Code No: R09221004 **R09** **Set No. 2**

II B.Tech II Semester Examinations,APRIL 2011
CONTROL SYSTEMS
Common to Instrumentation And Control Engineering, Electronics And Instrumentation Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. Write short notes in brief
   (a) Polar plots
   (b) Nyquist stability criterion
   (c) Effect of adding poles to G(s)H(s) on the shape of Nyquist plots. [5+5+5]
2. (a) What is meant by steady-state error? Derive the expression for steady state error?
   (b) Find all the time domain specifications for a unity feed back control system whose open loop T.F. is given by $G(s) = \frac{25}{s(s+6)}$. [5+10]
3. (a) Derive the expressions for resonant peak & resonant frequency and hence establish the correlation between time response & frequency response.
   (b) Given $\zeta = 0.7$ & $\omega_n = 10$ r/s find resonant peak, resonant frequency & Bandwidth. [10+5]
4. (a) A system is described by

$$\dot{x} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u.$$

$$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

   Find the transfer function and construct the signal flow graph.
   (b) Define state, state variable and explain the significance of state variable analysis? [10+5]
5. Sketch the root locus plot of a unity feed - back system whose open loop T.F is $G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$. [15]
6. (a) The signal flow graph shown in figure 6a has one forward path and two isolated loops.Determine the overall transfer function relating x_6 and x_1.

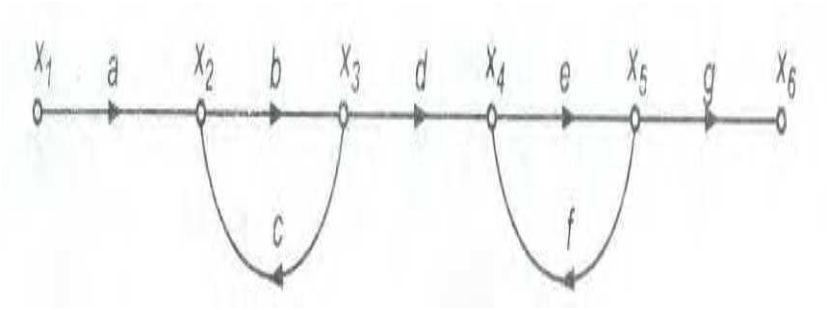

Figure 6a

(b) Explain the differences between AC servomotor and Dc servomotor. [9+6]

7. (a) Obtain the transfer function of the following system and draw its analogous electrical circuit. Figure 7a

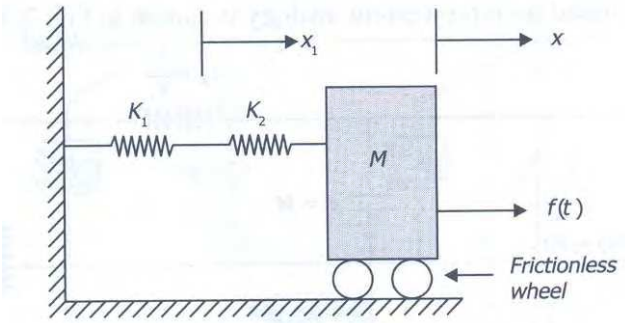

Figure 7a

(b) Explain the advantages and features of transfer function. [10+5]

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. [15]

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Code No: R09221004 **R09** **Set No. 4**

II B.Tech II Semester Examinations,APRIL 2011
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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) Explain the method of determination of range of 'K' for stability from Nyquist plots.
   (b) Which one of the following improves closed stability & why?
      i. Addition of poles
      ii. Addition of zeros. [7+8]
2. (a) Illustrate atleast three applications of feedback control systems?
   (b) Explain translatory and rotary elements of mechanical systems? [7+8]
3. (a) Define the term root locus and state the rule for finding out the root locus on the real axis?
   (b) Calculate the angle of asymptotes and the centroid for the system having $G(s)H(s) = \frac{K(s+3)}{s(s+2)(s+4)(s+5)}$
   (c) For $G(s)H(s) = \frac{K}{s(s+1)(s+3)}$, find the intersection point of the root locus with the $j\omega$ - axis? [4+5+6]
4. (a) Obtain the response of the following system for step input
$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$
$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$
With $x_1(0)=x_2(0)=0$. (Using laplace transform method.)
   (b) A feedback system is characterized by the closed loop $T(S) = \frac{S^2+3S+3}{S^3+2S^2+3S+1}$
Draw a suitable signal flow graph and construct a state model of a system? [10+5]
5. (a) Determine the transfer function $\frac{C(s)}{R(s)}$ for the following block diagram (Figure 5a)

Code No: R09221004 **R09** **Set No. 4**

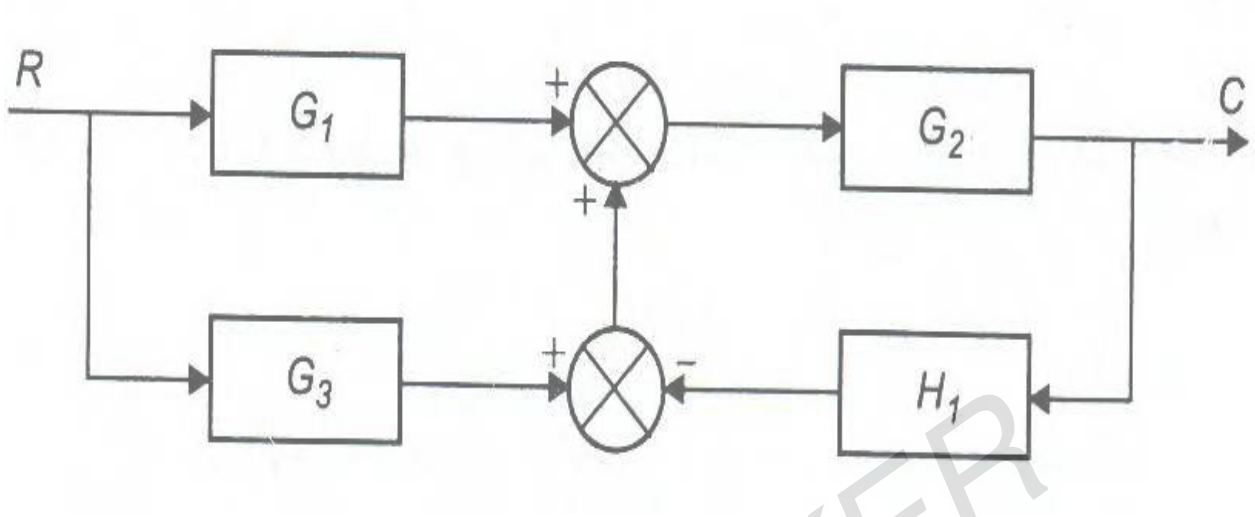

Figure 5a

(b) Explain the following terms. [10+5]

i. Input or source node
ii. Path gain
iii. Sink node
iv. Feedback path

6. (a) What do you mean by an "All pass function". Explain its significance. Also explain "Minimum phase & non minimum phase function".

(b) Draw the Bode plots for a system given by $G(s) = \frac{(1-0.2s)}{(1+0.2s)}$. [7+8]

7. For G(S) $= \frac{K}{S(S+2)(S+20)}$. Design a lag compensator given phase margin $\geq 35^0$ and $K_V \leq 20$. [15]

8. (a) Define type and order of a control system and hence find the type and order of the following systems?

i. $G(s)H(s) = \frac{100}{s(s^2+4s+200)}$
ii. $G(s)H(s) = \frac{200}{s^2(s^2+10s+200)}$
iii. $G(s)H(s) = \frac{4(s^2+10s+100)}{s(s+3)(s^2+2s+10)}$
iv. $G(s)H(s) = \frac{200}{(1+01s)(1+0.5s)}$

(b) The unit step response of a second order linear system with zero initial state is given by $c(t) = 1 + 1.25e^{-6t}Sin(8t - \tan^{-1} 1.333)$. Determine the damping ratio, un damped natural frequency of oscillations and peak overshoot? [7+8]

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Code No: R09221004 **R09** **Set No. 1**

II B.Tech II Semester Examinations,APRIL 2011
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1. (a) With respect to a function q(s) "Every s-plane contour which does not pass through any singular points of q(s) has a corresponding contour in q(s) plane" Elaborate.
   (b) What is the effect of adding a zero at origin to the open loop transfer function on polar plot? [7+8]
2. A unity feedback system has open loop transfer function on G_f (S) = $\frac{K}{S^2(1+0.25)}$. Design a lead compensator to meet the following specifications.
   (a) Acceleration error constant K_a =10
   (b) Phase margin =35^0. [15]
3. (a) A feed back system has a closed loop transfer function. $\frac{Y(s)}{V(s)} = \frac{10(s+4)}{s(s+1)(s+3)}$. Construct canonical state models for this system?
   (b) Consider the matrix A and compute e^{At}
   $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$
   (c) Explain the significance of state space Analysis. [6+5+4]
4. (a) Find the transfer function $\frac{\theta(s)}{T(s)}$ for the following system. Shown in figure 4a.

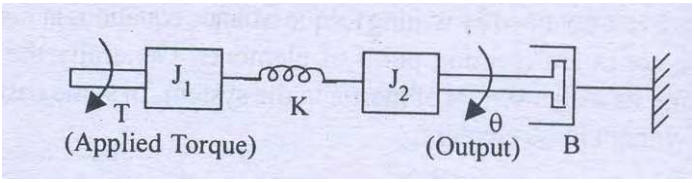

Figure 4a

   (b) Explain feedback characteristics of a closed loop systems. [7+8]
5. (a) Explain the term frequency response analysis.
   (b) Show that in Bode magnitude plot the slope corresponding to a quadratic factor is -40 dB/dec.
   (c) Explain with the help of examples
      i. Minimum phase function
      ii. Non minimum phase function
      iii. All pass function. [4+6+5]

Code No: R09221004 **R09** **Set No. 1**

6. (a) How the roots of the characteristic equation are related to stability?
   (b) What is the relation between stability and coefficients of characteristic polynomial?
   (c) What is break-away and break-in point? How to determine them?
   (d) What is centroid? How the centroid is calculated? [4+4+4+3]

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

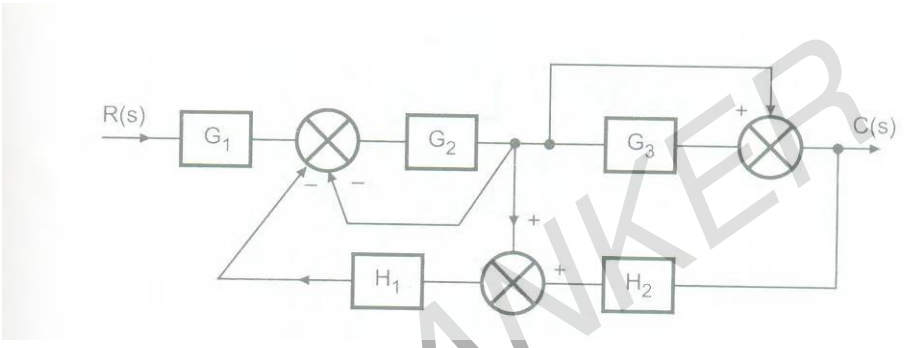

Figure 7a

   (b) Explain the need of Mason's gain formula for any system reduction. [10+5]

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+12]

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Code No: R09221004 **R09** **Set No. 3**

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1. (a) What are the necessary conditions to have all the roots of the characteristic Equation in the left half of s-plane?
   (b) What are the difficulties in RH stability crititerion? Explain, how you can over come them? [4+11]
2. Explain how you determine:
   (a) Stability and
   (b) Relative stability.

   from Nyquist plots. [7+8]
3. (a) Define frequency response.
   (b) Discuss the advantages & disadvantages of frequency response analysis.
   (c) Bring out the correlation between time response & frequency response and hence show that the correlation exists for the range of damping ratio $0 < \zeta < 0.707$. [2+6+7]
4. (a) What is compensation? what are the different types of compensators?
   (b) What is a lag compensator, obtain the transfer function of lag compensator and draw pole-zero plot?
   (c) Explain the different steps to be followed for the design of compensator using Bode plot? [3+3+9]
5. (a) Define steady state response and steady state error? How can you minimize the steady state error?
   (b) A second order system is given by $\frac{C(s)}{R(s)} = \frac{25}{s^2+6s+25}$. Find its rise time, peak time, peak overshoot and settling time if subjected to unit step input? Also calculate expression for its output response? [5+10]
6. (a) Obtain the state space representation of the electrical network shown in figure 6a.

Code No: R09221004 **R09** **Set No. 3**

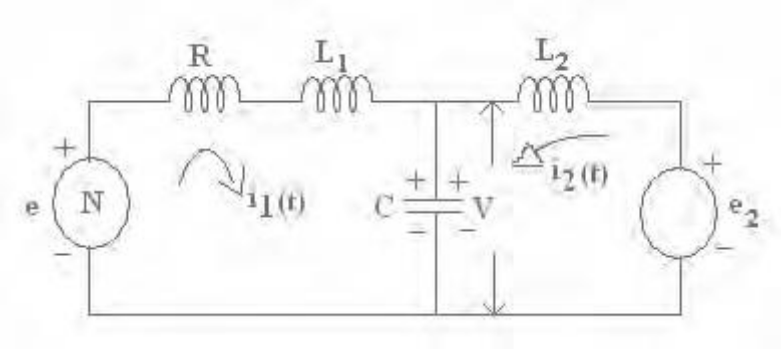

Figure 6a

Consider i_1, i_2, V as state variables.

(b) A system is characterized by the following state space equations.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u,\ t > 0$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Find state transition matrix. [7+8]

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

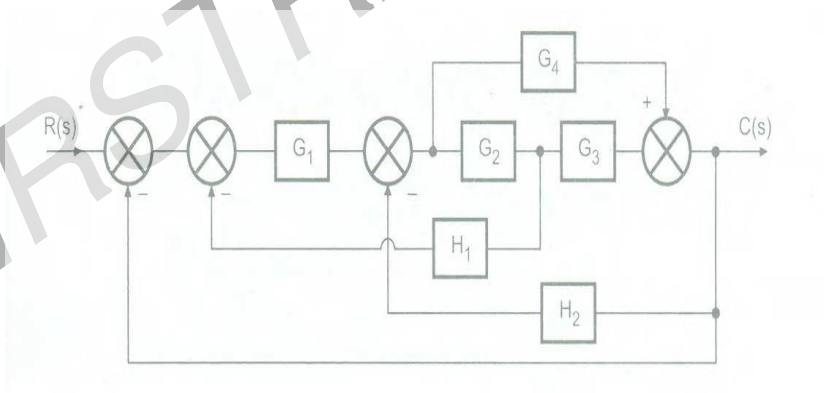

Figure 7a

(b) Explain synchro with neat sketch. [10+5]

8. (a) Derive the transfer function for the following rotational mechanical systems. Shown in figure 8a

Code No: R09221004 **R09** **Set No. 3**

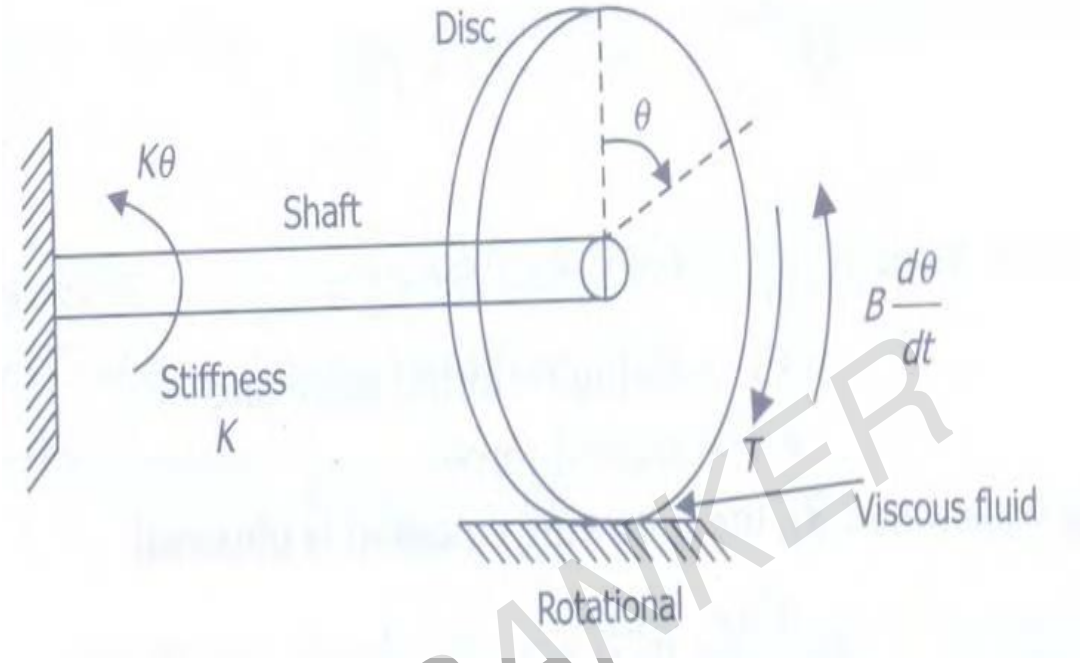

Figure 8a

(b) List out the limitation of open loop systems over closed loop systems. [10+5]

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