USN | | | | | | | | | | | **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.

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)**

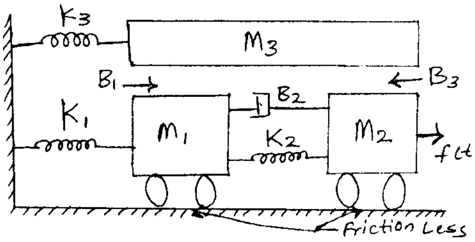

Fig.Q1(b)

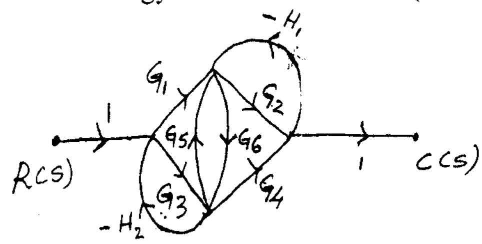

Fig.Q1(c)

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 $\frac{I(s)}{V_i(s)}$.

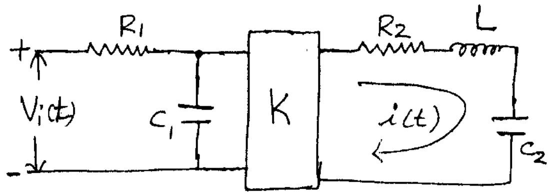

Fig.Q2(a) **(04 Marks)**

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

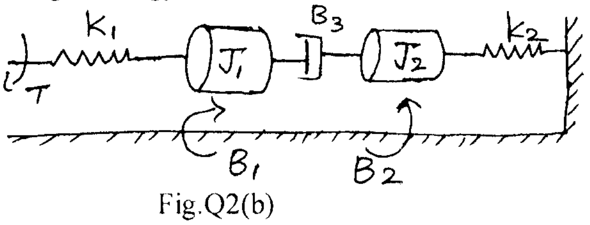

Fig.Q2(b) **(06 Marks)**

c. Obtain $\frac{C(s)}{R(s)}$ for the block diagram shown in Fig.Q2(c) using block diagram reduction techniques.

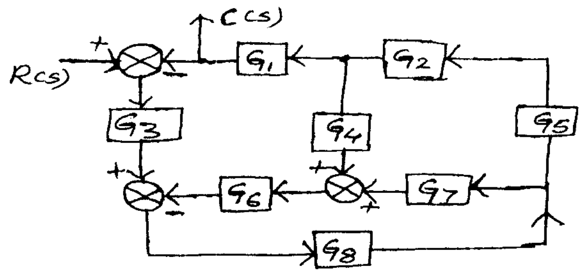

Fig.Q2(c) **(06 Marks)**

Module-2

3 a. List the standard test inputs used in control system and write their Laplace transform. **(04 Marks)**

b. Find K_p, K_v, K_a and steady state error for a system with open loop transfer function as

$$G(s)H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+4)(s+5)}$$

where the input is $r(t) = 3 + t + t^2$. **(06 Marks)**

c. For the system shown in Fig.Q3(c), obtain closed loop transfer function, damping ratio natural frequency and expression for the output response if subjected to unit step input.

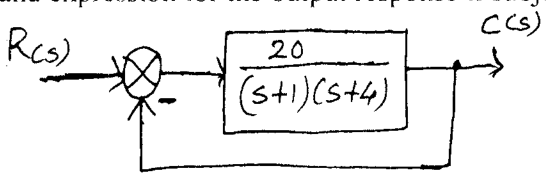

Fig.Q3(c) **(06 Marks)**

OR

4 a. Define rise time and maximum overshoot and write their formula. **(04 Marks)**

b. For a given system $G(s)H(s) = \frac{K}{s^2(s+2)(s+3)}$. Find the value of K to limit steady state error to 10 when input to system is $1 + 10t + 20t^2$. **(06 Marks)**

c. For a unity feedback control system with $G(s) = \frac{64}{s(s+9.6)}$. Write the output response to a unit step input. Determine:
i) The response at t = 0.1 sec.
ii) Settling time for ± 2% of steady state. **(06 Marks)**

Module-3

5 a. Explain Rouths-Harwitz stability criterion. **(04 Marks)**

b. $s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$. Find the number of roots of this equation with positive real part, zero real part and negative real part using RH criterion. **(06 Marks)**

c. Sketch the rough nature of the root locus of a certain control system whose characteristic equation is given by $s^3 + 9s^2 + Ks + K = 0$, comment on the stability. **(06 Marks)**

OR

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

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 $G(s)H(s)=\dfrac{K}{s(s+3)(s^2+2s+2)}$ 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 $G(s)=\dfrac{100}{s(s+8)}$, 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 $G(s)H(s)=\dfrac{5}{s(s-1)}$ **(08 Marks)**

OR

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

b. For a unity feedback system $G(s)=\dfrac{242(s+5)}{s(s+1)(s^2+5s+121)}$. 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 $\dfrac{d^3y(t)}{dt^3}+6\dfrac{d^2y(t)}{dt^2}+11\dfrac{dy(t)}{dt}+10y(t)=3u(t)$. **(04 Marks)**

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

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

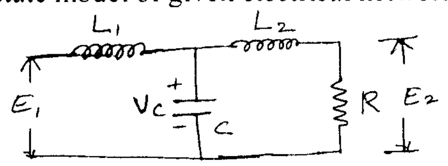

Fig.Q10(b) **(04 Marks)**

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

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