Control Engineering VTU Question Paper Set

USN

10ME/PM82

Eighth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Control Engineering

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define: i) System; ii) Controller; iii) Open loop system; iv) Closed loop system; v) Feed back, with examples. **(05 Marks)**

b. With the help of block diagram, explain i) PI ii) PID. **(10 Marks)**

c. List the advantages and disadvantages of i) Proportional controller; ii) Integral controller. **(05 Marks)**

2 a. Write the differential equations governing the mechanical system shown. Also draw F-V and F-C analogous circuits. **(14 Marks)**

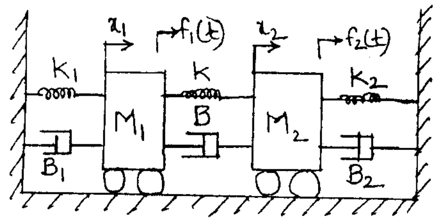

Fig.Q.2(a)

b. Obtain the transfer function for the given thermal system. **(06 Marks)**

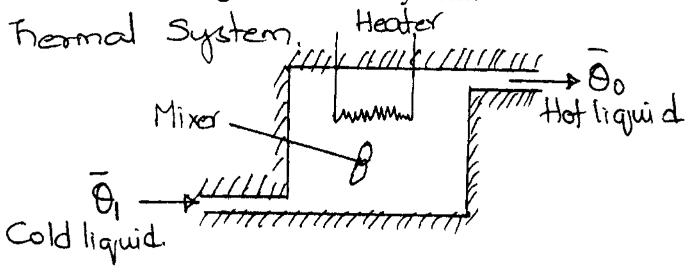

Fig.Q.2(b)

3 a. Reduce the block diagram and obtain control ratio $\frac{C(s)}{R(s)}$. **(10 Marks)**

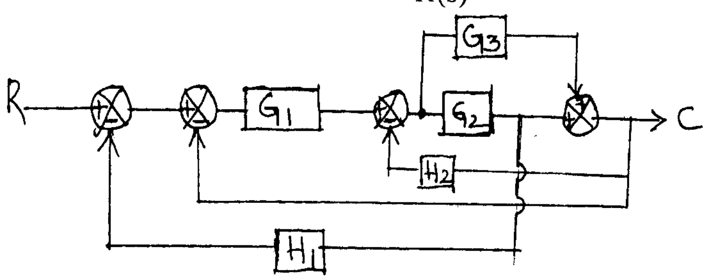

Fig.Q.3(a)

b. Obtain the overall TF $\frac{C(s)}{R(s)}$ of the SFG given: **(10 Marks)**

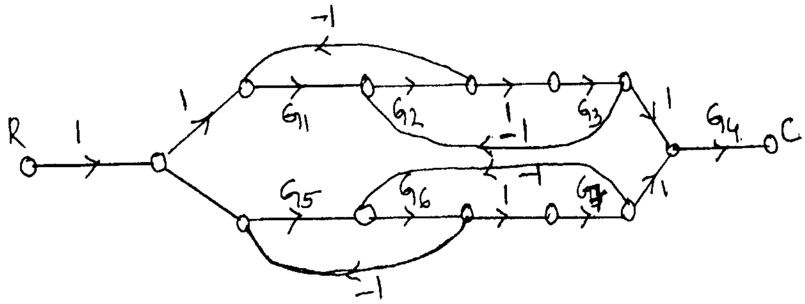

Fig.Q.3(b)

4 a. Define: i) Time response; ii) Step signal; iii) Ramp signal; iv) Parabolic signal; v) Impulse signal. **(05 Marks)**

b. Derive an expression for response of 1st order system for unit step input. **(05 Marks)**

c. A unity feedback CS has an OLTF $G(s) = \frac{10}{s(s+2)}$. Find tr, %M_p, t_p, t_s for a step input of 12 units. **(05 Marks)**

d. Using R-H criterion, determine the stability of the system represented by the characteristic equation $s^5 + 4s^4 + 8s^3 + 8s^2 + 7s + 4 = 0$. **(05 Marks)**

PART – B

5 a. Construct a Nyquist plot for a feedback control system whose OLTF is given by $G(s)H(s) = \frac{5}{s(1-s)}$. Comment on the stability of open loop and closed loop system. **(14 Marks)**

b. Define with respect to Nyquist plot, i) Gain Margin; ii) Phase Margin; iii) Relative stability. **(06 Marks)**

6 Sketch the bode plot for the following TF and determine phase margin and gain margin.

$$G(s) = \frac{75(1+0.2s)}{s(s^2+16s+100)}.$$ **(20 Marks)**

7 Sketch the root locus for UFB system whose open loop TF.

$$G(s) = \frac{K}{s(s^2+6s+10)}.$$ **(20 Marks)**

8 a. Define: i) State; ii) State variables; iii) State space; iv) State trajectory; v) State vector. **(05 Marks)**

b. Write a note on: i) Lag compensator; ii) Lead compensator. **(10 Marks)**

c. Explain the following terms with examples: i) Controllability; ii) Observability. **(05 Marks)**

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Eighth Semester B.E. Degree Examination, June/July 2016
Control Engineering

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define control system. Compare open loop and closed loop control systems with an example for each type. **(08 Marks)**

b. With a block diagram, explain proportional, proportional plus integral (PI) and proportional plus integral plus derivative (PID) controllers. Mention its characteristics. **(12 Marks)**

2 a. Derive the differential equation and obtain the transfer function $\frac{\theta(s)}{E_a(s)}$ for armature controlled DC motor coupled to mechanical load having inertia J and friction coefficient f_0. **(12 Marks)**

b. Draw the equivalent mechanical system (nodal basis) and write the set of equilibrium equations and obtain force voltage analogy for the system shown in Fig. Q2 (b). **(08 Marks)**

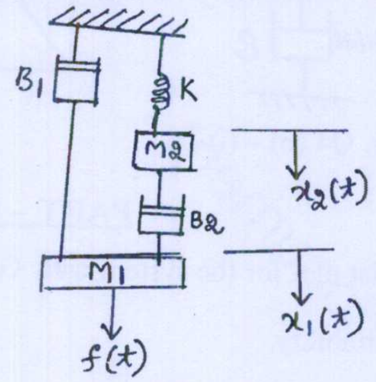

Fig. Q2 (b)

3 a. Reduce the block diagram using reduction technique and obtain $\frac{C(s)}{R(s)}$. **(10 Marks)**

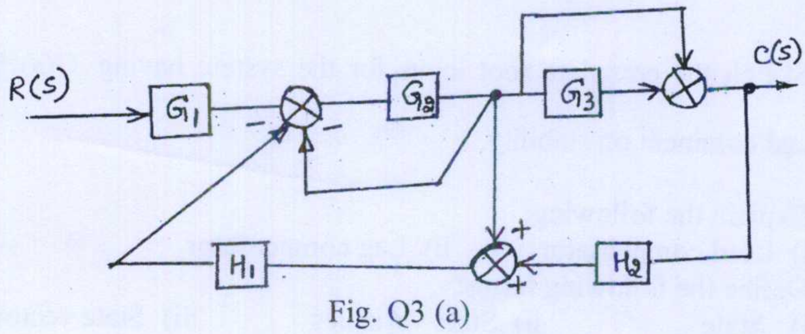

Fig. Q3 (a)

3 b. Find the transfer function by using Mason's Gain formula for the signal flow graph shown in the Fig. Q3 (b). **(10 Marks)**

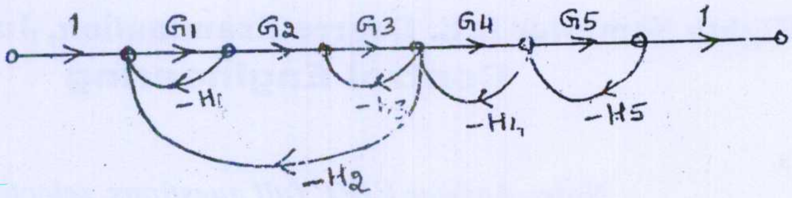

Fig. Q3 (b)

4 a. By applying Routh's criterion discuss the stability of the closed loop system whose characteristic equation is,
$s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$ **(10 Marks)**

b. For a spring mass damper system shown in the Fig. Q4 (b) – (i), a force of 9.6 Newtons is applied to the mass. The response C(t) is as shown in the Fig Q4 (b) – (ii). Find the value of M, B and K. **(10 Marks)**

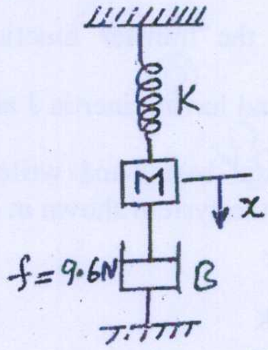

Fig. Q4 (b) – (i)

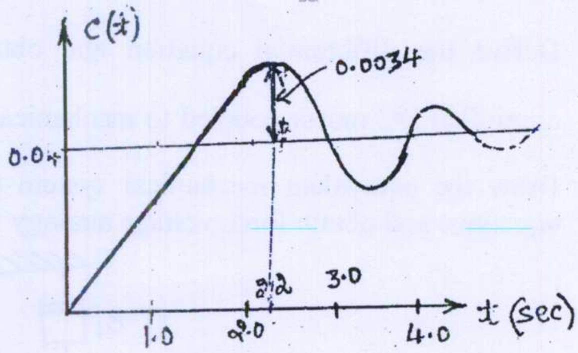

Fig. Q4 (b) – (ii)

PART – B

5 Sketch the Nyquist plot for the system with $G(s)H(s) = \frac{(1+0.5s)}{s^2(1+0.1s)(1+0.02s)}$. Find GM and comment on the stability. **(20 Marks)**

6 Plot the Bode magnitude and phase diagrams for the open loop transfer function,
$G(s)H(s) = \frac{100(s+2)}{s(s+4)(s+5)}$ and
Discuss the stability of the closed loop system and find GM and PM. **(20 Marks)**

7 Sketch the complete root locus for the system having $G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+11.25)}$ and comment on stability. **(20 Marks)**

8 a. Explain the following:
i) Lead compensator ii) Lag compensator **(10 Marks)**

b. Define the following terms:
i) State ii) State variables iii) State vector iv) State space
v) State equation. **(10 Marks)**

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10ME/PM82

Eighth Semester B.E. Degree Examination, Dec.2015/Jan.2016

Control Engineering

Time: 3 hrs. Max. Marks: 100

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

PART – A

1 a. What are the requirements of an ideal control system? **(06 Marks)**

b. Explain the concepts of open loop and closed loop control system, with examples and block diagrams. **(08 Marks)**

c. What are the characteristics of a P-I controller? **(06 Marks)**

2 a. Derive the transfer function for an armature controlled D.C. motor, which relates output angular displacement (θ) with input voltage (e). **(10 Marks)**

b. A thermometer is dipped in a vessel containing liquid at a constant temperature of θ_i. The thermometer has a thermal capacitance for storing heat as C and thermal resistance to limit heat flow as R. If the temperature indicated by thermometer is θ_0, obtain the transfer function of the system. **(07 Marks)**

c. Distinguish between hydraulic and pneumatic systems. **(03 Marks)**

3 a. Reduce the given block diagram shown in Fig.Q3(a) and determine the transfer function of the system.

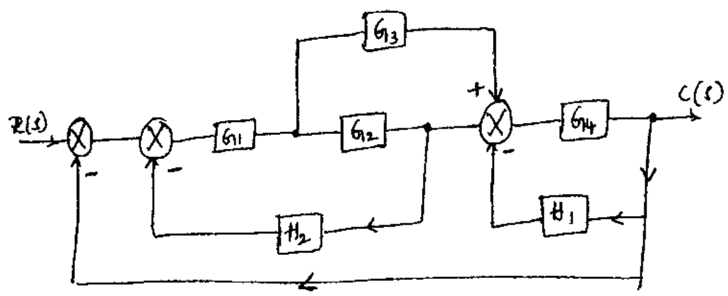

Fig.Q3(a) **(10 Marks)**

b. For the system shown in Fig.Q3(b), determine the transfer function using Mason's gain formula.

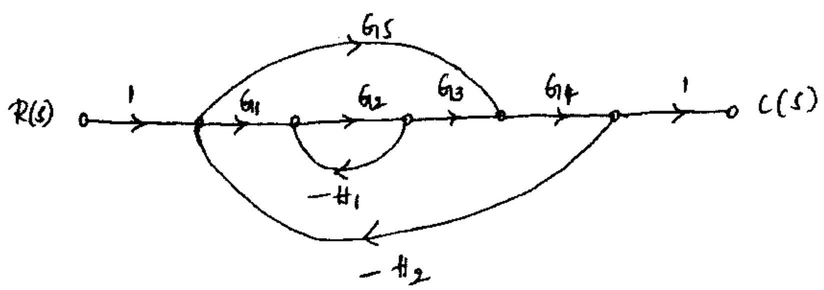

Fig.Q3(b) **(10 Marks)**

4 a. By applying Routh criterion, discuss the stability of the closed loop system, whose characteristics equation is $s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$. **(08 Marks)**

b. A system has the following transfer function,

$$\frac{C(s)}{R(s)} = \frac{20}{s+10}.$$

Determine its unit impulse, step and ramp response with zero initial conditions. Sketch the responses. **(12 Marks)**

PART – B

5 A feedback control system has open loop transfer function:

$$G(s)H(s) = \frac{K}{s(s+4)(s^2+4s+20)}.$$

Plot the root locus for K = 0 to ∞. Indicate the points on it. **(20 Marks)**

6 a. Define the terms gain margin and phase margin. Explain how these can be determined from Bode plots. **(06 Marks)**

b. Sketch the Bode plot for the transfer function

$$G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}.$$

Determine the value of K for the gain cross over frequency to be 5 rad/sec. **(14 Marks)**

7 a. What is system compensation? Explain the (i) series compensation, (ii) feedback compensation. **(08 Marks)**

b. Explain with a block diagram the (i) Lag-compensator, (ii) Lead-compensator. **(12 Marks)**

8 a. Draw the Nyquist plot for a given control system,

$$G(s)H(s) = \frac{K}{s(s+2)(s+10)}.$$

Determine the range of K for which the system is stable. **(14 Marks)**

b. State and explain the Nyquist stability criterion. **(06 Marks)**

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10ME/PM82

Eighth Semester B.E. Degree Examination, June/July 2015
Control Engineering

Time: 3 hrs. Max. Marks:100

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

PART - A

1 a. Distinguish between open loop and closed loop control systems, with suitable examples. **(04 Marks)**

b. What are the ideal requirements of control system? **(06 Marks)**

c. What is Control Action? Briefly explain proportional, proportional plus derivative and proportional plus derivative plus integral controllers, with the help of block diagrams. **(10 Marks)**

2 a. Obtain the differential equation for the mechanical system shown in fig. Q2(a) and draw the equivalent mechanical system, also draw the analogous electrical network based on i) Force – voltage analogy ii) Force – current analogy. **(10 Marks)**

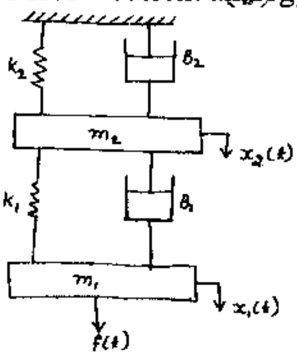

Fig.Q2(a)

b. Derive the transfer function of an armature controlled DC motor. The field current is maintained constant during operation. Assume that the armature coil has back emf $e_b = k_b \frac{d\theta}{dt}$ and the coil current produces a torque $T = K_m I$ on the rotor, K_b and K_m are the back emf constant and motor torque constant respectively. **(10 Marks)**

3 a. Reduce the block diagram shown in fig. Q3(a) to its simplest possible form and find its closed loop transfer function. **(10 Marks)**

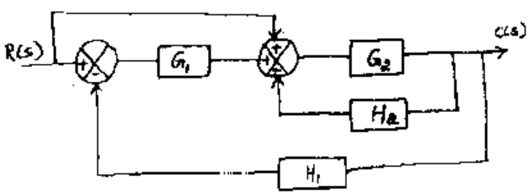

Fig.Q3(a)

b. Using Mason's gain formula, find the gain of the following system shown in fig. Q3(b). **(10 Marks)**

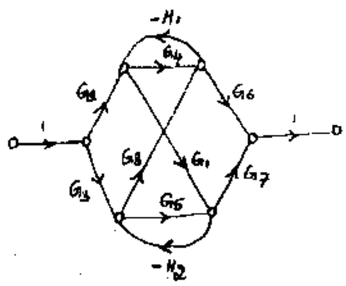

Fig.Q3(b)

4 a. Derive an expression for the unit step response of first order system. **(08 Marks)**

b. A unity feedback system is characterized by an open loop transfer function

$G(s) = \dfrac{K}{s(s+10)}$. Determine the gain K, so that the system will have a damping ratio of 0.5.

For this value of k determine peak time, setting time and peak overshoot for a unit step input. **(08 Marks)**

c. Ascertain the stability of the system given by the characteristic equation

$S^5 + 4S^4 + 12S^3 + 20S^2 + 30S + 100 = 0$, using R – H criteria . **(04 Marks)**

PART - B

5 a. Sketch the polar plot for the transfer function

$G(s) = \dfrac{10}{s(s+1)(s+2)}$. **(10 Marks)**

b. Apply Nyquist stability criterion to the system with transfer function.

$G(s)\ H(s) = \dfrac{4s+1}{s^2(1+s)(1+2s)}$ and ascertain its stability. **(10 Marks)**

6 Sketch the Bode plot for

$G(s)H(s) = \dfrac{2}{s(s+1)(1+0.2s)}$. Also obtain gain margin and phase margin and crossover frequencies. **(20 Marks)**

7 Sketch the root locus plot for

$G(s)H(s) = \dfrac{K}{s(s+2)(s+4)(s+6)}$. For what values of K the system becomes unstable? **(20 Marks)**

8 a. Explain the following : i) Lead compensator ii) Lag compensator. **(12 Marks)**

b. Determine the state controllability and observability of the system described by

$$\dot{x} = \begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} x.$$ **(08 Marks)**

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10ME82

Eighth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Control Engineering

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Explain open loop and closed loop control system with block diagrams. **(10 Marks)**

b. What are the requirements of a control system? Briefly explain. **(05 Marks)**

c. Explain the proportional integral differential controller with applications. **(05 Marks)**

2 a. Obtain the differential equations for the mechanical system shown in Fig.Q2(a). **(10 Marks)**

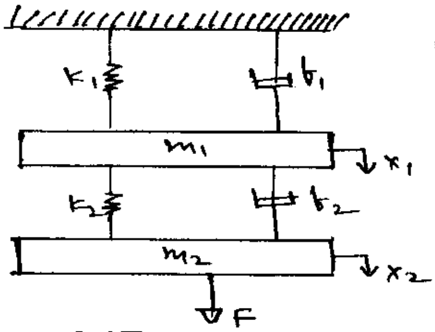

Fig.Q2(a)

b. A thermometer is dipped in a vessel containing liquid at a constant temperature of $\theta_i(t)$. The thermometer has a thermal capacitance for storing heat as C and thermal resistance to limit heat flow as R. If the temperature indicated by the thermometer is $\theta_o(t)$, obtain the transfer function of the system. **(10 Marks)**

3 a. Reduce the block diagram shown in Fig.Q3(a) to its simplest possible form and find its closed loop transfer function. **(10 Marks)**

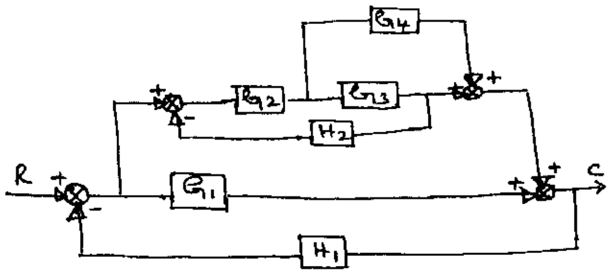

Fig.Q3(a)

b. Find C(s)/R(s) for the following system using Mason's gain rule shown in Fig.Q3(b).

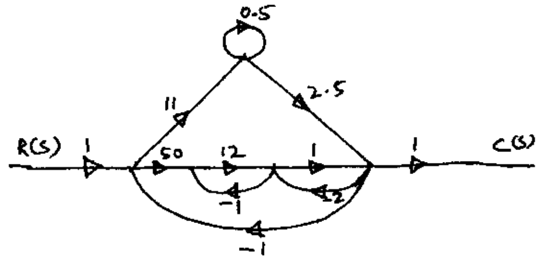

Fig.Q3(b) **(10 Marks)**

4 a. A unity feedback system has $G(s) = \frac{k}{s(s+2)(s^2+2s+5)}$

a) For a unit ramp i/p, it is desired $e_{ss} \le 0.2$ Find k.

b) Determine e_{ss} if input $r(t) = 2 + 4t + \frac{t^2}{2}$ **(10 Marks)**

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

$$G(s)H(s) = \frac{k(s+1)}{s(s-1)(s^2+4s+16)}$$ **(10 Marks)**

PART – B

5 a. Sketch the polar plot for the transfer function $G(s) = \frac{1}{s(-s+a)}$ **(08 Marks)**

b. Apply Nyquist stability criterion for the system with transfer function $G(s)H(s) = \frac{4s+1}{s^2(1+s)(1+2s)}$ and ascertain its stability. **(12 Marks)**

6 Sketch the Bode plot for

$$G(s) = \frac{10}{s(1+s)(1+0.02s)}$$

Also determine gain margin and phase margin and cross-over frequencies. **(20 Marks)**

7 a. Explain the root locus rules with suitable examples. **(05 Marks)**

b. Sketch the root locus of a control system having open-loop transfer function is given by

$$G(s) = \frac{k}{s(s+2)(s^2+6s+25)}$$ **(15 Marks)**

8 a. List the types of compensators used. Explain the need for system compensation. **(10 Marks)**

b. Explain the series and feedback compensated system, with block diagrams. **(10 Marks)**

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10ME/PM82

Eighth Semester B.E. Degree Examination, June/July 2014

Control Engineering

Time: 3 hrs.

Max. Marks: 100

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

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.

PART – A

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

b. Explain the requirements of a control system. **(05 Marks)**

c. Explain following controller. State its characteristics:

i) Proportional plus derivative control action

ii) Proportional plus integral plus derivative control action. **(10 Marks)**

2 a. Write the equilibrium equations for the mechanical system shown in Fig.Q2(a), hence obtain the F-I analogous system.

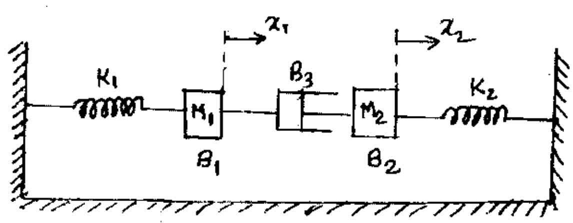

Fig.Q2(a) **(10 Marks)**

b. Obtain the transfer function of field controlled DC motor. **(10 Marks)**

3 a. Reduce the block diagram and obtain its transfer function $\frac{C(s)}{R(s)}$.

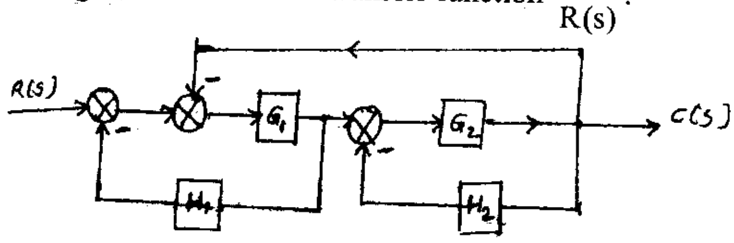

Fig.Q3(a) **(10 Marks)**

b. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula.

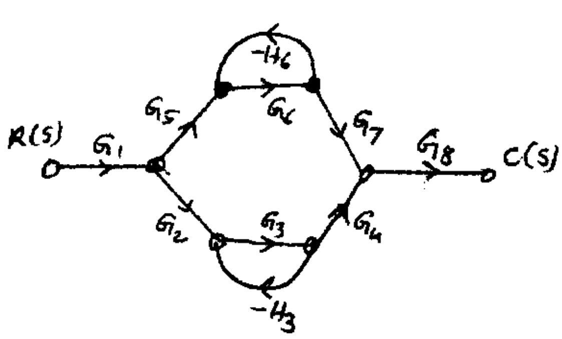

Fig.Q3(b) **(10 Marks)**

4 a. Obtain an expression for time response of the first order system subjected to unit step input. **(08 Marks)**

b. Determine the damping ratio and natural frequency for the system whose maximum overshoot response is 0.2 and peak time is 1 sec. Find rise time and settling time. **(06 Marks)**

c. State whether the system is stable or unstable $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$ using Routh's stability criterion. **(06 Marks)**

PART – B

5 a. Sketch the polar plot of TF $G(s)H(s) = \frac{1}{(1+5s)(1+10s)}$. **(06 Marks)**

b. Sketch the Nyquist plot for a system, whose transfer function, $G(s)H(s) = \frac{K}{s(s+4)(s+8)}$. Determine the range of values of K for which the system is stable. **(14 Marks)**

6 For a system $G(s)H(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$, sketch the Bode plot. Find ω_{pc} and ω_{gc}, GM, PM. Comment on stability. **(20 Marks)**

7 For a unity feedback system, $G(s)H(s) = \frac{K}{s(s+4)(s+2)}$, sketch the rough nature of the root locus, showing all details on it. **(20 Marks)**

8 a. What is compensation? How are compensators classified? **(06 Marks)**

b. Write notes on:
   i) Lead compensator
   ii) Lag compensator **(08 Marks)**

c. A system is governed by the differential equation $\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 10y = 8u(t)$ where y is the output and u is the input of the system. Obtain a state space representation of the system. **(06 Marks)**

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