Reg. No. : ____________

Question Paper Code : 30808

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024

Fourth Semester

Instrumentation and Control Engineering

IC 8451 – CONTROL SYSTEMS

(Common to: Electrical and Electronics Engineering/Electronics and Instrumentation Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

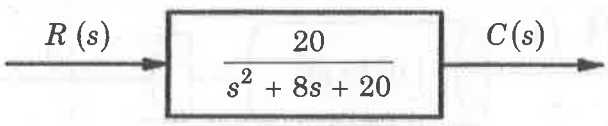
PART A — (10 × 2 = 20 marks)

1. Compare the open loop and closed loop system.

2. Find the transfer function for the system represented by an equation $\frac{dc(t)}{dt} + 5c(t) = r(t)$ Where $c(t)$ is output and $r(t)$ is the input.

3. Define poles and zeros of a transfer function.

4. Find the value of damping ratio (ζ) and report the kind of response expected for the system shown in Figure.



5. Define Gain margin and Phase Margin.

6. Draw the plot of type 1, order 2 system.

7. Write the necessary and sufficient conditions of Routh-Hurwitz criteria.

8. Define Nyquist stability criterion.

9. Define the term controllability and observability.

10. Write the general state space equation of a system.

PART B — (5 × 13 = 65 marks)

11. (a) Find the $G(s) = VL(s)/V(s)$ for the each network shown in Figure 11a.

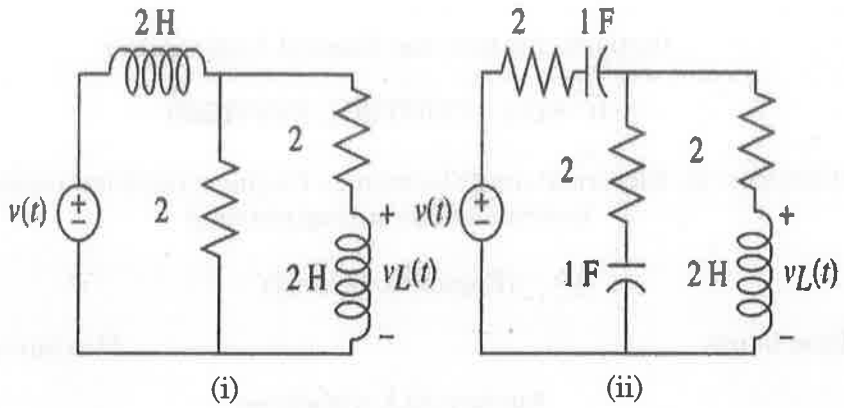


Fig. 11a

Or

(b) Derive the transfer function of AC servo motor.

12. (a) For the system shown in Figure 12a, a step torque is applied at $\theta_1(t)$.

Find:

(i) The transfer function, $G(s)=\theta_2(s)/T(s)$ (7)

(ii) The percent overshoot, settling time and peak time for $\theta_2(t)$ (6)

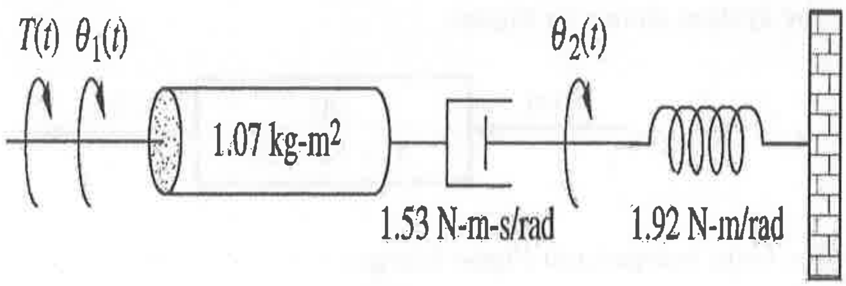


Fig. 12a

Or

(b) For each pair of second-order system specifications that follow, find the location of the second-order pair of poles

(i) %OS = 12%; Ts = 0:6 second (4)

(ii) %OS = 10%; Tp = 5 seconds (4)

(iii) Ts = 7 seconds; Tp = 3 seconds (5)

13. (a) Sketch the bode plot for the following transfer function and determine phase margin and gain margin.

$$G(s)=\frac{10}{s(1+0.4s)(1+0.1s)}$$

Or

(b) Consider a unity feedback system having a open loop transfer function

$G(s)=\dfrac{K}{s(1+0.5s)(1+4s)}$. Sketch a polar plot and determine the value of K so that

(i) Gain Margin is 20 db and (7)

(ii) phase margin is 30°. (6)

14. (a) Using the Routh-Hurwitz criterion for the unity feed-back system given by open loop transfer function,

$$G(s)=\frac{K}{s(s+1)(s+2)(s+6)}$$

(i) Find the range of K for stability (4)

(ii) Find the value of K for marginal stability (4)

(iii) Find the actual location of the closed-loop poles when the system is marginally stable. (5)

Or

(b) Design a lead compensator for a unity feedback system with open loop transfer function, $G(s)=\dfrac{K}{s(s+1)(s+5)}$ to satisfy the following specifications

(i) Velocity error constant, $K_V \geq 50$ (7)

(ii) Phase margin is $\geq$ 20°. (6)

15. (a) Determine whether the system is controllable and observable.

$$\dot{x} = Ax + Bu = \begin{bmatrix} -2 & -1 & -3 \\ 0 & -2 & 1 \\ -7 & -8 & -9 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \\ 2 \end{bmatrix} u$$

$$y = Cx = [4\ 6\ 8]\ x$$

Or

(b) Convert the state and output equations shown below in to a transfer function.

$$\dot{x} = \begin{bmatrix} -4 & -1.5 \\ 4 & 0 \end{bmatrix} x + \begin{bmatrix} 2 \\ 0 \end{bmatrix} u(t)$$

$$y = [1.5\ \ 0.625]\ x$$

PART C — (1 × 15 = 15 marks)

16. (a) Given a unity feedback system that has the forward transfer function.

$$G(s) = \frac{K(s-2)(s-4)}{s^2+6s+25}$$

Do the following:

(i) Sketch the root locus. (2)

(ii) Find the imaginary-axis crossing. (2)

(iii) Find the gain, K, at the $j\omega$-axis crossing. (2)

(iv) Find the break-in point. (2)

(v) Find the point where the locus crosses the 0.5 damping ratio line. (2)

(vi) Find the gain at the point where the locus crosses the 0.5 damping ratio line. (3)

(vii) Find the range of gain, K, for which the system is stable. (2)

Or

(b) For a unity feedback system with a forward transfer function

$$G(s) = \frac{K}{s(s+50)(s+120)}$$

Use frequency response techniques to find the value of gain, K to yield a closed-loop step response with 20% overshoot.

Reg. No. : [| | | | | | | | | | |]

Question Paper Code : 80803

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fourth Semester

Instrumentation and Control Engineering

IC 8451 – CONTROL SYSTEMS

(Common to : Electrical and Electronics Engineering/Electronics and Instrumentation Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Transfer Function.

2. Give the analogy between Electrical and Thermal Systems.

3. Justify why steady state error can be found only for Stable System.

4. List the effects of PI controller on the system.

5. Define the terms Gain Margin and Phase Margin.

6. Give the Bode approximation for $\frac{1}{S+a}$.

7. State Nyquist stability criterion.

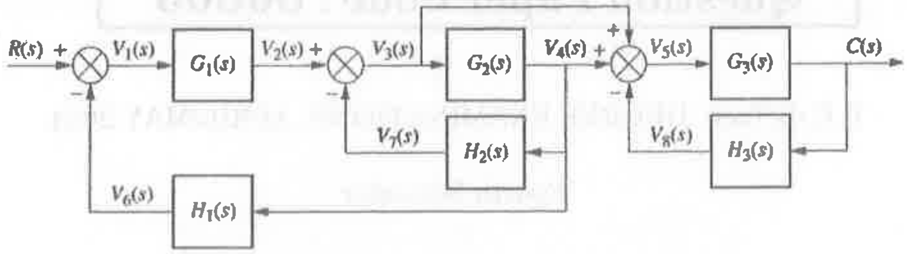
8. Give the importance of characteristic equation.

9. List the advantages of State Space Analysis.

10. Define the terms Controllability and Observability.

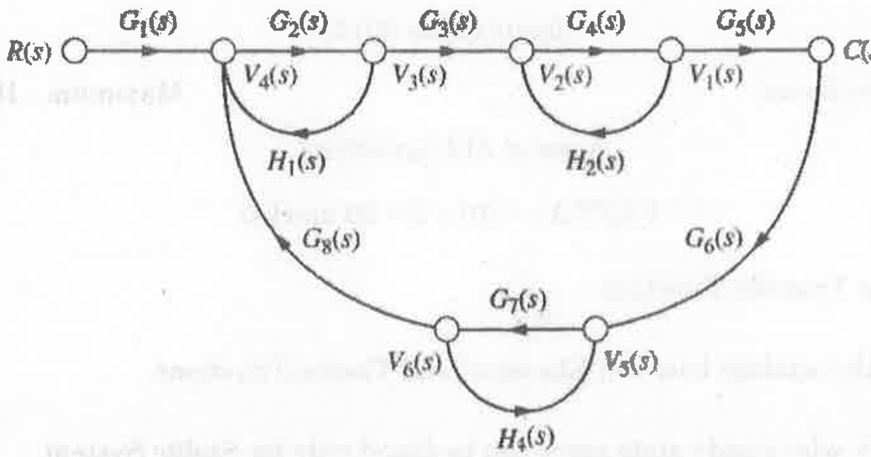
PART B — (5 × 13 = 65 marks)

11. (a) Reduce the given block diagram, into a single transfer function using block diagram reduction technique.



Or

(b) Determine the transfer function for the signal flow graph using Mason Gain Formula.



12. (a) The 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 overshoot and time at peak overshoot for a unit step input.

Or

(b) A unity feedback system has the forward transfer function $G(S)=\frac{K(2S+1)}{S(5S+1)(1+S)^2}$. When the input $r(t)=1+6t$ determine the minimum value of K so that the steady error is less than 0.1

13. (a) Sketch the Bode plot for the function $G(S)=\frac{5(1+2S)}{(1+4S)(1+0.25S)}$ and determine the Gain Margin and Phase Margin.

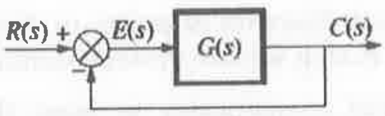
Or

(b) Sketch the root locus of the system whose open loop transfer function is,

$$G(S)=\frac{K}{S(S+2)(S+4)}.$$

Find the value of K so that the damping ratio of the closed loop system is 0.5.

14. (a) For the system given below, where $G(S)=\frac{K}{(S+2)(S+4)(S+6)}$.



do the following :

(i) Plot the Nyquist diagram

(ii) Use your Nyquist diagram to find the range of gain, K for stability.

Or

(b) Given the transfer function $G(S)=\frac{10(S+1)}{(S+2)(S+3)}$ analyze the stability and performance characteristics of the closed-loop system using the Nyquist stability criterion and frequency response compensation techniques.

(i) Apply the Nyquist stability criterion to determine the stability of the closed-loop system for varying values of gain K. (5)

(ii) Design a lag-lead compensator to improve system performance. The compensator should ensure a phase margin of at least 60 degrees and a gain crossover frequency of 5 rad/s. Employ the Bode plot method to design the compensator and provide its transfer function. (8)

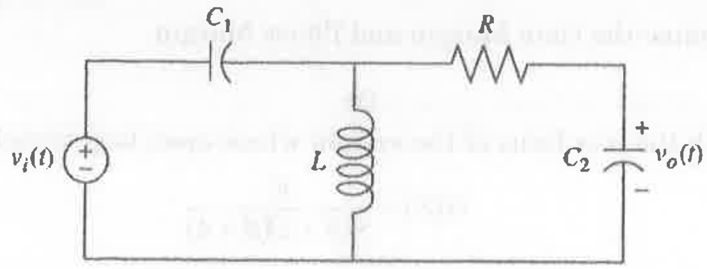
15. (a) Determine the transfer function T(s) = Y(s)/U(s) for the given state space representation.

$$\dot{X}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -2 & -3\end{bmatrix}x+\begin{bmatrix}10\\ 0\\ 0\end{bmatrix}u$$

$$y=[1 \quad 0 \quad 0]x.$$

Or

(b) Determine the state space representation for the following system



PART C — (1 × 15 = 15 marks)

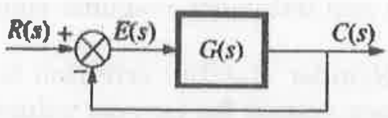
16. (a) Consider a transfer function $G(S)=\dfrac{K(S+1)}{(S+2)(S+3)(S+4)}$ representing a closed-loop system. Perform the following tasks:

(i) Use the Routh-Hurwitz criterion to determine the range of values for the gain K that ensure system stability.

(ii) Design a lead compensator to meet the following specifications: steady-state error less than 0.1 for a unit step input, phase margin of at least 45 degrees, and bandwidth of 10 rad/s. Utilize the Bode plot method to design the compensator, and provide the transfer function of the compensator.

Or

(b) For the system given below, where $G(S)=\dfrac{K}{(S+5)(S+20)(S+50)}$



do the following.

(i) Draw the Bode log-magnitude and phase plots.

(ii) Find the range of K for stability from your Bode plots.

(iii) Evaluate gain margin, phase margin, zero dB frequency, and 180° frequency from your Bode plots for K =10000.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 51016

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fifth Semester

Electrical and Electronics Engineering

EE 3503 — CONTROL SYSTEMS

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

(Semi log sheets and polar sheets may be permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List any two advantages of closed loop control system.

2. Write the characteristics of feed back control system.

3. Name any two standard test signals.

4. Write the condition for the system to be stable.

5. List any two frequency domain specifications.

6. Define phase cross over frequency.

7. List any two properties of state transition matrix.

8. Define controllability.

9. List any one advantages of using lag compensator.

10. Give the tuning method for PID controller design.

PART B — (5 × 13 = 65 marks)

11. (a) Build the transfer functions of the mechanical systems as shown in Figure 1.

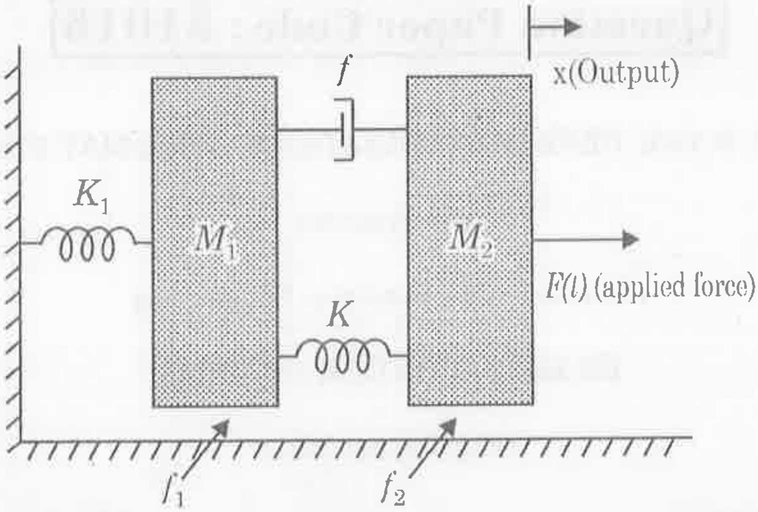


Figure. 1

Or

(b) Develop the overall transfer function C/R from the signal flow graph as shown in Figure. 2.

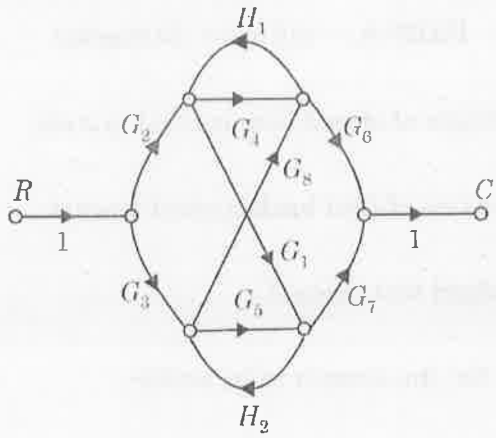


Figure. 2

12. (a) Construct an expression for an under damped second order system response for a unit step input.

Or

(b) Analyze the stability of the following characteristic equation using Rough criterion

$$s^5 + s^4 + 3s^3 + 9s^2 + 16s + 10 = 0$$

Also determine the number of roots lying one the right half of s-plane.

13. (a) Construct the bode plot of the following open loop transfer function and determine the gain cross over frequency.

$$G(s) = \frac{5(1+2s)}{s(4s+1)(0.25s+1)}$$

Or

(b) Draw the polar plot and obtain gain and phase margin of the following system.

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

14. (a) (i) A linear time invariant system is characterized by the homogeneous state equation (6)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Compute the solution by assuming $X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$.

(ii) Consider now that the system has a forcing function and is represented by the non-homogeneous state equation. (7)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

Where u is a unit-step input? Compute the solution by assuming initial conditions of part (i).

Or

(b) Determine the controllability and observability of the following system.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

15. (a) Explain in detail about the procedure to obtain the controller settings using Process Reaction Curve method.

Or

(b) With neat block diagram explain controller tuning using Ziegler-Nichols method.

PART C — (1 × 15 = 15 marks)

16. (a) Consider a type-1 unity feedback system with an open-loop transfer function

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

Design a suitable lead compensator in frequency domain with $K_v = 12$ sec^{-1}. PM = 40 degrees.

Or

(b) A unit feedback system is characterized by the open-loop transfer function

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

It is desired to obtain a phase margin of 40 degrees without sacrificing the K_v of the system. Design a suitable lag-network and compute the value of network components assuming any suitable impedance level.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50768

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Instrumentation and Control Engineering

IC 8451 — CONTROL SYSTEMS

(Common to Electrical and Electronics Engineering/ Electronics and Instrumentation Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

(Provide Semilog sheet, Polar graph and ordinary graph sheet)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write Mason's gain formula and mention the advantages.

2. What are the advantages of a closed loop control system over open loop system?

3. The damping ratio and the undamped natural frequency of a second order system are 0.5 and 5 respectively. Calculate the resonant frequency.

4. Differentiate transient and steady state response.

5. Mention the frequency domain specifications and define resonant peak and bandwidth.

6. Draw the electrical equivalent of lag- lead compensator and write the transfer function

7. Define stability.

8. State Nyquist stability Criterion.

9. What are the advantages of state space modeling using physical variable?

10. List the important properties of a state transition matrix.

PART B — (5 × 13 = 65 marks)

11. (a) Obtain the transfer function $\frac{C(S)}{R(S)}$ for the block diagram shown in figure 11 a. using block diagram reduction technique.

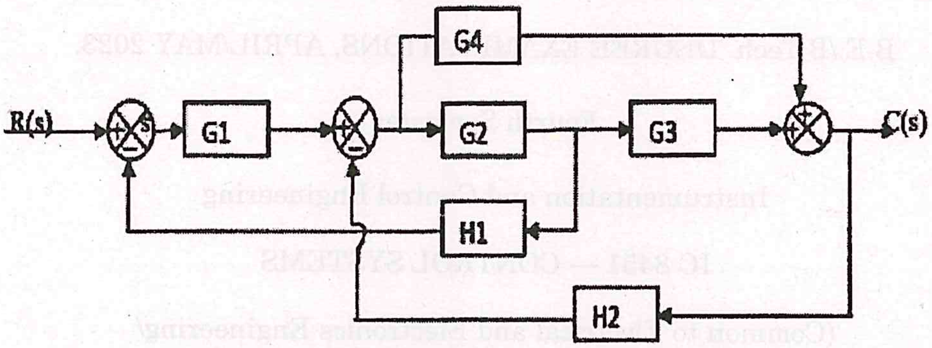


Figure 11a

Or

(b) Illustrate Mason's formula to derive the transfer function of a given signal flow graph in figure 11b.

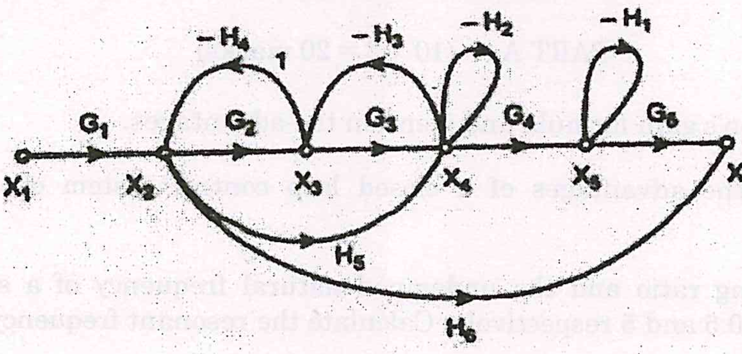


Figure 11b

12. (a) Estimate the step response of a second order under damped system. Use standard notations.

Or

(b) The unity feedback system characterized by open loop transfer function $G(S) = \frac{K}{S(S+10)}$ Evaluate the gain K such that damping ratio will be 0.5 and find time domain specifications for a unit step input.

13. (a) A unity feedback control system has $G(S) = \frac{15}{(S+1)(S+3)(S+6)}$. Draw the Bode plot.

Or

(b) Design a lead compensator to meet the following specifications for a unity feedback system with open loop transfer function $G(S) = \frac{K}{S(S+1)}$. It is desired to have the velocity error constant $K_v = 12\sec^{-1}$ and phase margin is 40°.

14. (a) Consider the sixth order system with the characteristic equation $S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$. Use Routh-Hurwitz criterion to examine the stability of the system and comment on location of the roots of the characteristics equation.

Or

(b) The open loop transfer function of a unity feedback system is given by, $G(S) = \frac{K}{S(S+1)+(S+5)}$ where $K > 0$. Apply Nyquist stability criterion to determine range of K over which the closed loop system will be stable.

15. (a) Solve the state equation for the system as given in below to obtain the time response $x(t)$ for a unit step input

$$X = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; Y = \begin{bmatrix} 1 & 0 \end{bmatrix} X$$. Assume zero initial conditions.

Or

(b) Test the controllability and observability of the system by any one method whose state space representation is given as,

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t); y(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + o[u]$$

EEE

PART C — (1 × 15 = 15 marks)

16. (a) Develop the differential equations governing the mechanical translational system shown in figure 16a and determine the transfer function $\frac{V_1(S)}{F(S)}$

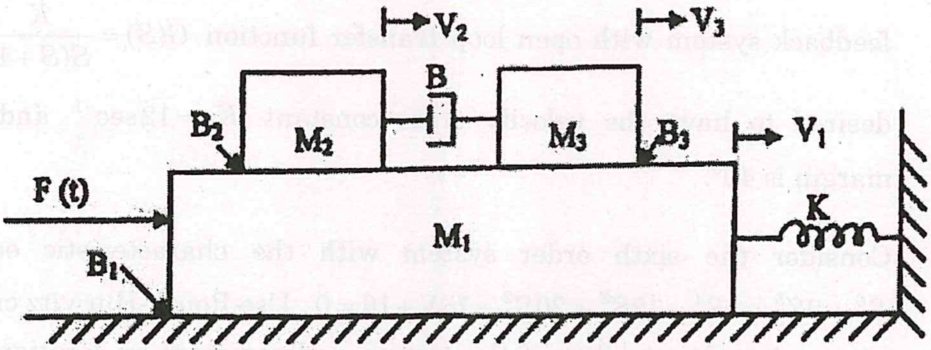


Figure 16a

Or

(b) Write the differential equations governing the mechanical system as shown it figure 16b. Draw force-voltage and force-current electrical analogous circuits.

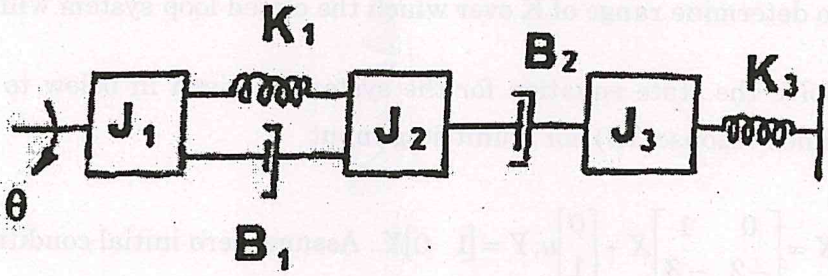


Figure 16b

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 90751

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Fourth Semester

IC 8451 – CONTROL SYSTEMS

(Common to: Electrical and Electronics Engineering/Electronics and Instrumentation Engineering/Instrumentation and Control Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define control system.

2. Draw the block diagram of closed loop control system.

3. List the parts of time response of a control system.

4. Draw the block diagram of a second order control system.

5. Write an equation for maximum overshoot.

6. For a second order system where does the resonant peak occur?

7. List the difficulties faced while applying Routh-Hurwitz criterion.

8. How does Nyquist criterion differ from Routh-Hurwitz criterion?

9. Define state variable.

10. Distinguish between state vector and state space.

PART B — (5 × 13 = 65 marks)

11. (a) Explain the poles and zeros of the transfer function.

Or

(b) Explain how you represent a continuous system by signal flow graph. List the rules for drawing signal flow graph. (9+4)

12. (a) Explain the specified input test signals applied for time response analysis of a control system.

Or

(b) Explain the time response of a first order continuous system subjected to unit step function.

13. (a) Explain the initial slope of Bode plot.

Or

(b) How do you determine gain margin and phase margin from Bode plot?

14. (a) How do you obtain closed loop frequency response of a unity feedback control system from Nyquist plot?

Or

(b) Explain the application of Nyquist criterion to determine stability of a closed loop control system.

15. (a) Explain the infinite series method to solve homogeneous state equation.

Or

(b) Explain the state space representation of n^{th} order differential equation.

PART C — (1 × 15 = 15 marks)

16. (a) Explain the important rules for block diagram reduction.

Or

(b) With suitable schematic derive the transfer function of thermal water heating system.

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 70706

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fifth Semester

Electronics and Instrumentation Engineering

IC6501 – CONTROL SYSTEMS

(Common to Electrical and Electronics Engineering/Instrumentation and Control Engineering)

(Regulations 2013)

(Also Common to : PTIC6501– Control Systems for B.E. (Part-Time) – Third Semester- Electrical and Electronics Engineering – (Regulations – 2014)

Time : Three hours Maximum : 100 marks

Codes / Tables / Charts to be permitted, if any may be indicated

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define open loop and closed loop control system.

2. What are the basic elements used for modeling mechanical translational system?

3. What are the standard tests signals employed for time domain studies?

4. Define: Settling time.

5. Define phase and gain cross over frequencies.

6. What is Lag-Lead compensation?

7. Differentiate between gain margin and phase margin.

8. What is dominant pole?

9. What is meant by 'State' of a dynamic system?

10. When do you say that a system is completely state controllable?

PART B — (5 × 13 = 65 marks)

11. (a) Find the transfer function $\frac{y_2(s)}{f(s)}$.

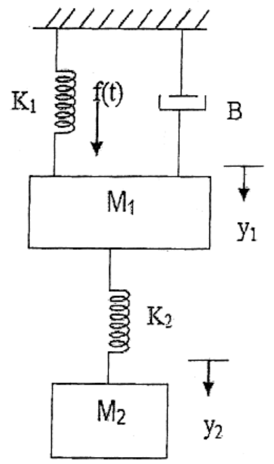


Fig. 11 a

Or

(b) Find the overall gain $C(S)/R(S)$ for the signal flow graph shown in Fig. 11 b.

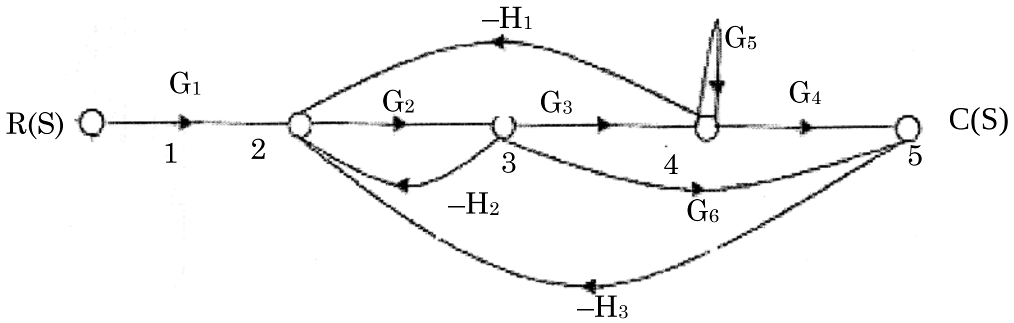


Fig. 11b

12. (a) (i) Outline the time response of first order system when it is subjected to a unit step input. (8)

(ii) Determine the response of the unity feedback system whose open loop transfer function is $G(s) = \frac{4}{s(s+5)}$ and when the input is unit step. (5)

Or

(b) (i) A unity feedback system has the forward transfer, function $G(s) = \frac{K_1(2s+1)}{s(5s+1)(1+s)^2}$ when the input $r(t) = 1 + 6t$, determine the minimum value of K_1 so that the steady error is less than 0.1. (8)

(ii) Derive the transfer function of PID controller. (5)

13. (a) Construct Bode plot for the system whose open loop transfer function is given below and determine (13)

(i) the gain margin,

(ii) the phase margin, and

(iii) closed-loop system stability.

$$G(s) = \frac{4}{s(1+0.5s)(1+0.08s)}$$

Or

(b) (i) Explain the use of Nichol's chart to obtain closed loop frequency response from open loop frequency response of a unity feedback system. (7)

(ii) Describe the correlation between time and frequency domain specifications. (6)

14. (a) (i) Use R–H criterion to determine the location of the roots and stability for the system represented by Characteristic Equation (7)

$$s^5 + 4s^4 + 8s^3 + 8s^2 + 7s + 4 = 0$$

(ii) Write the procedure for the design of Lag compensator using Bode plot. (6)

Or

(b) Draw the Nyquist plot for the system whose open loop transfer function $G(S)H(S) = \frac{K}{S(S+2)(S+10)}$ (13)

Determine the range of K for which closed loop system is stable.

15. (a) Explain with neat diagram, the working of AC and DC Servo motors. (13)

Or

(b) Explain with neat diagram, the working of DC and AC tacho generators. (13)

PART C — ($1 \times 15 = 15$ marks)

16. (a) For the given system, $G(s) = K/s(s+1)(s+2)$, design a suitable lag-lead compensator to give, velocity error constant = 10 sec-1

phase margin = 50°, gain margin ≥ 10dB.

Or

(b) Realize the basic compensators using electrical network and obtain the transfer function.

Reg. No. :

Question Paper Code : X10604

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020 AND APRIL/MAY 2021

Fourth Semester

Electrical and Electronics Engineering

IC 8451 – CONTROL SYSTEMS

(Electronics and Instrumentation Engineering/Instrumentation and Control Engineering)

(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Define transfer function.

2. What are the memory elements in mechanical translation and electrical system ?

3. Derive the impulse response of first order system.

4. An open loop transfer function of unity feedback system is given as $G(s) = \frac{10}{(s+1)}$. What is its steady state error for unit step input ?

5. Define gain margin and phase margin.

6. Find the type and order of the system $G(s) = \frac{10}{s^2(s+1)(s+2)}$.

7. Define Nyquist stability criterion.

8. Compare lag compensator with lead compensator.

9. What are the advantages of state space analysis ?

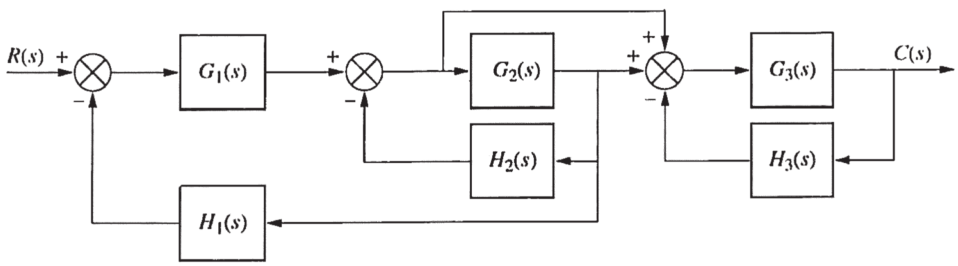
10. Write the state model of a linear time invariant system.

PART – B **(5×13=65 Marks)**

11. a) Derive the transfer function of armature controlled DC motor with essential block diagrams.

(OR)

b) Determine the transfer function of the given system using block diagram reduction technique.



12. a) i) A closed loop control system is represented by the differential equation $\frac{d^2C}{dt^2} + 4\frac{dc}{dt} = 16e$ where $e = r - c$ is the error signal. Determine the undamped natural frequency, damping ratio and percentage maximum overshoot for a unit step input. **(8)**

ii) A unity feedback system is characterized by the open loop transfer function $G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$. Determine the steady state errors for unit-step, unit-ramp and unit-acceleration input. **(5)**

(OR)

b) Construct the root locus of the open loop transfer function

$$G(s)H(s) = \frac{K}{s(s+2)(s^2+2s+5)}.$$

13. a) Sketch the Bode plot for the given transfer function. Determine Gain cross-over frequency phase cross-over frequency, gain margin and phase margin

$$G(s)H(s) = \frac{2000}{s(s+2)(s+100)}.$$

(OR)

b) Sketch the Polar plot for a unity feedback system with open loop transfer function $G(s) = \frac{1}{s(1+s)^2}$. Also find the frequency at which $|G(j\omega) = 1|$ and the corresponding phase angle.

14. a) A unity feedback control system is characterized by the open loop transfer function $G(s) = \dfrac{K(s+13)}{s(s+3)(s+7)}$. Using Routh criterion, calculate the range of values of K for the system to be stable. Also determine the value of K the system become marginally stable and calculate the frequency of oscillation if any.

(OR)

b) Draw the Nyquist plot and assess the stability of the closed loop system whose open loop transfer function is $G(s)H(s) = \dfrac{(s+4)}{(s+1)(s-1)}$.

15. a) i) Obtain the state model for the system described by the transfer function

$$T(s) = \frac{Y(s)}{U(s)} = \frac{1}{s^3 + 6s^2 + 10s + 5}.$$ **(8)**

ii) Obtain state transition matrix for the state model whose A matrix is given by $A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$. **(5)**

(OR)

b) Determine the state controllability and observability of the system

$$\dot{x}(t) = Ax(t) + Bu(t) \quad Y(t) = Cx(t) \quad A = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -1 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}.$$

PART – C **(1×15=15 Marks)**

16. a) Compensate the system with the open loop transfer function $G_f(s) = \dfrac{K}{s(s+1)(s+5)}$ to meet the following specifications

i) Damping ratio $\zeta = 0.3$

ii) Settling time $t_s = 12s$

Velocity error constant $K_v \geq 8\ s^{-1}$.

(OR)

b) An unity feedback servo mechanism whose $G(s) = \dfrac{K_v}{s(1+ST)}$ is designed to keep a radar antenna pointed at a flying aeroplane. If the aeroplane is flying with a velocity of 600 km/h, at a range of 2 km and the maximum tracking error is to within 0.1°, determine the required velocity error coefficient K_v.

Reg. No. :

Question Paper Code : X 60499

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
Fourth Semester
Electrical and Electronics Engineering
EE 2253/EE 44/EE 1253 A/080280033/10133 IC 401 – CONTROL SYSTEMS
(Common to Instrumentation and Control Engineering and Electronics and Instrumentation Engineering)
(Regulations 2008/2010)
(Also common to PTEE 2253 – Control Systems for B.E. (Part-Time) Third Semester – Electronics and Instrumentation Engineering – Regulations 2009 and 10133 IC 401 – Control System for B.E. (Part-Time) Third Semester – EEE – Regulations 2010)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

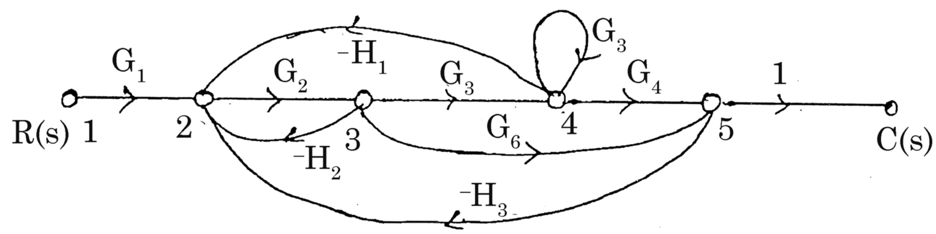
1. State the advantages of closed loop system over the open loop system.
2. Write the force balance equation of ideal dashpot and ideal spring.
3. What is meant by time constant of the system ?
4. Determine the type and order of the following system

   $G(s) = \dfrac{K}{(s+2)(s+1)}$.

5. Draw the polar plot of G(s) = 1/(1+sT).
6. Define phase and gain margin.
7. What is the condition for the system $G(s) = \dfrac{k(s+a)}{s(s+b)}$ to have a circle in its root locus ?
8. State Nyquist stability criterion.
9. Write the need for compensation.
10. Draw the circuit of lag-lead compensator.

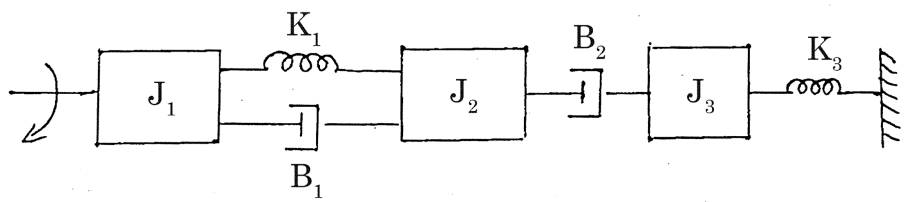
PART – B **(5×16=80 Marks)**

11. a) Find the overall gain for the signal flow graph shown.



(OR)

b) Write the differential equation governing the mechanical rotational system shown and draw the torque voltage and torque-current electrical analogous circuits and verify by writing mesh equations.



12. a) i) A unity feedback control system has the open loop transfer function $G(s) = \frac{K}{(s+A)(s+2)}$. Find the values of K and A, so that the damping ratio is 0.707 and the peak time for unit step response is 1.8 sec. **(8)**

ii) Obtain the impulse and step responses of the following unity feedback control system with open loop transfer function $G(s) = \frac{6}{s(s+5)}$. **(8)**

(OR)

b) i) For the unity feedback system whose forward path transfer function $G(s) = \frac{1}{s(s+1)}$ and the input signal is $r(t) = 4 + 6t + 2t^3$. Find the generalized error coefficients and steady state error. **(10)**

ii) Explain the effect of P, PI and PID controllers on the system performances. **(6)**

13. a) For the following transfer function, sketch the Bode magnitude and phase plot $G(s) = \frac{40(1+s)}{(5s+1)(s^2+2s+4)}$. **(16)**

(OR)

b) Obtain the relationship between any three frequency domain specifications in terms of time domain specifications. **(16)**

14. a) Determine the stability of the given characteristic equation using Routh-Hurwitz Criterion

i) $S^5 + 4S^4 + 8S^3 + 8S^2 + 7S + 4 = 0$. **(8)**

ii) $S^6 + S^5 + 3S^4 + 3S^3 + 3S^2 + 2S + 1 = 0$. **(8)**

(OR)

b) Sketch the root locus of the system G(s) = K/[s(s+2)(s+4)] and determine the value of K such that the damping ratio of the closed loop system is 0.5.

15. a) The open loop transfer function of the uncompensated system is $G(s) = \frac{5}{s(s+2)}$.

Design a suitable compensator for the system so that the static velocity error constant K_v is 20/sec, the phase margin is atleast 55° and the gain margin is atleast 12 dB. **(16)**

(OR)

b) Open loop transfer function of the uncompensated system is $G(s) = \frac{1}{s(s+1)(s+2)}$.
Compensate the system by cascading suitable lag-lead compensator so that the compensated system has the static velocity error constant of 10/sec, the phase margin of 45° and gain margin of 10 dB or more. **(16)**