Code: 9A19401

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

CONTROL SYSTEMS

(Electronics & Computer Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

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1. (a) What are the basic elements of control system? Explain each of them in detail.
   (b) Explain the differences between open loop and closed loop control systems.

2. Explain the construction and working principle of synchro transmitter and synchro control transformer.

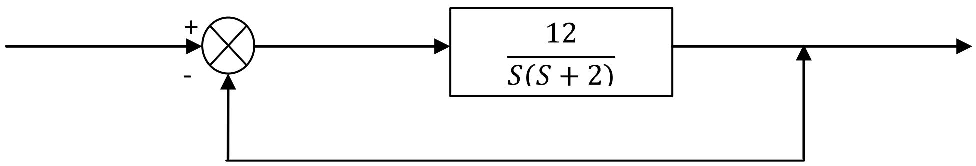
3. (a) Obtain the response of first order system:
   $C(S)/R(S) = \frac{1}{1+TS}$ for unit step input.
   (b) A unity feedback control system has an open loop transfer function: $G(S) = \frac{10}{S(S+2)}$, find different time domain specifications for a step input of 12 units.

4. Using Routh criterion, determine the stability of the system represented by the characteristic equation:
   (i) $S^4+8S^3+18S^2+16S+5=0$.
   (ii) $S^5+S^4+2S^3+2S^2+3S+5=0$.
   (iii) $S^7+9S^6+24S^5+24S^4+24S^3+24S^2+23S+15=0$.

5. Sketch the 'Bode plot' for the transfer function:
   $G(S) = \frac{75(1+0.2S)}{S(S^2+16S+100)}$ and determine the gain margin and phase margin.

6. The open loop transfer function of a unity feedback system is: $G(S) = \frac{1}{S^2(1+S)(1+2S)}$. Sketch the polar plot and determine the gain margin and phase margin.

7. Design a lead compensation for the following system such that the closed loop system satisfies the following specifications: static velocity error constant=$24S^{-1}$, phase margin =55°, gain margin ≥,13dB.



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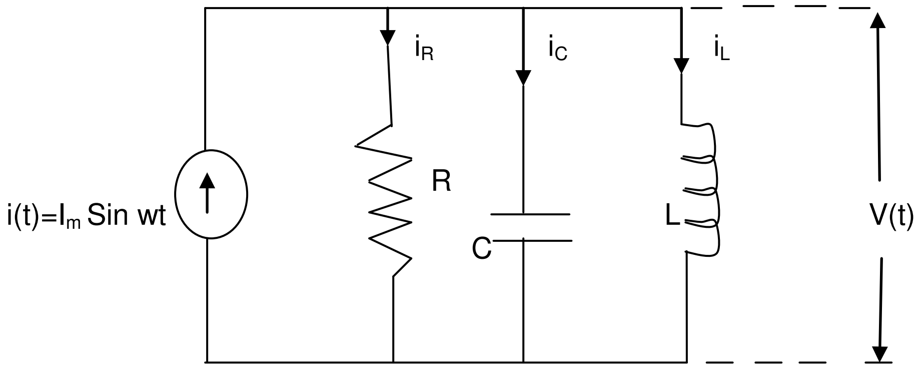
8. (a) What are the advantages of state space analysis over transfer function analysis?
   (b) Obtain state model for the following RLC network.



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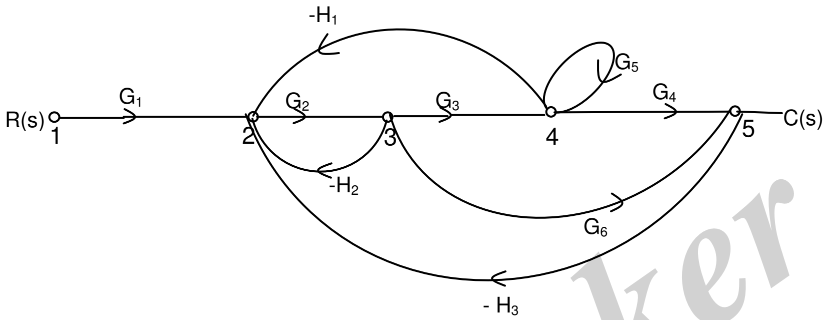
1. (a) Explain in detail the basic classification of control systems.
   (b) What is the effect of feedback on control systems performance? Explain.

2. Find the overall gain $C(S)/R(s)$ for the following signal flow graph using Mason's gain formula



3. (a) Explain in detail different types of test signals.
   (b) A closed loop servo is represented by the differential equation: $\frac{d^r c}{dt^r} + 8.\frac{dc}{dt} = 64e$. where 'c' is the displacement of the output shaft, 'r' is the displacement of the input shaft and e='r'-c. Determine the undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input.

4. Sketch the 'Root Locus ' for a unity feedback control system has an open loop transfer functions: $G(S) = K/S(S^2 + 4S + 13)$.

5. For the system: $G(S) = \frac{K.e^{-0.2S}}{S(S+2)(S+8)}$, find 'K' so that the system is stable with gain margin equal to 6 dB and phase margin equal to 45°.

6. Sketch the Nyquist plot for a open loop system $G(S)H(S) = \frac{K(1+0.5S)(1+S)}{(1+10S)(S-1)}$. Determine the range of values of 'K' for which the system is stable.

7. What is the need of compensation? Explain in detail design procedure of lag compensator in frequency domain.

8. A linear time-invariant system is characterized by the homogeneous state equation:

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -6 & -5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

The initial state is : $\begin{bmatrix}x_1\\ x_2\end{bmatrix} = \begin{bmatrix}1\\ 0\end{bmatrix}$

Find the resolvant matrix: $\phi(s)$, state transition matrix: $\phi(t)$, $\phi^{-1}(t)$ and the solution of the given equation.

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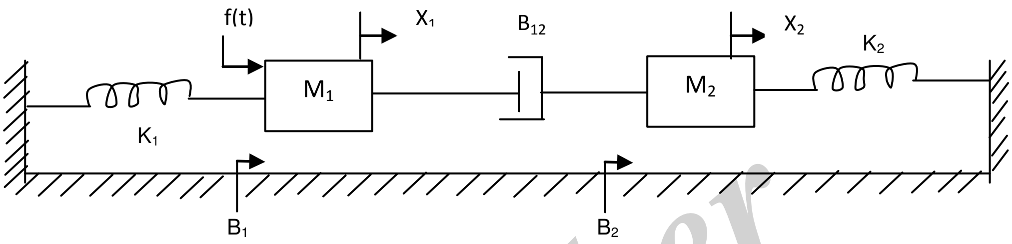
1. Determine the transfer function $\frac{X_1(s)}{F(s)}$ and $\frac{X_2(s)}{F(s)}$ for the following systems:



2. Explain the working principle of AC servomotor and also derive its transfer function.

3. (a) What is the effect of proportional, integral and derivative controllers on the system performance?
   (b) Explain in detail various time domain specifications.

4. Find the stability of the following characteristic equations using Routh's stability:
   (i) $S^7+5S^6+9S^5+9S^4+4S^3+20S^2+36S+36=0$
   (ii) $S^5+4S^4+8S^3+8S^2+7S+4=0$
   (iii) $S^6+S^5+3S^4+3S^3+3S^2+2S+1=0$.

5. A unity feedback control system has $G(S) = \frac{400(S+2)}{S^2(S+5)(S+10)}$. Draw 'Bode plot' and find gain margin, phase margin.

6. A unity feedback open loop transfer function is: $G(S) = \frac{K}{S(1+0.2S)(1+0.05S)}$. Sketch the polar plot and determine the value of 'K' so that, (i) gain margin=18 dB. (ii) phase margin =60°.

7. The open loop transfer function of a unity feedback system: $G(S) = \frac{K}{S(S+1)(S+2)}$. Design suitable lag-lead compensator to achieve: static velocity error constant=$10S^{-1}$, phase margin =50° and gain margin ≥ 10 dB.

8. (a) State and prove different properties of state transition matrix.
   (b) Find state transition matrix of $A = \begin{bmatrix} 0 & 0 & 2 \\ 0 & 1 & 0 \\ -1 & 0 & 3 \end{bmatrix}$

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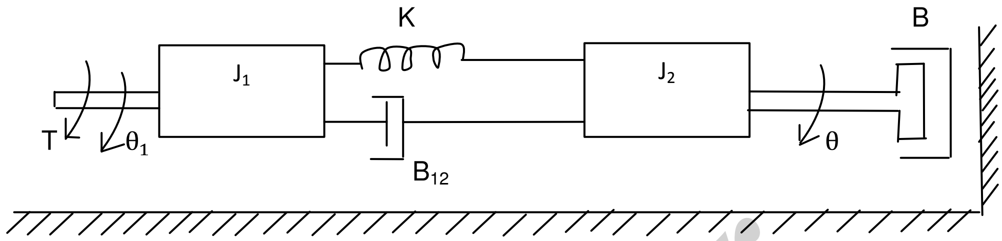
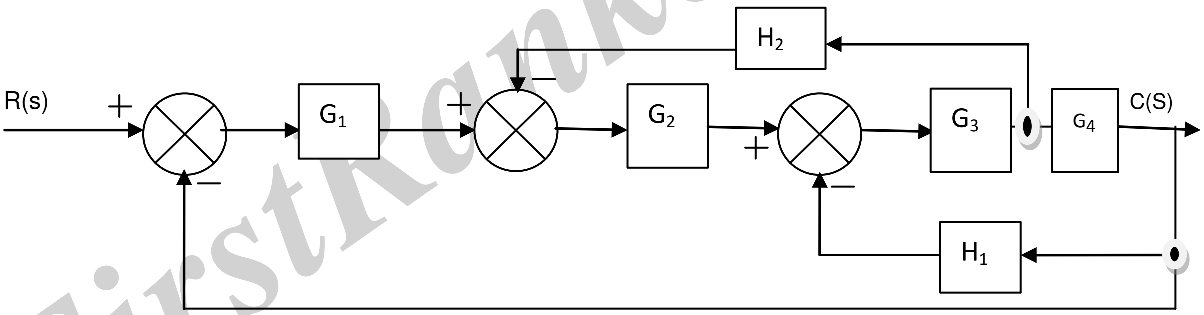
1. Write the differential equations for the following mechanical rotational system:



and determine the transfer function $\theta(s)/T(s)$.

2. Determine the overall transfer functions $C(s)/R(s)$ for the following system:



3. For a unity feedback control system the open loop transfer function $G(S) = 10(S+2)/S^r(S+1)$ find: (i) the position, velocity and acceleration error constants. (ii) the steady state error when the input is $R(S) = 3/S - 2/S^r + 1/3S^3$.

4. Sketch the root locus of the system whose open loop transfer function is: $G(S) = \frac{K}{S(S+4)(S+10)}$. Find the value of 'K' so that the damping ratio of the closed loop system is 0.5.

5. A unity feedback control system has $G(S) = K/S(S+4)(S+10)$. Draw the 'Bode plot' find 'K' when gain margin =10 dB.

6. By Nyquist stability criterion, determine the stability of closed loop system whose open loop transfer function is: $G(S)H(S): (S+2)/(S+1)(S-1)$. Comment on the stability of open loop and closed loop system?

7. What is the importance of PID controller in control system design? Discuss their advantages disadvantages and tuning rules.

8. (a) Estimate the controllability of: $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -8 & -14 & -7 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} 4$ using Gilbert's Test.

   (b) Evaluate the observability of: $\dot{x} = AX + BU, Y = CX.$ where,

   $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -3 & -4 \end{bmatrix} B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ and $C = [2 \;\; 3 \;\; 1]$ using Kalman's Test.

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