obtain the transfer function for the system described below :

$$x_1^1(t) = -x_1(t) + x_3(t)$$
$$x_2^1(t) = x_1(t) - 2x_2(t)$$
$$x_3^1(t) = 3x_3(t) + u(t)$$
$$y(t) = x_1(t) + x_2(t)$$

(08 Marks)

3 a. Obtain the modal matrix, which diagonalizes the matrix A given :

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}.$$ **(10 Marks)**

b. Obtain the time-response of the following system :

$$[x'(t)] = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}[x(t)] + \begin{bmatrix} 1 \\ 1 \end{bmatrix}u(t)$$

Where u(t) is a unit step occurs at t = 0 $x^T(0) = [1\ 0]$. **(10 Marks)**

4 a. Find $f(A) = e^{At}$, using Cayley – Hamilton method for

$$A = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 1 & 0 \\ 1 & 0 & 3 \end{bmatrix};\ x(0) = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}.$$ **(10 Marks)**

b. Write the state equation for the system shown in Fig.Q4(b), in which x_1 x_2 and x_3 constitute state vector. Determine the whether the system is completely controllable or not using Kalman's test.

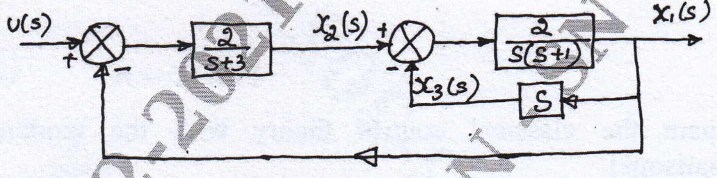

Fig.Q4(b) **(10 Marks)**

PART – B

5 a. Briefly discuss the stability improvement by state feedback. **(05 Marks)**

b. Explain the Ackermann's formula method of obtaining state feedback gain matrix. **(05 Marks)**

c. A single input system is described by the following state equations :

$x_1^1(t) = -6x_1(t) + 10u(t),\ x_2^1(t) = -2x_2(t) + x_1(t) + u(t)$ and $x_3^1(t) = 2x_1(t) + x_2(t) - 3x_3(t)$

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

6 a. Given that : $x_1^1(t) = x_2, x_2^1(t) = u(t), y(t) = x_1(t)$

Design an observer by any two methods, such that the observer is critically damped with settling time of 0.4sec. **(10 Marks)**

b. Explain the basic features of commonly encountered nonlinearities with examples. **(10 Marks)**

7 a. Explain the different types of singular points with phase portraits. **(06 Marks)**

b. Define the following :

i) Phase plane
ii) Phase trajectory
iii) Phase portrait
iv) Singular point. **(04 Marks)**

c. Explain the phase trajectories construction by

i) Analytical method
ii) Isoclines method. **(10 Marks)**

8 a. What is Laipunov's function? Explain the Krasovskii's method of constructing Liapunov functions for nonlinear systems. **(06 Marks)**

b. Explain the basic stability theorems with respect to direct method of Liapunov. **(06 Marks)**

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

$$x'(t) = Ax(t);\ \text{where}\ A = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}.$$ **(08 Marks)**

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