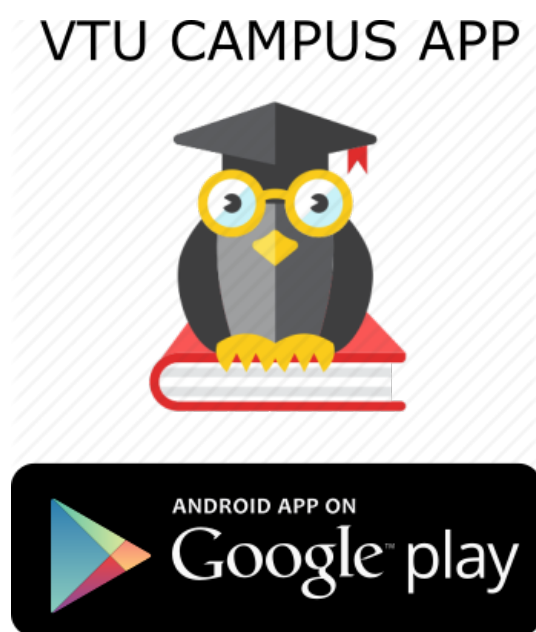


Control Engineering VTU CBCS Question Paper Set 2018



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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)

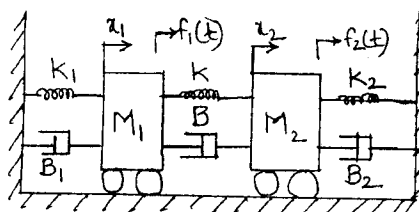


Fig.Q.2(a)

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

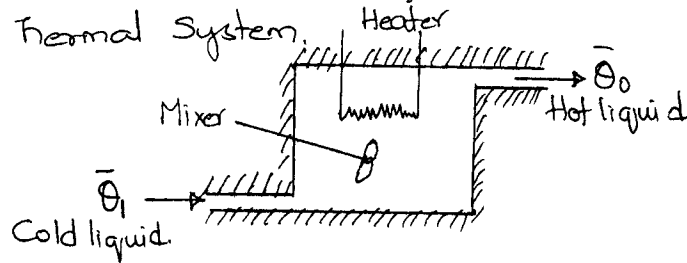


Fig.Q.2(b)

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

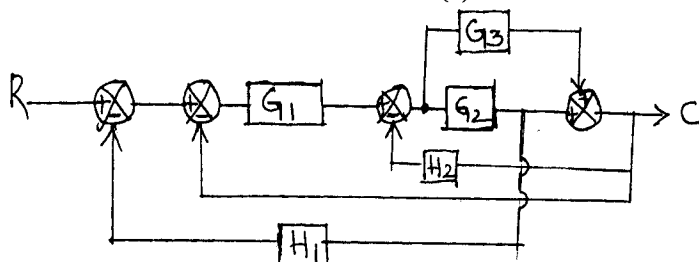
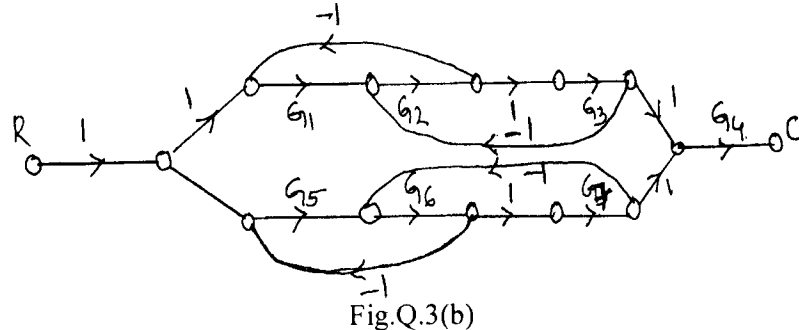


Fig.Q.3(a)

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



- 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. (20 Marks)
- $$G(s) = \frac{75(1+0.2s)}{s(s^2 + 16s + 100)}$$
- 7 Sketch the root locus for UFB system whose open loop TF. (20 Marks)
- $$G(s) = \frac{K}{s(s^2 + 6s + 10)}$$
- 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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10ME82

Eighth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Control Engineering

Time: 3 hrs.

Max. Marks:100

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

PART - A

1. a. Explain regulator and follow-up closed loop control system with examples. (08 Marks)
b. What are the requirements of an ideal control system? (04 Marks)
c. Explain Proportional controller and Integral controller with block diagrams. (08 Marks)
2. a. Obtain differential equations for the mechanical system shown in the Fig.Q2(a). Also draw equivalent force-voltage and force-current circuits using analogues quantities. (10 Marks)

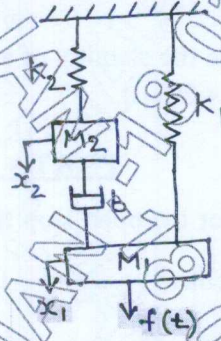


Fig.Q2(a)

- b. Fig.Q2(b) shows liquid level system in which q_i is inflow rate, q_o is out flow rate, R is hydraulic resistance, C is hydraulic capacitance and h is head of liquid. Obtain transfer function $\frac{Q_o(s)}{Q_i(s)}$. (06 Marks)

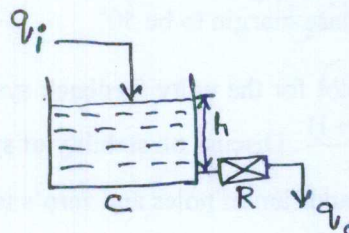


Fig.Q2(b)

- c. Obtain differential equation for RLC circuit. (04 Marks)
3. a. Obtain closed loop transfer function of the block diagram shown in Fig.Q3(a) using block diagram reduction techniques. (10 Marks)

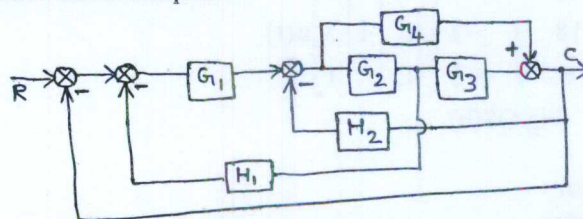


Fig.Q3(a)

(10 Marks)

- b. Draw signal flow graph for the system shown in Fig.Q3(b) and find $\frac{C}{R}$ using Mason's gain formula.

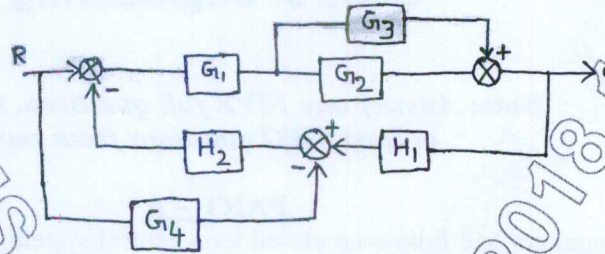


Fig.Q3(b)

(10 Marks)

- 4 a. Obtain response equation for a first order mechanical system subjected to unit step input. (08 Marks)
- b. Define the following terms:
- i) Rise time
 - ii) Delay time
 - iii) Settling time
 - iv) Maximum overshoot
- c. Using RH criteria determine the stability of a system whose characteristic equation is given by $s^5 + 4s^4 + 3s^3 + 12s^2 + 5s + 20 = 0$. (08 Marks)

PART B

- 5 Plot the Nyquist diagram for the open loop transfer function $G(s)H(s) = \frac{12}{s(s+1)(s+2)}$ and determine the nature of stability. (20 Marks)
- 6 The open loop transfer function of a certain unity feedback system is $G(s) = \frac{K}{s(s+2)(s+20)}$, construct Bode plots and determine:
- i) Limiting value of K for system to be stable.
 - ii) Value of K for gain margin to be 10 db.
 - iii) Value of K for phase margin to be 50°.
- (20 Marks)
- 7 a. Sketch Root Locus plot for the unity feedback system whose open loop transfer function is given by $G(s) = \frac{K(s+1)}{s^2}$. Discuss on stability of system. (14 Marks)
- b. Explain the effect of addition of poles and zero's to the system. (06 Marks)
- 8 a. A system is represented by a differential equation $\ddot{y} + 6\dot{y} + 12y + 10y = 4U$, where y is the output and U is the input of the system. Obtain state space equation. (06 Marks)
- b. Find controllability and observability of the system shown in Fig.Q8(b) using Kalman test.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -6 & 2 & -4 \\ -18 & 3 & -8 \\ -6 & 1 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 3 \\ 1 \end{bmatrix} u(t)$$

Fig.Q8(b)

(06 Marks)

- c. Write notes on:
- i) Lag compensator
 - ii) Lead compensator.

(08 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.

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.

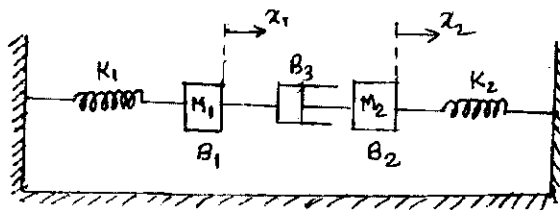


Fig.Q2(a)

- b. Obtain the transfer function of field controlled DC motor. (10 Marks)
3. a. Reduce the block diagram and obtain its transfer function $\frac{C(s)}{R(s)}$. (10 Marks)

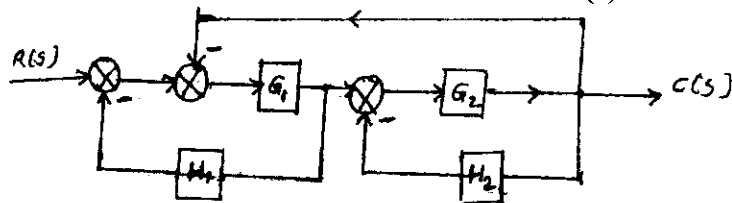


Fig.Q3(a)

- b. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula. (10 Marks)

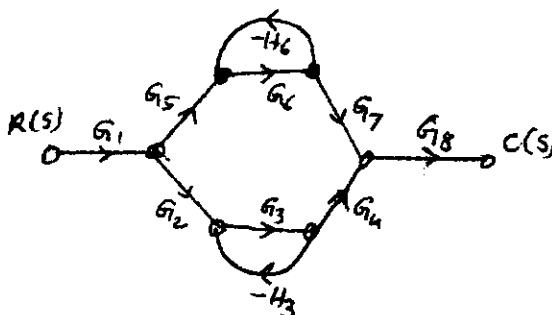


Fig.Q3(b)

(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 $G(s)H(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+12)}$, 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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10ME/PM82

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

Time: 3 hrs.

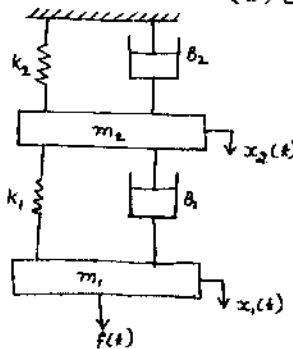
Max. Marks:100

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)

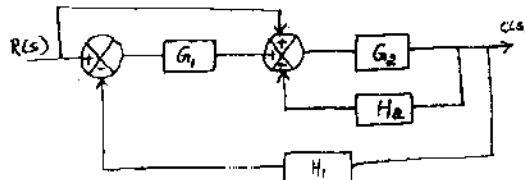
Fig.Q2(a)



- 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)

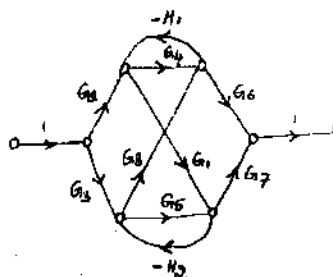
- 3 a. Reduce the block diagram shown in fig. Q3(a) to its simplest possible form and find its closed loop transfer function. (10 Marks)

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

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

$$G(s) = \frac{10}{s(s+1)(s+2)}$$
 (10 Marks)
 b. Apply Nyquist stability criterion to the system with transfer function.

$$G(s) H(s) = \frac{4s+1}{s^2(1+s)(1+2s)}$$
 and ascertain its stability. (10 Marks)
- 6 Sketch the Bode plot for

$$G(s) H(s) = \frac{2}{s(s+1)(1+0.2s)}$$
 Also obtain gain margin and phase margin and crossover frequencies. (20 Marks)
- 7 Sketch the root locus plot for

$$G(s) H(s) = \frac{K}{s(s+2)(s+4)(s+6)}$$
 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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10ME/PM82

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)

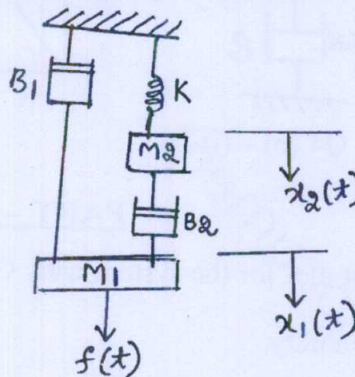


Fig. Q2 (b)

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

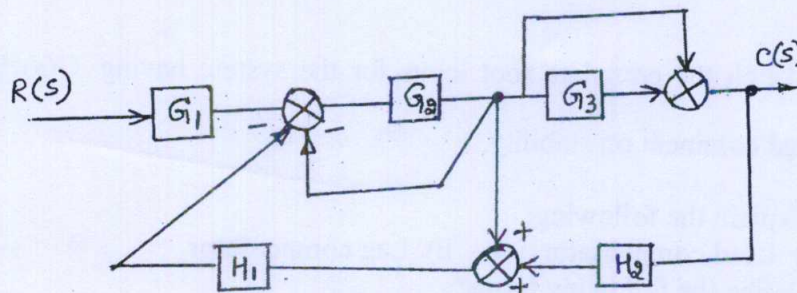


Fig. Q3 (a)

- 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)

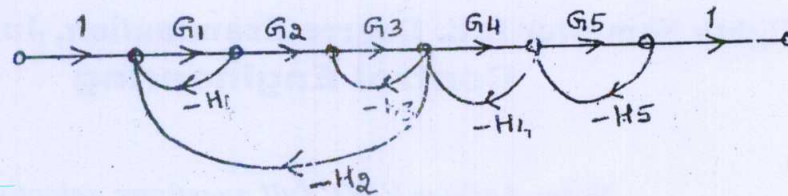


Fig. Q3 (b)

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

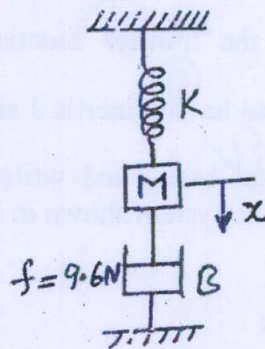


Fig. Q4 (b) - (i)

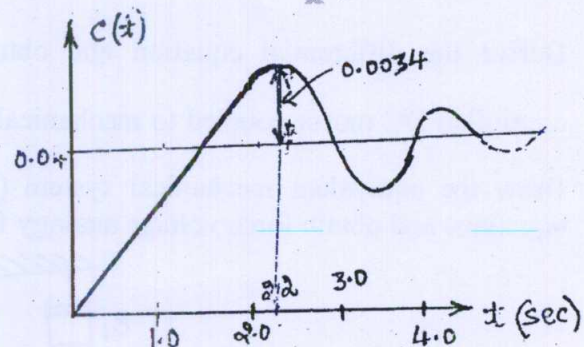


Fig. Q4 (b) - (ii)

PART - B

- 5 Sketch the Nyquist plot for the system with $G(s)H(s) = \frac{(1+0.5s)}{s^2(1+0.5s)(1+0.2s)}$. 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: (10 Marks)
- Lead compensator
 - Lag compensator
- b. Define the following terms: (10 Marks)
- State
 - State variables
 - State vector
 - State space
 - State equation.

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10ME/PM82

Eighth Semester B.E. Degree Examination, June/July 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 control system. Compare open loop and closed loop control system with an example for each type. (08 Marks)
- b. What are the ideal requirements of control system? (06 Marks)
- c. Draw the block diagram of proportional plus integral plus derivative controller and state its characteristics. (06 Marks)
- 2 a. Write the differential equations governing the behaviour of the mechanical system shown in Fig.Q2(a). Also obtain the analogous electrical circuit based on force voltage analogy and loop equations.

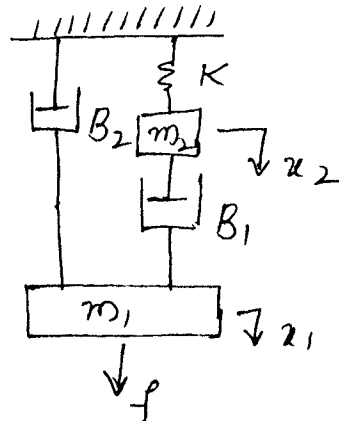


Fig.Q2(a)

- b. Obtain the transfer function of field controlled DC motor. (10 Marks)
- 3 a. Reduce the block diagram shown in Fig.Q3(a) and obtain the transfer function $\frac{C(s)}{R(s)}$. (10 Marks)

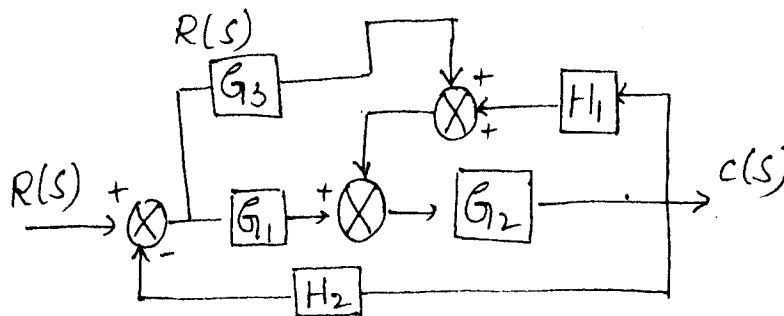


Fig.Q3(a)

(10 Marks)

- b. Find the transfer function by using Mason's gain formula for the signal flow graph shown in Fig.Q3(b).

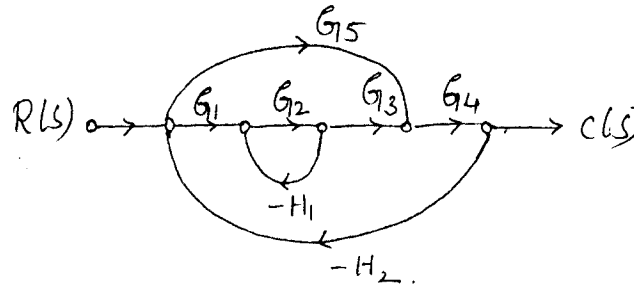


Fig.Q3(b)

(10 Marks)

- 4 a. A units feedback system characterized by an open loop transfer function

$$G(s) = \frac{10}{s^2 + 2s + 6}$$

Determine the following, when the system is subjected to a unit step input:

- Undamped natural frequency
- Damping ratio
- Peak overshoot
- Peak time
- Settling time

(10 Marks)

- b. Explain Routh Hurwitz criterion for stability of a control system and examine the stability of $s^4 + 2s^3 + 3s^2 + 8s + 2 = 0$ using the same.

(10 Marks)

PART - B

- 5 a. Sketch the polar plot for the transfer function $G(s) = \frac{10}{s(s+1)(s+2)}$.

(10 Marks)

- b. Plot the Nyquist diagram for the open loop transfer function

$$G(s)H(s) = \frac{12}{s(s+1)(s+2)}$$

and determine the nature of stability.

(10 Marks)

- 6 Sketch the bode plot for a unity feed-back system, whose open loop transfer function is given by $G(s)H(s) = \frac{10}{s(1+s)(1+0.02s)}$, find:

- Gain and phase cross over frequencies.
- Gain and phase margin.
- Stability of the closed loop system.

(20 Marks)

- 7 Sketch the root locus plot for the system whose open loop transfer function is given by

$$G(s)H(s) = \frac{K}{s(s+2)(s^2+8s+20)}$$

(20 Marks)

- 8 a. Explain the following:

- Lead compensator
- Lag compensator

(10 Marks)

- b. Explain the series and feedback compensated system, with block diagrams.

(10 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)

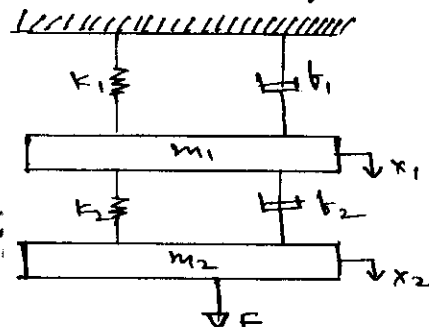


Fig.Q2(a)

- 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)

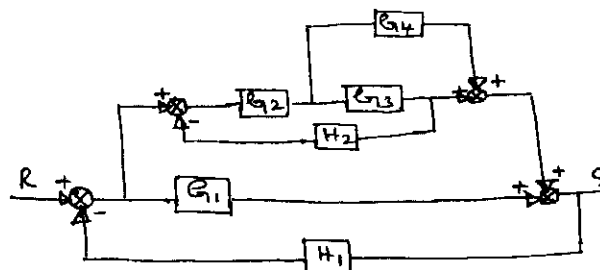


Fig.Q3(a)

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

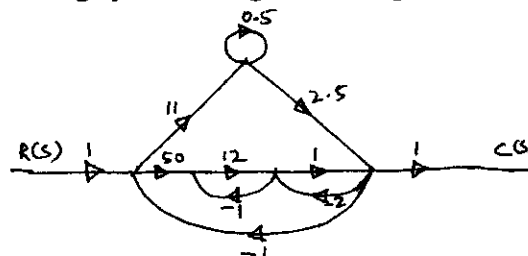


Fig.Q3(b)

(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 $e_{ss} \leq 0.2$ Find k.

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

(10 Marks)

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

$$G(s)H(s) = \frac{4s+1}{s^2(1+s)(1+2s)}$$

(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

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

(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, 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_o , 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. (10 Marks)

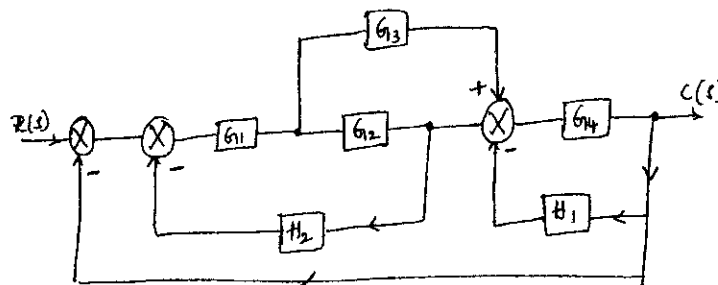


Fig.Q3(a)

(10 Marks)

- b. For the system shown in Fig.Q3(b), determine the transfer function using Mason's gain formula. (10 Marks)

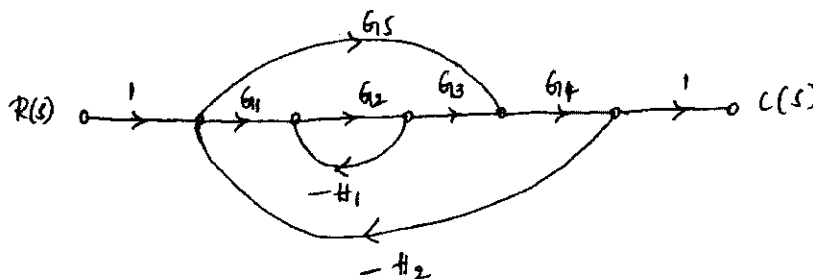


Fig.Q3(b)

(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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