COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Electrical & Control Engineering
Lecturer : Staff
Course : Control Systems II
Course Code : EE 412 **Marks :** 40
Date : 23 / 5 / 2015 **Time :** 2 hours

Answer the following three questions and either question 4 or 5:

Question 1:

For the circuit shown in figure 1, find: **(A.15, B.2)**

- The state equations. **(10 Marks)**
- The state transition matrix.
- The state diagram.

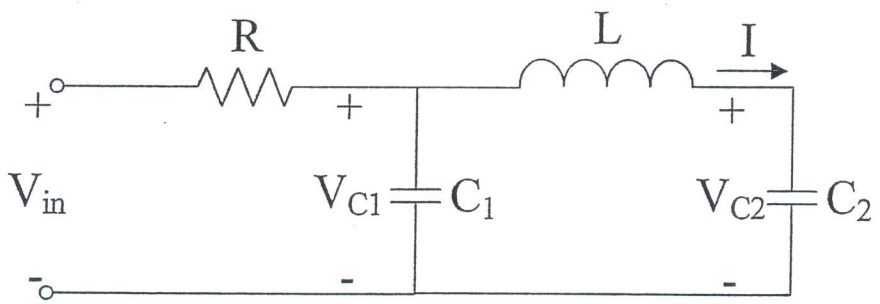

Figure 1

Given that: $\mathbf{R = 2\Omega}$, $\mathbf{L = 1H}$ and $\mathbf{C_1 = C_2 = 0.5F}$
The system states are $\mathbf{X_1 = I}$, $\mathbf{X_2 = V_{C1}}$ and $\mathbf{X_3 = V_{C2}}$

Question 2:

Obtain the observability canonical state mode for the system given by the transfer function:

$$\frac{Y(S)}{U(S)} = \frac{S+2}{(S+1)(S^2+2S+2)}$$ **(A.27) (8 Marks)**

Then discuss the stability of this system.

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Question 3:

(A.4, A31)
(10 Marks)

Consider the control system given by the state model

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

$$C = [1 \quad 0 \quad 0] \qquad D = 0$$

- Check the controllability and observability of the system.
- Design a state feedback such that the closed loop poles located at $S_{1,2} = -4 \pm 4j$ and $S_3 = -10$.

Solve one of the following questions:

Question 4:

- Using the describing function method, study the stability of the shown non-linear system in figure 2. Determine the frequency and amplitude of limit cycles if exists.

(A.27)
(12 Marks)

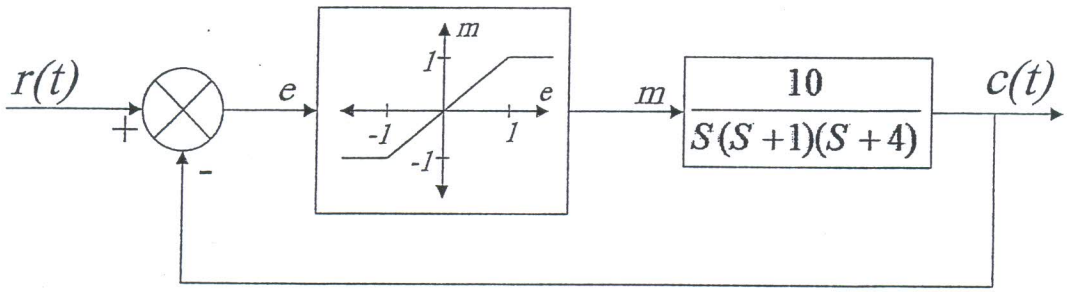

Figure 2

Question 5:

For the system shown in figure 2, if the linear transfer function is replaced by $\frac{1}{S^2 + S + 1}$, where $c(0) = 2$ and $\dot{c}(0) = 0$. Draw the phase-plane portrait in $\dot{e} - e$ plane for $r(t) = 0\ ;\ t \geq 0$

(A.15)
(12 Marks)

GOOD LUCK

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