III B. Tech I Semester Regular Examinations, Dec/Jan -2022-23
CONTROL SYSTEMS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
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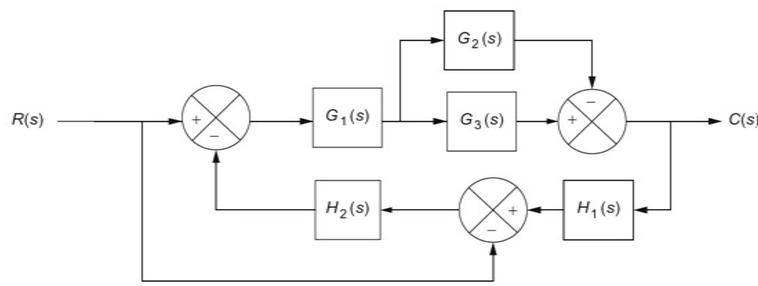
UNIT-I

1. a) What are the requirements for good servomotor? [7M]
   b) For the block diagram of the system shown in below Fig., determine the closed-loop transfer function using the block diagram reduction technique. [7M]



(OR)

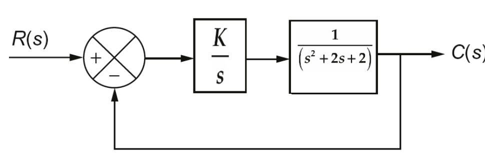
2. a) State and explain the Mason's gain formula. [7M]
   b) What do you mean by the sensitivity of the control system and discuss the effect of feedback on sensitivity? [7M]

UNIT-II

3. a) Discuss the effect of PD and PI on performance of a control system [6M]
   b) A unity feedback system is characterized by an open loop transfer function G(s)= K/s(s +)5 . Determine the gain K so that the system will have a damping factor of 0.7. For this value of K determine the natural frequency of the system. It is subjected to a unity step input. Obtain the closed loop response of the system in time domain. [8M]

(OR)

4. a) Discuss the concept of steady-state error when the system is excited by following inputs: (a) Unit-step, (b) unit-ramp and (c) unit-parabolic. [7M]
   b) A unity feedback control system shown in below Fig. has a controller. Find the loop transfer function of the system and construct the root locus of the system. [7M]



UNIT-III

5. a) Derive the expressions for frequency domain specifications of a second order system. [7M]

   b) Given the open loop transfer function of a unity feedback system $G(s)H(s)=10s/(s+2)(s+5)$ Draw the Bode plot and measure from the plot the frequency at which the magnitude is 0 dB. [7M]

(OR)

6. a) Given the open loop transfer function G(s) = K/s(s +)(1 s +)5. Sketch the Nyquist plot and investigate the open loop and closed loop systems stability. [7M]

   b) Explain the general procedure for constructing Bode plots. [7M]

UNIT-IV

7. a) Design a phase lag network for a plant with the open loop transfer function $G(s)=5/s(1+0.1s)^2$ to have a phase margin of 45^0. Verify the performance of the compensated system with the specification. [7M]

   b) Draw the electrical equivalent circuits of lead, lag and lag-lead compensators. [7M]

(OR)

8. a) What is lead-lag compensator? Write the procedure to design using Bode plots. [7M]

   b) Design a lead compensator for the system with an open loop transfer function [7M]
   $G_f(s) = K/s^2(1+0.1s)$ for the specifications of K_a =10 and $\emptyset_{pm}=30^0$

UNIT-V

9. a) What is State transmission matrix? Discuss the properties of state transition matrix. [7M]

   b) Discuss the concept of controllability and observability with an example. [7M]

(OR)

10. a) List out the advantages and disadvantages of state space techniques. [7M]

    b) Determine the state model of the system characterized by the differential equation $(s^4 + 2s^3 + 8s^2 + 4s + 3)\ Y(s) = 10\ U(s)$. [7M]

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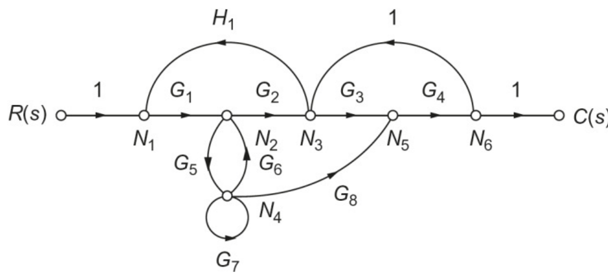
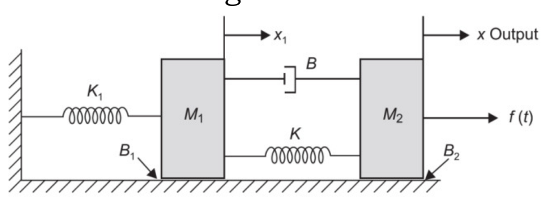
UNIT-I

1. a) Derive the transfer function and develop the block diagram of Armature controlled DC servo motor [7M]
   b) The SFG for a system is shown in below Fig. Obtain the transfer function of the given SFG using Mason's gain formula. [7M]



(OR)

2. a) What are the advantages and disadvantages of closed loop control system? [7M]
   b) Obtain the transfer function of the mechanical system shown in below Fig. and draw its analogous circuit. [7M]



UNIT-II

3. a) Obtain the time response of a first order system for a unit step input and plot its response [7M]
   b) A system described by the differential equation is given by [7M]

$$\frac{d^2y(t)}{dt^2}+8\frac{dy(t)}{dt}+25y(t)=50x(t)$$

Determine (i) response of the system and (ii) the maximum output of the system when a step input of magnitude 2.5 units is applied to the system.

(OR)

4. a) Find the stability of the control system having characteristic equation $s^4 + 2s^3 + 8s^2 + 4s + 3$. [7M]
   b) How does the steady-state value of the system changes when the following controllers are added to the system: (a) PD controller, (b) PI controller and (c) PID controller? [7M]

UNIT-III

5. a) A unit-step response test conducted on a second order system yielded peak overshoot M_p =0.12, and peak time t_p=0.2s. Obtain the corresponding frequency response indices ((Mr ,ω_r,ω_b) for the system [7M]

   b) State and explain the Nyquist stability criterion. [7M]

(OR)

6. a) Draw the Bode plot for the unity feedback control system whose transfer function is given as [7M]

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

   From the plot, determine the values of gain margin and phase margin. State whether the system is stable or not.

   b) A unity feedback control system is represented by its open loop transfer function [7M]

$$G(s)H(s) = \frac{8}{s(s+1)(s+2)}$$

   Sketch the polar plot and examine whether the system is stable or not. Also calculate its gain margin from the polar plot.

UNIT-IV

7. a) Write the differences between lag and lead compensator. [7M]

   b) Draw electrical network configuration for phase-lead compensator and hence derive the transfer function for the same. [7M]

(OR)

8. a) Explain the procedural steps to design a phase lag compensator using Bode analysis. [7M]

   b) Draw the electrical equivalent circuits of lead-lag and lag-lead compensator. [7M]

UNIT-V

9. a) State and explain the concepts of Controllability and Observability. [7M]

   b) Given G(s) = $2/S^2+5s+6$ obtain the state space model of the system in the diagonal canonical form. [7M]

(OR)

10. a) Explain the procedure to obtain the transfer function of electrical network using state space representation. [7M]

    b) Determine the state model of the system characterized by the differential equation $(5s^4 + 2s^3 + 8s^2 + 8s + 4)\,Y(s) = 10\,U(s)$. [7M]

Code No: R2031023 **R20** SET - 3

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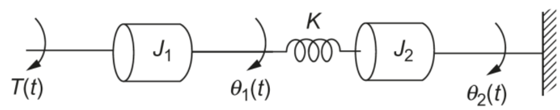
UNIT-I

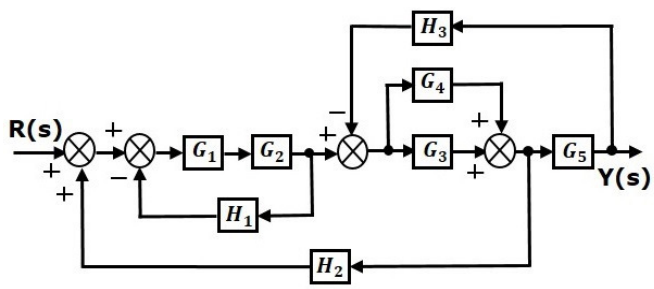
1. a) What are the advantages and disadvantages of open loop control system [7M]

   b) For the mechanical rotational system shown in below Fig., obtain (i) differential equations and (ii) transfer function of the system. [7M]



(OR)

2. a) Using block diagram reduction technique finds the transfer function for the system shown in below Figure [7M]



   b) Why is negative feedback invariably preferred in closed loop systems? [7M]

UNIT-II

3. a) What are the standard test signals? Explain them. [7M]

   b) The open-loop transfer function of a unity feedback control system is given by [7M]

$$G(s)=\frac{K}{(s+2)(s^3+10s^2+49s+100)}$$

(i) Examine the range of values of gain K, using Routh's table for the system to be stable.
(ii) Also, determine the value of K which causes sustained oscillation in the system and then determine the frequency of sustained oscillations.

(OR)

4. a) Define the steady state error for different types of inputs? Derive the steady state error and error constants for different types of inputs. [7M]

   b) Sketch the root locus of the open-loop transfer function as given below [7M]

$$G(s)H(s)=\frac{80}{s(s+2)(s+20)}$$

UNIT-III

5. a) Given the open loop transfer function with unity feedback as $G(s) = Ke^{-10s}/s(2+s)(1+5s)$. Draw the bode plot and determine the gain K for the gain cross over frequency to be 4 rad/sec. [7M]

b) The open-loop transfer function of a unity feedback control system is given as [7M]

$$G(s)\,H(s) = \frac{K}{(1+\tau_1 s)(1+\tau_2 s)}$$

Examine the stability of the system by applying Routh–Hurwitz criterion, and Nyquist stability criterion.

(OR)

6. Given the open loop transfer function $G(s)=5/(1+2s+s^2)(1+3s)$ Sketch the Nyquist plot and investigate the open loop and closed loop systems stability. [14M]

UNIT-IV

7. a) Design a lag compensator that will provide a phase lag of 50^0 and alternation of 15 dB at 2 rad/sec. Also determine the transfer function. [7M]

b) What is the need of lag-lead compensator? [7M]

(OR)

8. a) Design a phase lag network for a plant with the open loop transfer function $G(s)= 5/s(1+0.1s)^2$. [7M]

b) Explain the design procedure of lead compensator. [7M]

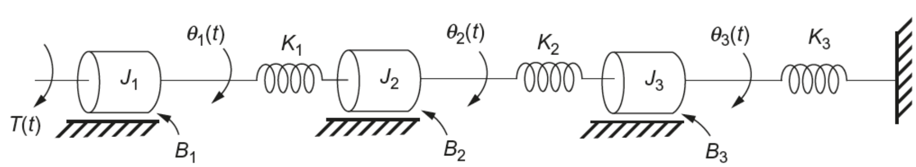
UNIT-V

9. a) Explain the concepts of state, state variables and state model. [7M]

b) Given $G(s) = 2/s^2+8s+4$ obtain the state space model of the system in the diagonal canonical form. [7M]

(OR)

10. a) Obtain the state equation and output equation of the rotational mechanical system shown in below Fig. [7M]



b) Discuss the procedure diagonalization using linear transformation? [7M]

Code No: R2031023 **R20** SET - 4

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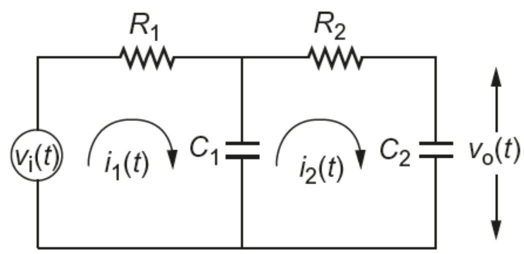
UNIT-I

1. a) What are the basic elements used for modeling rotational mechanical system? Write its force balance equations? [7M]
   b) State whether the transfer function is applicable for non-linear system? Justify the answer. [7M]

(OR)

2. a) Determine the transfer function of the electrical network shown in below Fig. [7M]



   b) What is meant by non-touching loops in the signal flow graph? Explain. [7M]

UNIT-II

3. a) Explain the special cases in Routh's stability criterion with examples. [7M]
   b) Sketch the root locus for the characteristic equation is $s (s+1) (s+2) + k (s + 1.5) = 0$. [7M]

(OR)

4. a) What are the necessary and sufficient conditions of stability for linear time invariant systems? [7M]
   b) The open loop transfer function of a unity feedback control system is given by $G(s) = K/s(s+3)^2$, Sketch the root locus plot of the closed loop system for positive values of k and there from determine the value of k that would make the system. [7M]

UNIT-III

5. a) Sketch the Bode plot for the following transfer function and determine the system gain K for the gain crossover frequency to be i)10 rad/s and ii) 0.5 rad/s. [7M]
   $G(s)\ H(s) = Ks^2/(1+0.25s)(1+0.025)$
   b) Explain the general procedure for constructing Bode plots. [7M]

(OR)

6. a) The open loop transfer function of a unity feedback control system is G(s) =K/(s+1)(2s+1) Use Nyquist stability criterion to determine the critical value of gain 'K' for stability. [7M]

   b) The open-loop transfer function of a system is [7M]

$$G(s)H(s) \; \frac{K}{s(s+2)(s+3)}$$

   Determine the value of K for which the system will remain stable with (i) phase margin of 60° and (ii) gain margin of 6 dB.

UNIT-IV

7. Consider a unity feedback system with open loop transfer function G(s)= K/s(1+s)(2+s) design a suitable compensator so that the compensated system has K_v = 10 sec^{-1}, Phase margin = 40^0 and Gain margin ≤ 12 db. [14M]

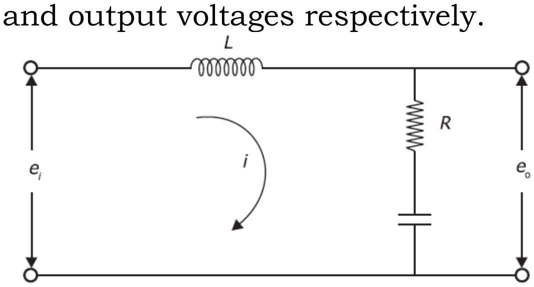
(OR)

8. a) For the given open loop transfer function, G(s) = K/s(s+4)(s+6) Design suitable lead compensation so that phase margin is ≥ 30^o and velocity error constant, K_v ≥ 15 [7M]

   b) Draw the electrical equivalent circuits of lead, lag and lag-lead compensators [7M]

UNIT-V

9. a) Consider the electrical circuit shown in below Fig. Obtain a state model of the system with zero initial condition where $e_i(t)$ and $e_0(t)$ are input and output voltages respectively. [7M]



   b) Obtain the transfer function for linear time invariant system. And also draw the state model. [7M]

(OR)

10. a) What is controllability and observability? Test the controllability and observability of the system with [7M]

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, \quad B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 10 & 5 & 1 \end{bmatrix}.$$

   b) By using parallel decomposition, Construct the state model for the system represented by $5(s+1)/5(s+3)^2$ [7M]