Code No: 07A4EC03 **R07** **Set No. 2**

II B.Tech II Semester Examinations,December 2010
CONTROL SYSTEMS
Common to E.COMP.E, ETM, E.CONT.E, ECE, EEE

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain temperature control system with neat block diagram.
   (b) Human being is an example of closed loop system. Justify your answer. [8+8]
2. (a) Obtain the state model of the system shown in figure 2a.

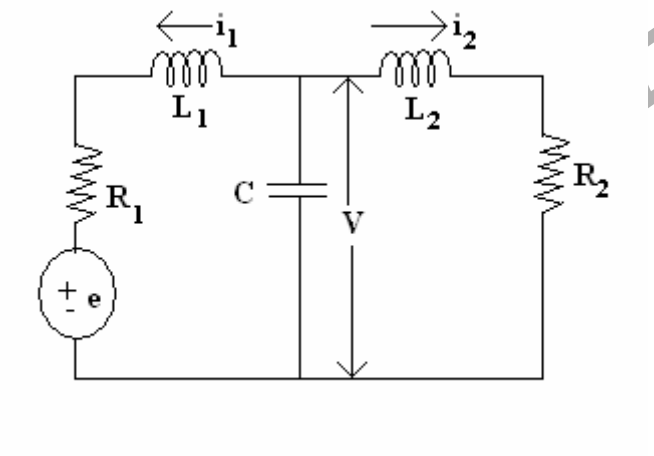

Figure 2a

   Consider the state variables as i_1, i_2, v
   (b) Obtain the state model of a field controlled motor? [8+8]
3. (a) Define the following terms:
      i. Steady-state error
      ii. Settling time
      iii. Peak overshoot
      iv. type and order of a control system.
   (b) Sketch the transient response of a second order system and derive the expression for rise time and peak overshoot? [8+8]
4. (a) Explain the significance of Bandwidth in the design of linear control systems.
   (b) Show that the error contributed by a simple pole in the Bode magnitude plot is -3 dB at corner frequency.
   (c) The asymptotic plot of a system is shown in figure 4c

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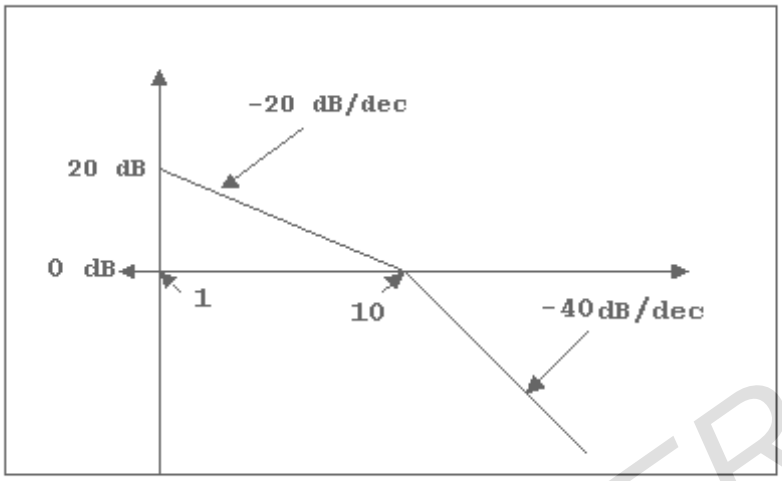

Figure 4c

Find the loop transfer function of the system. [4+4+8]

5. (a) Distinguish between polar plots & Nyquist plots.
   (b) Discuss the effect of adding poles & zeros to G(s)H(s) on the shape of Nyquist plots [6+10]

6. (a) Define the following terms
      i. Stable system
      ii. Critically stable system
      iii. Conditionally stable system.
   (b) For the system having characteristic equation $2S^4 + 4S^2 + 1 = 0$, find the following
      i. the no. of roots in the left half of s-plane
      ii. the no. of roots in the right half of s-plane
      iii. the no. of roots on the imaginary axis. [6+10]

   Use the RH stability criterion

7. (a) Reduce the given block diagram (figure 7a) and hence obtain the transfer function $\frac{C(s)}{R(s)}$

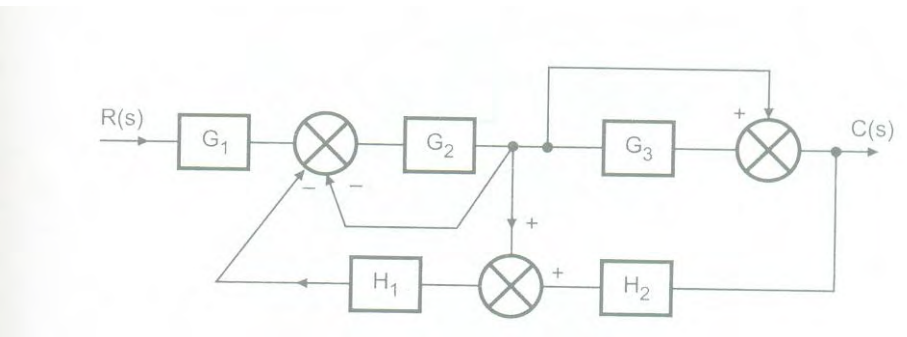

Figure 7a

(b) Explain the need of Mason's gain formula for any system reduction. [10+6]

8. For the unity feed back control system forward path transfer function G(S) = K/S (S+4) (S+20). Design a lag-lead compensator so that PM $\geq$ 40 and steady state error for unit ramp input $\leq$ 0.04 rad. [16]

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1. (a) "Addition of a non zero pole to a transfer function results in further rotation of the polar plot by -90^o as $\omega \rightarrow \infty$". Justify with the help of an example
   (b) A system is given by $G(s) = \frac{1}{s^2(s+1)(s+10)}$. Determine the magnitude & phase angle at zero & ∞ frequencies. Hence sketch the polar plot. [10+6]

2. (a) Define
      i. Bandwidth
      ii. Resonant peak
   (b) Explain how stability can be determined from Bode plots
   (c) Find resonant peak & resonant frequency given $\zeta = 0.5$. If the damping ratio is changed to 0.9 find resonant peak & resonant frequency. Comment on the result. [4+6+6]

3. (a) Explain the need of lead compensator and obtain the transfer function of lead-lag compensator.
   (b) Expalin the signinificance of compansion? [10+6]

4. (a) Explain the significance of generalized error series?
   (b) For a system $G(s)H(s) = \frac{K}{s^2(s+2)(s+3)}$, find the value of K to limit the steady state error to 10 when the input to the system is r(t)=(1+10t+40)/2 t^2. [6+10]

5. (a) The signal flow graph shown in figure 5a has one forward path and two isolated loops. Determine the overall transfer function relating x_6 and x_1

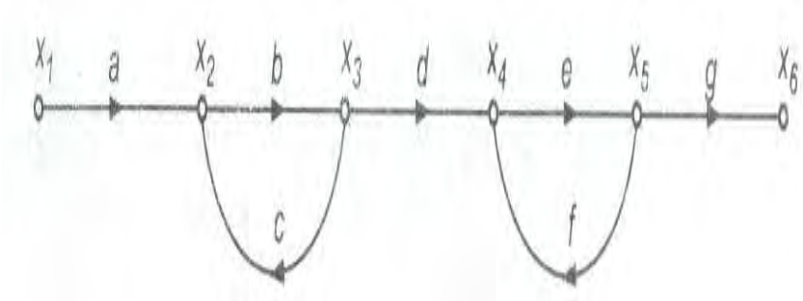

Figure 5a

   (b) Explain the differences between AC servomotor and DC servomotor. [9+7]

6. (a) Find a state model (phase variable form) for the system with transfer function. $\frac{Y(S)}{U(S)} = \frac{S+4}{S^3+6S^2+11S+6}$

(b) A feedback system is represented by a signal flow graph shown in figure 6b.

i. Construct a state model of the system

ii. Diagnotize the Coefficient matrix A of the state model. [6+10]

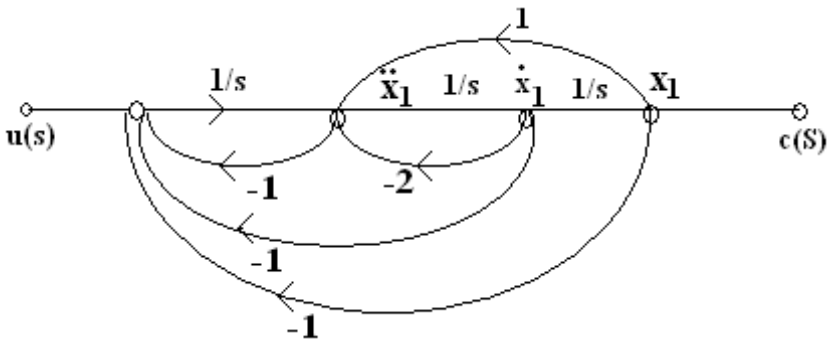

Figure 6b

7. (a) Explain sensitivity?

(b) Determine the sensitivity of the closed loop system shown in figure 7(b)ii at $\omega = 1$ rad/sec w.r.t

i. forward path transfer function

ii. feedback path transfer function. [6+10]

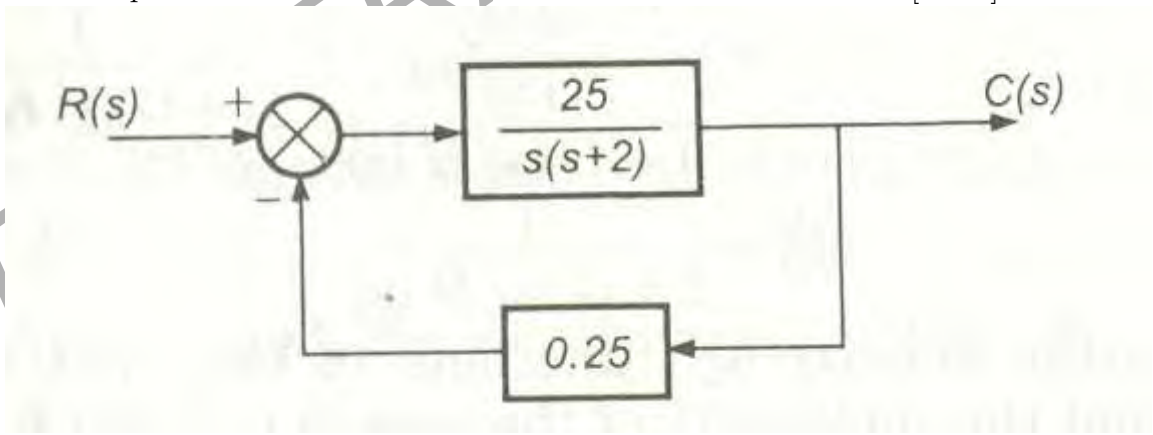

Figure 7(b)ii

8. (a) Show that that the break-away and break-in points ,if any, on the real axis for the root locus for $G(s)H(s) = \frac{KN(s)}{D(s)}$, where N(s) and D(s) are rational polynomials in S, can be obtained by solving the equation $\frac{dK}{ds} = 0$

(b) Check whether the points (-1+ j) and (-3+ j) lie on the root locus of a system given by $G(s)H(s) = \frac{K}{(s+1)(s+2)}$. Use the angle condition. [8+8]

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1. (a) Define
   i. Minimum phase tf
   ii. Non minimum phase tf
   (b) Enlist the steps for the construction of Bode plots
   (c) Explain the procedure for determination of transfer function from Bode plots. [4+4+8]

2. (a) Discuss the properties of state transition matrix.
   (b) Determine the canonical state model of system, whose transfer function is $T(s) = \frac{2(s+5)}{(s+2)(s+3)(s+4)}$.
   (c) What are advantages of state space analysis compared to transfer function analysis? [6+6+4]

3. Explain the following terms :
   (a) Impulse response
   (b) Rotational mechanical systems
   (c) Translational systems
   (d) Sensitivity. [16]

4. (a) What is compensation? What are the different types of compensators?
   (b) What is lag-lead compensator, obtain the transfer function of lag-lead compensator and draw it's pole-zero plot?
   (c) Explain the different steps to be followed for the design of lag lead compensator using Bode plot? [3+3+10]

5. Sketch the root locus plot of a unity feed back system whose open loop T.F is $G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$. [16]

6. (a) State how the type of a control system is determined? How it effects the steady-state error of the system?
   (b) A unity feed-back system has $G(s) = \frac{40(s+2)}{s(s+1)(s+4)}$. Determine
   i. Type of the system
   ii. All the error coefficient

iii. Error for ramp input with magnitude. [6+10]

7. (a) Compare the Nyquist stability method with other methods & hence bring out the advantages of the Nyquist method.

   (b) Relative stability analysis for open loop unstable cannot be carried out by Nyquist method. Why? [10+6]

8. (a) Reduce the given block diagram (figure 8a)and hence obtain the transfer function $\frac{C(s)}{R(s)}$

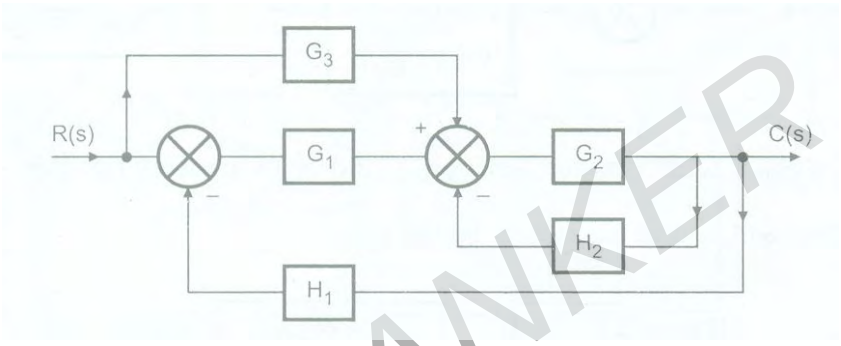

Figure 8a

   (b) Explain synchro with neat sketch. [10+6]

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Time: 3 hours **Max Marks: 80**

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1. The open loop T.F. of a control system is given by $G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$ Sketch the root locus plot and determine
   (a) the break-away points
   (b) The angle of departure from complex poles
   (c) the stability condition. [5+5+6]

2. (a) How can you control the system dynamics by using feedback?
   (b) What is a mathematical model of a physical system? Explain briefly. [8+8]

3. (a) Obtain the state model of the system whose transfer function is given as. $\frac{Y(s)}{V(s)} = \frac{10}{S^3+4S^2+2S+1}$
   (b) Consider the matrix A compute e^{At}? [8+8]
   $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

4. (a) What is compensation? What are the different types of compensators?
   (b) What is a lead compensator, obtain the transfer function of lead compensator and draw pole-zero plot?
   (c) Explain the different steps to be followed for the design of lead compensator using Bode plot? [3+3+10]

5. (a) Reduce the given block diagram (Figure 5a) and hence obtain the transfer function $\frac{C(s)}{R(s)}$

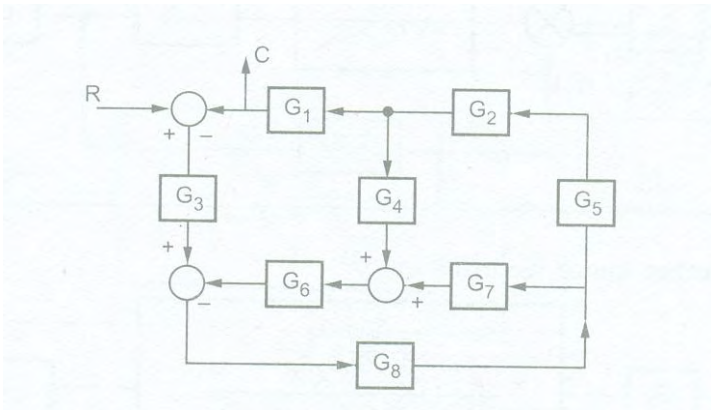

Figure 5a

   (b) Explain the practical applications of servomotors. [10+6]

6. (a) Explain Nyquist stability criterion.
   (b) With the help of Nyquist plot assess the stability of a system $G(s) = \frac{3}{s(s+1)(s+2)}$ What happens to stability if the numerator of the function is changed from 3 to 30? [6+10]

7. (a) What do you mean by a critically stable system? How do you find out whether a given system is critically stable from Bode plots?
   (b) Define
      i. Gain Margin
      ii. PhaseMargin
   (c) Sketch Bode phase angle plot of a system $G(s) = \frac{1}{(1+s)(1+2s)}$. [4+4+8]

8. (a) Explain error constants K_p, K_v, K_a for type-1 system?
   (b) A unity feed back system has an open loop transfer function $G(s) = \frac{25}{s(s+8)}$. Determine its damping ratio, peak overshoot and time required to reach the peak output. Now a derivative component having T.F. of s/10 is introduced in the system. Discuss its effect on the values obtained above? [3+13]

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