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EC3351 CONTROL SYSTEM

IMPORTANT QUESTIONS

UNIT I - CONTROL SYSTEM MODELLING
PART - A

1. Write Mason's gain formula.
2. What is control system?
3. What are the two major types of control systems?
4. Define open loop and closed loop systems.
5. What is feedback? What type of feedback is employed in control system?
6. Why negative feedback is preferred in control systems?
7. Distinguish between open loop and closed loop systems.
8. Define transfer function.
9. Write force balance equation of ideal spring, ideal mass.
10. Name the two types of electrical analogous for mechanical system.
11. What is signal flow graph?
12. Define non-touching loop.
13. What is called feedback control system? Give an example.
14. Write the analogous electrical elements in torque-voltage analogy for the elements of mechanical rotational system.
15. What are the advantages of closed loop control system?
16. List the properties of signal flow graph.
17. What are the advantages of AC servomotor?

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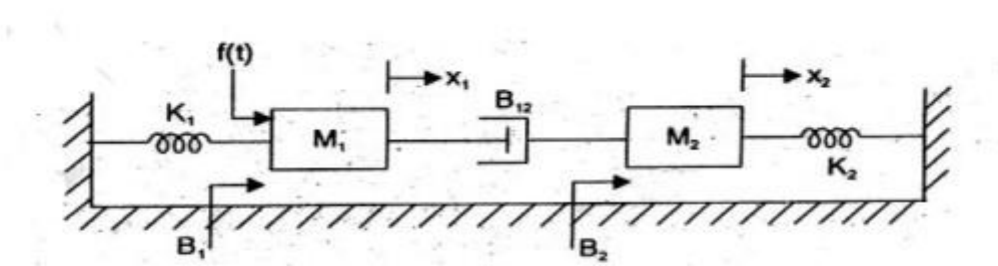
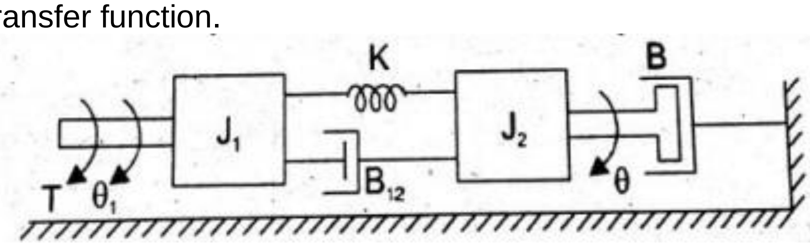
PART - B

1. For the given translational mechanical system, write the differential equations and find the function.



2. For the given rotational mechanical system, write the differential equations and find the transfer function.



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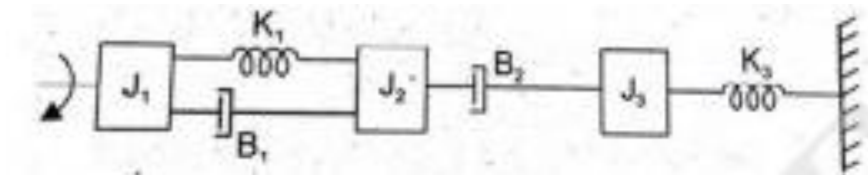
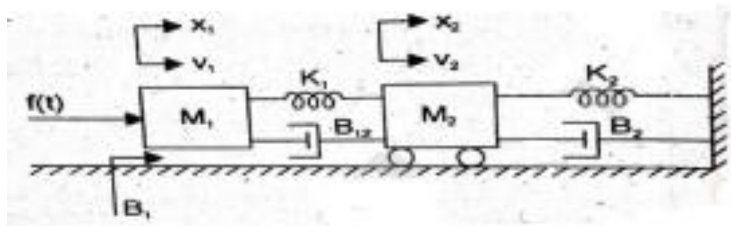
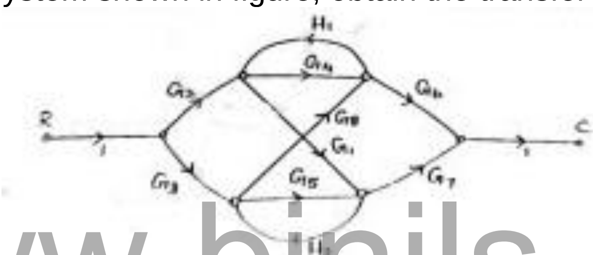
3. Write the differential equations governing the mechanical rotational system shown in the figure below. Draw the torque-voltage and torque-current electrical analogous circuits.



4. Write the differential equations governing the mechanical translational system shown in the figure below. Draw the force-voltage and force-current electrical analogous circuits.



5. Considering the system shown in figure, obtain the transfer function using Masons Gain formula.



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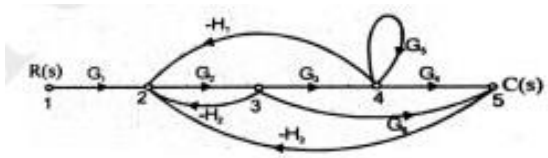
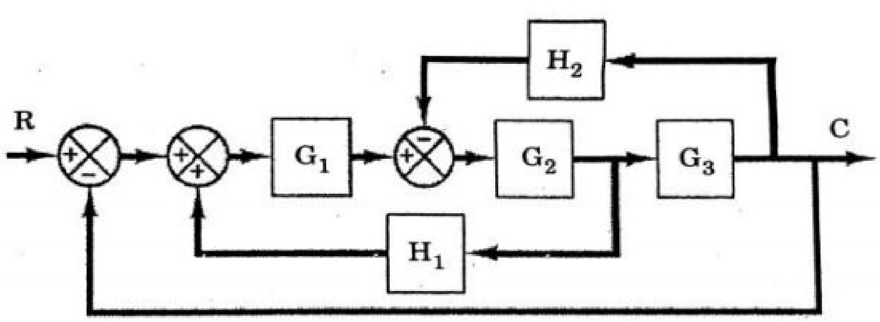
6. Considering the system shown in figure, obtain the transfer function using Masons Gain formula.



7. Using block diagram reduction rules, obtain the closed loop transfer function CYS)/R(S) of the given



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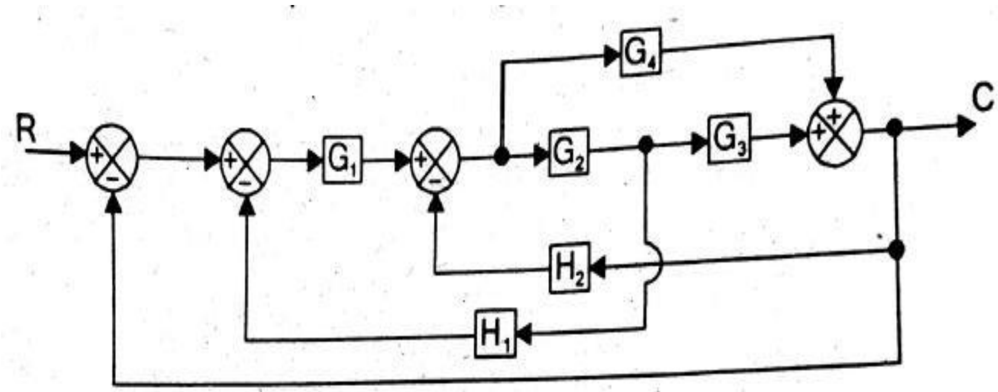
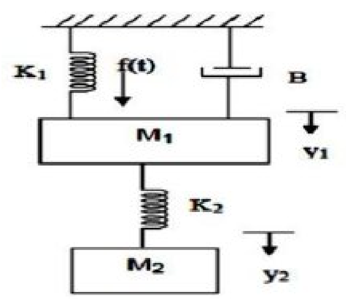
8. Using block diagram reduction rules, obtain the closed loop transfer function C (S)/R(S) of the given



9. For the given translational mechanical system, write the differential equations and find the



10. For the given rotational mechanical system, write the differential equations and find the transfer system function

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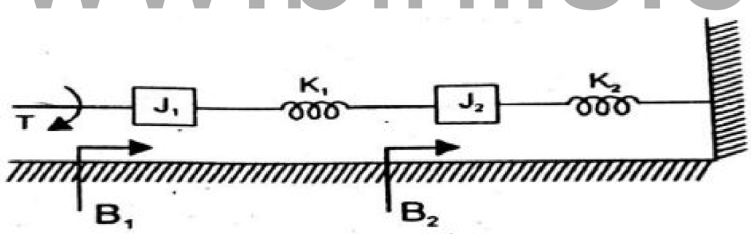
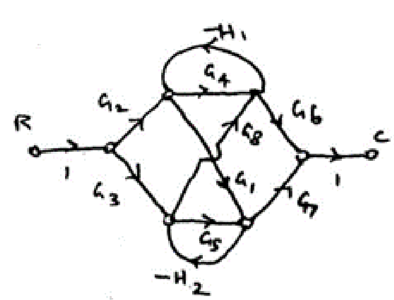


11. Considering the system shown in figure, obtain the transfer function using Masons Gain formula



12. Considering the system shown in figure, obtain the transfer function using Masons Gain formula.

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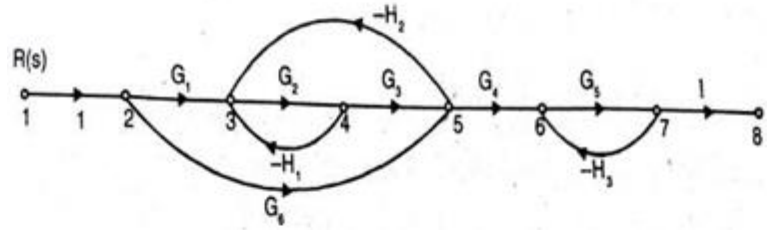

UNIT II- TIME RESPONSE ANALYSIS

PART - A

1. The damping ratio and the undamped natural frequency of a second order system are 0.5 and 5 respectively. Calculate the resonant frequency. (NOV/DEC 2016)
2. Write the mathematical expressions for step input and impulse input.
3. Draw the time response of a second order under damped system when excited with unit step input.
4. How the system is classified depending on the value of damping ratio?
5. The closed loop transfer function of a second order system is given by 400/(s +2s+400). Determine damping ratio and natural frequency of oscillation.
6. Draw the unit-step response curve for the second order system and show the time domain specifications.
7. What are the standard tests signals employed for time domain studies?
8. List out the time domain specification parameters.
9. What is time response?
10. What is transient and steady state response?
11. Name the test signals used in time response analysis
12. The closed-loop transfer function of second order system is C(S)/R(S) -10/ S* 465 +10. What is the type of damping?
13. Define rise time, delay time, peak time.
14. What is steady state error?
15. What are static error constants?
16. Define position, velocity error constants.
17. What are generalized error constants?
18. List the advantages of generalized error constants.

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PART - B

1. Draw the response of second order systems for critically damped case and when input is unit step signal.

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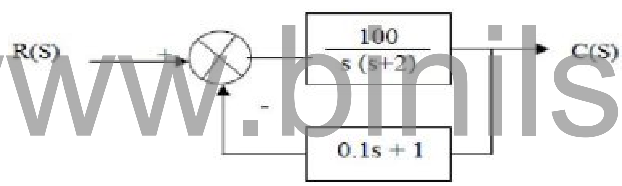
2. The unity feedback system is characterized by an open loop transfer function G(s)=K/s(s+10). Determine the gain K, so that the system will have a damping ratio of 0.5. For this value of K, determine settling time, peak overshoot and time to peak overshoot for a unit step input.
3. The open loop transfer function of a unity feedback system is given by,G(s) = K / S(ST + 1). Where K and T are positive constant. By what factor should the amplifier gain K be reduced, so that the peak overshoot of unit step response is reduced from 75% to 25%.
4. A unity f/b control system has open loop transfer function of G(S) =10/S(S+2). Determine its closed loop transfer function, damping ratio and natural frequency of oscillations. Also evaluate the rise time, peak overshoot, peak time and settling time for a step input of 12 units.
5. Derive the response of undamped second order systems for unit step input.
6. The response of a servomechanism is $c(t) = 1 + 0.2\, e^{-60t} – 1.2\, e^{-10t}$ when subject to a unit step input. Obtain an expression for closed loop transfer function. Determine the undamped natural frequency and damping ratio. (NOV/DEC 2010)
7. Derive the output response of a first order system for unit step input.
8. Derive the output response of the following system.



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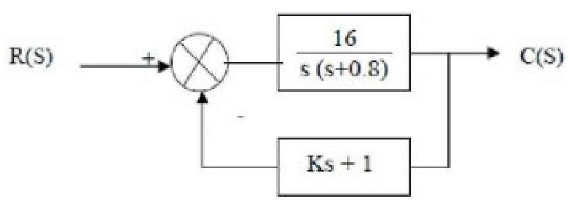
9. Derive the output response of the following system.



10. Derive the response of critically damped second order systems for unit step input.

UNIT III - FREQUENCY RESPONSE ANALAYSIS

PART – A

1. What is frequency response analysis?
2. Draw the polar plot of the function G(S) =1/S(S+T1) (1+ST2)
3. What is polar plot?
4. Define gain cross over frequency.
5. Define Phase cross over frequency.
6. Define Phase Margin.

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7. Define Gain Margin.

8. How do you calculate the gain margin from the polar plot?

9. How do you find the stability of the system by using polar plot?

10. What are the advantages of Bode plot?

11. List the Frequency domain specifications.

12. What is cut off frequency?

13. Compare bode plot and Nyquist plot analysis.

14. What is Bandwidth?

15. What is lag-lead compensation?

16. What is lag-lead compensator?

17. Draw electrical lag-lead compensator network.

18. Write transfer function of lag-lead compensator.

19. Compare series compensator and feedback compensator.

20. What is compensator? What are the different types of compensator?

21. What is resonant frequency?

PART - B

1. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies G(S) = 10/ S(1+0.4S) (1+0.1S) (APR/MAY 2018)

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2. The open loop transfer function of a unity feedback system is G(S) = 1/ S(1+S) (1+2S). Sketch the Polar plot and determine the Gain margin and Phase margin.

3. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. G(S) = 0.75(1+0.2S)/ S(1+0.5S) (1+0.1S)

4. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. G(S) = 10(S+3)/ S(S+2) (S^2+4S+100)

5. Sketch the polar plot for the following transfer function and find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. G(S) = 10(S+2)(S+4)/ S (S^2 - 3S+10)

6. Construct the polar plot for the function GH(S) =2(S+1)/ S^2. Find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. (NOV/DEC 2010)

7. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies G(S) =K S^2 / (1+0.2S) (1+0.02S). Determine the value of K for a gain cross over frequency of 20 rad/sec.

8. Sketch the polar plot for the following transfer function and find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. G(S) = 400/ S (S+2)(S+10)

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9. A unity feedback system has open loop transfer function G(S) = 20/ S(S+2)(S+5).Using Nichol’s chart determine the closed loop frequency response and estimate all the frequency domain specifications.
10. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin. G(S) = 10(1+0.1S)/ S(1+0.01S) (1+S).
11. What is compensation? Why it is needed for control system? Explain the types of compensation?
12. Realize the basic compensators using electrical network and obtain the transfer function.
13. Design a suitable lead compensator for a system with unity feedback and having open loop transfer function G(S)= K/ S(S+1) (S+4) to meet the specifications. (i)Damping ratio=0.5 (ii) Undamped natural frequency ωn =2 rad/sec.
14. A unity feedback system has an open loop transfer function G(S)= K/ S(S+1)/(0.2S+1). Design a suitable phase lag compensators to achieve following specifications Kv= 8 and Phase margin 40 deg with usual notation.
15. Explain the procedure for lead compensation and lag compensation?
16. Explain the design procedure for lag- lead compensation.
17. Consider a type 1 unity feedback system with an OLTF G(S) =K/S (S+1) (S+4).The system is to be compensated to meet the following specifications Kv> 5sec and PM>43 deg. Design suitable lag compensators

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UNIT IV - STABILITY ANALYSIS

PART - A

1. State Nyquist stability Criterion.
2. What is root locus? (NOV/DEC 2012) 3. What is the necessary condition for stability?
3. What is characteristic equation?
4. How the roots of characteristic are related to stability?
5. Define stability.
6. What do you mean by dominant pole?
7. What are break away points?
8. How will you find the root locus on real axis?
9. What is break-in point? How to determine them?
10. Define a limitedly stable system.
11. What is meant by Centroid?
12. What is meant by Asymptotes?

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PART – B

1. Using Routh criterion determine the stability of the system whose characteristics equation is $S^4+8S^3+18S^2+16S+5=0$.
2. $F(S)=S^6+S^5-2S^4-3S^3-7S^2-4S-4=0$. Find the number of roots falling in the RHS plane and LHS plane.
3. Draw the Nyquist plot for the system whose open loop transfer function is G(S)H(S) =K/S (S+2) (S+10). Determine the range of K for which closed loop system is stable.
4. Construct Nyquist plot for a feedback control system whose open loop transfer function is given by G(S)H(S) =5/ S(1-S). Comment on the stability of open loop and closed loop transfer function.
5. Sketch the Nyquist plot for a system with the open loop transfer function G(S)H(S) =K(1+0.5S) (1+S) / (1+10S) (S-1). Determine the range of values of K for which the system is stable.
6. Using routhcriterian determine the location of the roots of the given characteristics equation and comments on the stability of the system. $S^4+8S^3+18S^2+16S+5=0$
7. Using routhcriterian determine the location of the roots of the given characteristics equation and comments on the stability of the system
   i) $3S^4+10S^3+5S^2+5S+3=0$
   ii) $S^5+S^4+4S^3+24S^2+3S+63=0$
8. Construct Routh Array and determine the stability of the system whose characteristic equation is

$$S^6+2S^5+8S^4+12S^3+20S^2+16S+16=0$$

9. Construct Routh Array and determine the stability of the system whose characteristic equation is
   i) S + 55 + 9s '+95 + 48 + 208 + 365+36 = 0
   ii) S'+28 +24S'+48S'-25S-50=0

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UNIT V - STATE VARIABLE ANALYSIS & DIGITAL CONTROL SYSTEMS

PART - A

1. What are the advantages of state face analysis?
2. Write the properties of state transition matrix.
3. Write the state model of no order system?
4. Define Controllability.
5. Define Observability.
6. What is state and state variable?
7. What are the advantages of state space modeling using physical variable?
8. Write the state transition matrix.
9. What is advantage and disadvantage in Kalman's test for controllability?
10. What is the need for observability test?

PART - B

1. Determine the transfer function for the given data

   $A = \begin{pmatrix} -3 & 1 \\ 0 & -1 \end{pmatrix} B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} C = [1 \quad 1] \; D = 0$

2. Check for controllability of the given transfer function. (NOV/DEC 2016)

   $$\frac{Y(S)}{G(S)} = \frac{S+2}{S^3 + 9S^2 + 26S + 24}$$

3. Derive the state model equation of the state space representation.

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4. Determine the controllability and Observability of the given system using Kalman's test and Gilbert's test.

   $$\dot{X} = \begin{pmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 1 & 1 \end{pmatrix} X + \begin{pmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{pmatrix} U$$

   $$Y = \begin{pmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix} X$$

5. Determine the controllability and Observability of the following system.

   $$\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ 10 \end{pmatrix} u \quad y = [1 \quad 0 \quad 0] \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}.$$

6. Derive the transfer function of the state space representation.
7. Consider the following system with differential equation is given by

   d^2yldt^2 + 6dy/dt+1 1dy/dt+6y = 6u

   Obtain the state model in diagonal canonical form.

8. State the properties of state transition matrix in detail.
9. A system is characterized by transfer function Y(s)/U(s) = 2/(S^3+6S^2-+11S-6).

   Find the state and output equation in Matrix form.

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10. Find the controllability and observability of the following transfer function.

$Y(s)/U(s) = 2/(S^3+6S^2-+1\ 1S-6)$.

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