CBCS Scheme

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

15EC43

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Control Systems

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define control system. Distinguish between open loop and closed loop systems with examples. **(05 Marks)**

b. Write the differential equations for the mechanical system shown in Fig.Q1(b) and obtain F-V and F-I analogous electrical networks. **(05 Marks)**

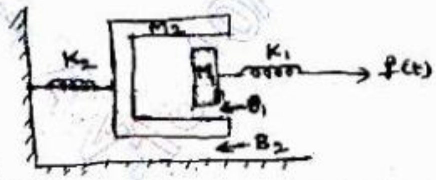

Fig.Q1(b)

c. Using Mason's gain formula, find the gain of the system shown in Fig.Q1(c). **(06 Marks)**

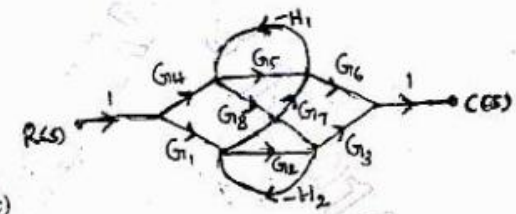

Fig.Q1(c)

OR

2 a. Write the Mason's gain formula for signal flow graph. Indicate what each term represents. **(04 Marks)**

b. Show that two systems shown in Fig.Q2(a) are analogous systems, by comparing their functions. **(06 Marks)**

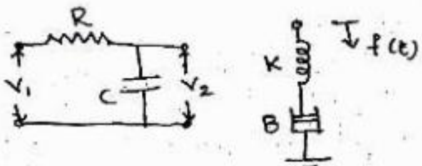

Fig.Q2(b)

c. Reduce the block diagram shown in Fig.Q2(c) using reduction rules and obtain C(s)/R(s). **(06 Marks)**

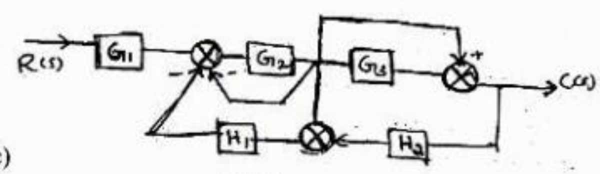

Fig.Q2(c)

Module-2

3 a. Obtain an expression for time response of the first order system subjected to unit step input. **(04 Marks)**

b. Explain proportional + integral + differential controller and their effect on stability. **(06 Marks)**

c. A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{k}{s(s+10)}$.

Determine the gain K so that system will have a damping ratio of 0.5. For this value of K, find settling time (2% criterion), peak overshoot and time to peak overshoot for a unit step input. **(06 Marks)**

OR

4 a. With a neat sketch explain all the time domain specifications. **(10 Marks)**

b. For the system shown in Fig.Q4(b). Determine the value of 'a' which gives damping factor 0.7. What is the steady state error to unit ramp input for value of 'a'. **(06 Marks)**

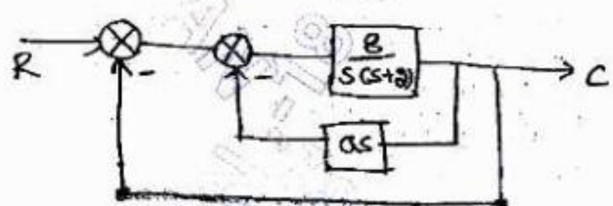

Fig.4Q(b)

Module-3

5 a. State and explain Routh-Hurwitz criterion. **(05 Marks)**

b. List the advantages of Root Locus method. **(05 Marks)**

c. Using RH criterion determine the stability of the system having the characteristic equation : $s^6 + 2s^5 + 5s^4 + 8s^3 + 8s^2 + 8s + 4 = 0$. **(06 Marks)**

OR

6 a. By applying Routh criterion, discuss the stability of the closed loop system as a function of K for the following open loop transfer function :

$$G(s)H(s) = \frac{K(s+1)}{s(s-1)(s^2+4s+16)}.$$ **(06 Marks)**

b. The open loop transfer function of a control system is given by $G(s) = \frac{k}{s(s+2)(s^2+6s+2s)}$.

Sketch the complete root locus as k is varied from zero to infinity. **(10 Marks)**

Module-4

7 a. The open loop transfer function of a system is $G(s) = \frac{K}{s(1+0.5s)(1+0.2s)}$ using Bode plot.

Find K so that : i) Gain margin is 6dB ii) Phase margin is 25°. **(12 Marks)**

b. What is Nyquist plot? State the Nyquist stability criterion. **(04 Marks)**

OR

8 a. The open loop transfer function of a control system is $G(s)H(s) = \frac{1}{s^2(s+2)}$. Sketch the Nyquist plot, path and ascertain the stability. (10 Marks)

b. Write a note on lead compensator. (06 Marks)

Module-5

9 a. What is signal reconstruction? Explain it with sample and hold circuit. (08 Marks)

b. Consider the circuit of Fig.Q9(b). Identify suitable state variables and write its state vector matrix equation. Note that there are two inputs. (08 Marks)

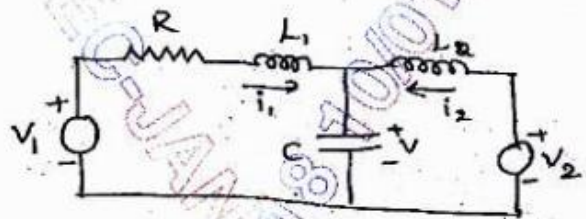

Fig.Q9(b)

OR

10 a. List the properties of state transition matrix. (06 Marks)

b. A single input single output system has the state and output equations :

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r$$

$$y = [5 \quad 0] x$$

i) Determine its transfer function

ii) Find its state transition matrix. (08 Marks)

c. What is sampled data control system? (02 Marks)

* * * * *

CBCS Scheme

USN 2HN15EC028 **15EC43**

Fourth Semester B.E. Degree Examination, June/July 2017
Control Systems

Time: 3 hrs. Max. Marks: 80

Note: Answer FIVE full questions, choosing one full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain linear and non-linear control system. **(04 Marks)**

b. For the mechanical system shown in Fig.Q1(b):
i) Draw the mechanical network.
ii) Obtain equations of motion.
iii) Draw an electrical network based on force current analogy. **(06 Marks)**

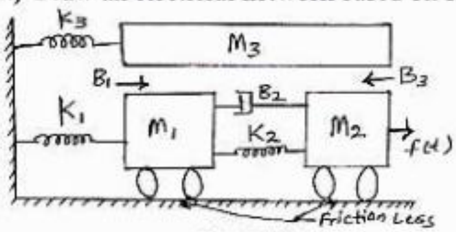

Fig.Q1(b)

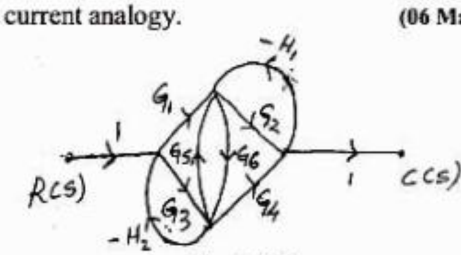

Fig.Q1(c)

c. For the signal flow graph shown in Fig.Q1(c), determine the transfer function $\frac{C(s)}{R(s)}$ using Mason's gain formula **(06 Marks)**

OR

2 a. For the circuit shown in Fig.Q2(a), 'K' is the gain of an ideal amplifier. Determine the transfer function $\frac{I(s)}{V_i(s)}$.

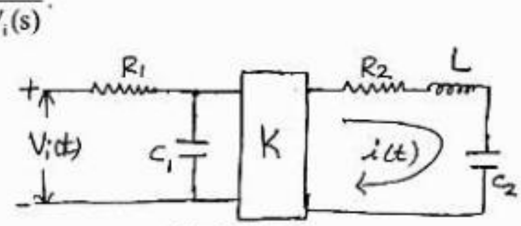

Fig.Q2(a) **(04 Marks)**

b. For the mechanical system shown in Fig.Q2(b):
i) Draw equivalent mechanical network.
ii) Write performance equations.
iii) Draw torque-voltage analogy.

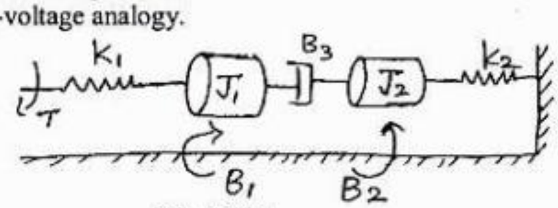

Fig.Q2(b) **(06 Marks)**

6 a. The open loop transfer function of a unity feedback system is $G(s) = \frac{K(s+2)}{s(s+3)(s^2+5s+10)}$.

i) Find the value of K so that the steady state error for the input r(t)=tu(t) is less than or equal to 0.01.

ii) For the value of K found in part (i). Verify whether the closed loop system is stable or not using R-H criterion. **(06 Marks)**

b. Sketch the root locus plot for a negative feedback control system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+3)(s^2+2s+2)}$ for all values of K ranging from 0 to ∞. Also find the value of K for a damping ratio of 0.5. **(10 Marks)**

Module-4

7 a. For a closed loop control system $G(s) = \frac{100}{s(s+8)}$, H(s) = 1. Determine the resonant peak and resonant frequency. **(04 Marks)**

b. Explain lag-lead compensator network and briefly discuss the effects of lead-lag compensator. **(04 Marks)**

c. Using Nyquist stability criterion, find the closed loop stability of a negative feedback control system whose open-loop transfer function is given by $G(s)H(s) = \frac{5}{s(s-1)}$. **(08 Marks)**

OR

8 a. Draw polar plot of $G(s)H(s) = \frac{100}{s^2+10s+100}$. **(06 Marks)**

b. For a unity feedback system $G(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$. Sketch the bode plot and find ω_{gc}, ω_{pc}, gain margin and phase margin. **(10 Marks)**

Module-5

9 a. With block diagram, explain system with digital controller. **(04 Marks)**

b. Obtain the state model for the system represented by the differential equation $\frac{d^3y(t)}{dt^3} + 6\frac{d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 10y(t) = 3u(t)$. **(04 Marks)**

c. Find the transfer function of the system having state model.

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$ **(08 Marks)**

OR

10 a. Explain signal reconstruction scheme using sampler and zero order hold. **(04 Marks)**

b. Obtain the state model of given electrical network shown in Fig.Q10(b).

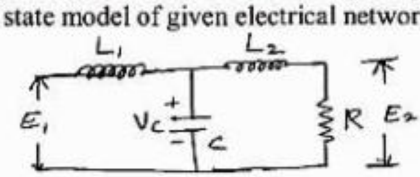

Fig.Q10(b) **(04 Marks)**

c. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. **(08 Marks)**

* * * * *

6 a. The open loop transfer function of a unity feedback system is $G(s) = \frac{K(s+2)}{s(s+3)(s^2+5s+10)}$.

i) Find the value of K so that the steady state error for the input r(t)=tu(t) is less than or equal to 0.01.

ii) For the value of K found in part (i). Verify whether the closed loop system is stable or not using R-H criterion. **(06 Marks)**

b. Sketch the root locus plot for a negative feedback control system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+3)(s^2+2s+2)}$ for all values of K ranging from 0 to ∞. Also find the value of K for a damping ratio of 0.5. **(10 Marks)**

Module-4

7 a. For a closed loop control system $G(s) = \frac{100}{s(s+8)}$, H(s) = 1. Determine the resonant peak and resonant frequency. **(04 Marks)**

b. Explain lag-lead compensator network and briefly discuss the effects of lead-lag compensator. **(04 Marks)**

c. Using Nyquist stability criterion, find the closed loop stability of a negative feedback control system whose open-loop transfer function is given by $G(s)H(s) = \frac{5}{s(s-1)}$. **(08 Marks)**

OR

8 a. Draw polar plot of $G(s)H(s) = \frac{100}{s^2+10s+100}$. **(06 Marks)**

b. For a unity feedback system $G(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$. Sketch the bode plot and find ω_{gc}, ω_{pc}, gain margin and phase margin. **(10 Marks)**

Module-5

9 a. With block diagram, explain system with digital controller. **(04 Marks)**

b. Obtain the state model for the system represented by the differential equation $\frac{d^3y(t)}{dt^3} + 6\frac{d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 10y(t) = 3u(t)$. **(04 Marks)**

c. Find the transfer function of the system having state model.

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$ **(08 Marks)**

OR

10 a. Explain signal reconstruction scheme using sampler and zero order hold. **(04 Marks)**

b. Obtain the state model of given electrical network shown in Fig.Q10(b).

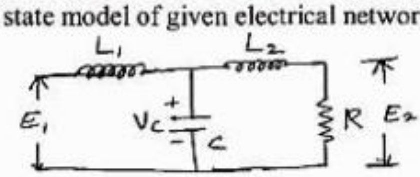

Fig.Q10(b) **(04 Marks)**

c. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. **(08 Marks)**

* * * * *