Code No: RR220206 **Set No.1**

II B.Tech. II Semester Regular Examinations, April/May -2005
CONTROL SYSTEMS
(Common to Electrical & Electronic Engineering,Electronics & Communication Engineering,Electronics & Instrumentation Engineering,Electronics & Control Engineering,Electronics & Telematics and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks
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1. Distinguish between:
   (a) Linear and non linear system
   (b) Single variable and multivariable control systems
   (c) Regenerative and degenerative feeds back control systems.

   Give an example for each of the above.

2. (a) Explain the effect of feedback on the stability of a closed loop system?
   (b) Explain the effect of feedback on the sensitivity of a closed loop system?

3. In a unity feedback control system the open loop transfer function G(S)=10/s(s+1)
   (a) Find the time response of the system
   (b) Find the time constant and % overshoot for a unit step input.

   To reduce the % overshoot by 50% it is proposed to add a tachometer feedback 100p. Find the tachometer feedback gain to be used.

4. (a) The open-loop transfer function of a servo system with unity feedback is $G(s) = \frac{10}{s(0.1s+1)}$. Evaluate the static error constants (K_p, K_v, K_a) for the system. Obtain the steady-state error of the system when subjected to an input given by the polynomial $r(t) = a_0 + a_1 t + \frac{a_2}{2} t^2$
   (b) The open-loop transfer function of a unity feedback control system is given by $G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}$. By applying the Routh criterion, discuss the stability of the closed-loop system as a function of K. Determine the values of K, which will cause sustained oscillations in the closed-loop system. What are the corresponding oscillation frequencies?

5. (a) Find the angle of arrival and the angle of departure at the complex zeros and complex poles for the root locus of a system with open-loop transfer function $G(s)H(s) = \frac{K(s^2+1)}{s(s^2+4s+8)}$.
   (b) Draw the root locus diagram for a feedback system with open-loop transfer function $G(s) = \frac{K(s+5)}{s(s+3)}$, following systematically the rules for the construction of root locus. Show that the root locus in the complex plane is a circle.

6. (a) Briefly explain the correlation between time and frequency response of a system.
   (b) ketch the Bode Plot for the following Transfer function G(s) = $\frac{10(1+0.5s)}{s(1+0.1s)(1+0.2s)}$ Calculate Gain margin and phase margin.

7. (a) Explain how Nyquist contour is selected for stability analysis.
   (b) Discuss the stability of the following system using Nyquist stability criterion $G(s)H(s) = \frac{K}{(Ts+1)s}$.

8. (a) For the given system $\dot{X}$ = AX + BU, Y = CX.

   $$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C = [1 \quad 0 \quad 0]$$

   Obtain Jordan form representation of state equation of A. Also find the transfer function.
   (b) Derive the expression for the transfer function G(s) = Y(s) / U(s) .Given the state model
   $\dot{X}$ = A X + B U
   Y = C X + D U

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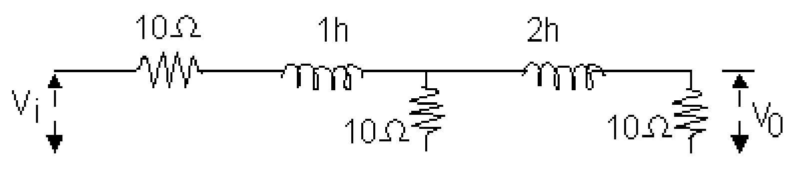
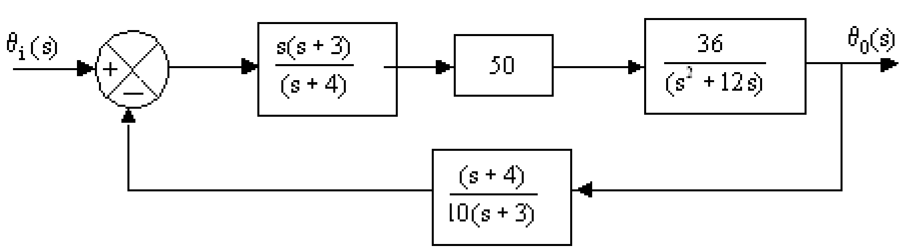
1. (a) Explain, with example, the use of control system concepts to engineering and non engineering fields.
   (b) For the electrical network given below, derive the transfer function



2. Derive the Transfer Function for the field controlled d.c. servomotor with neat sketch.

3. (a) Derive the time response of second order under damped system due to unit step input
   (b) Derive the expressions for rise time, peak over shoot, settling time of 2^{nd} order system of unit step input.

4. (a) For the system shown in figure, find the value of the steady state output when an input $\theta_i(t) = (2t + 5e^{-3t})$is applied. Determine the steady state error of the system. What is the type and order of the system?



   (b) Explain the Hurwitz criterion to determine the stability of dynamical system.

5. (a) Determine the breakaway points of the system which have the open loop transfer function $G(s)H(s) = \frac{K(s+4)}{(s^2+2s+4)}$.

(b) Derive the magnitude and angle criteria for stability.

6. (a) Define phase margin and gain margin.
   (b) The open loop transfer function of a system is G(s) = $\frac{K}{s(1+0.5s)(1+0.2s)}$ using Bode Plot. Find K so that
      i. Gain margin is 6 dB,
      ii. Phase margin is 25^0.

7. (a) Sketch the polar plot of a unity feed back system with open loop transfer function G(s) = $1/S(1+S)^2$. Also find the frequency at which |G(jW)| =1 and the corresponding phase angle $\underline{/G(jW)}$.
   (b) Determine the stability of the system whose open loop transfer function $G(s)H(s) = \frac{1}{s(1+2s)(1+s)}$. Also find gain and phase margin (using Nyquist plot).

8. (a) Reduce the matrix A to diagonal matrix.
   $$A = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix}$$
   (b) Derive the state models for the system described by the differential equation in phase variable form.
   $\dddot{y} + 4\ddot{y} + 5\dot{y} + 2y = 2\ddot{u} + 5\dot{u} + 5u$

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1. Define system and explain about various types of control systems with examples and their advantages.

2. Derive the Transfer Function for armature controlled d.c. servomotor, with neat diagram.

3. (a) What are the time response specifications? Explain each of them.

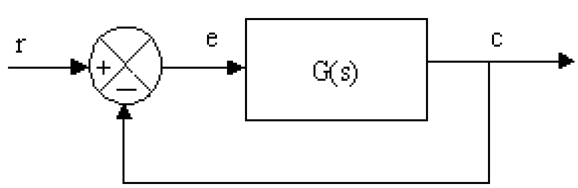
   (b) For a negative feedback control system having forward path transfer function: $G(s) = \frac{\mathrm{k}}{\mathrm{s(s+6)}}$ and H(s)=1. Determine the value of gain k for the system to have damping ratio of 0.8. For this value of gain k, determine the complete time response specifications.

4. (a) Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system.

   (b) For the feedback control system shown in figure, it is required that :

      i. the steady-state error due to a unit-ramp function input be equal to 1.5.

      ii. the dominant roots of the characteristic equation of the third-order system are at –1+j1 and –1-j1. Find the third-order open-loop transfer function G(s) so that the foregoing two conditions are satisfied.



5. (a) Determine the value of K and the angle of the open loop transfer function at the root locus point A for a unity feedback system of $G(s) = \frac{K}{(s+1)(s^2+6s+8)}$ Point A is defined by $s_1 = -1+\sqrt{3}j$.

   (b) Determine:

      i. The number of root loci

      ii. Asymptote informations

iii. Root loci on the real axis if any on $G(s)\,H(s) = \frac{K(s+1)(s+3)}{s(s+2)(s+6)}$.

6. (a) Derive an expression for peak resonance and band width for standard second order system.

   (b) Sketch the Bode Plot for a unity feedback control system with forward path transfer function $G(s) = \frac{24}{(s+2)(s+6)}$. Determine the gain margin and phase margin.

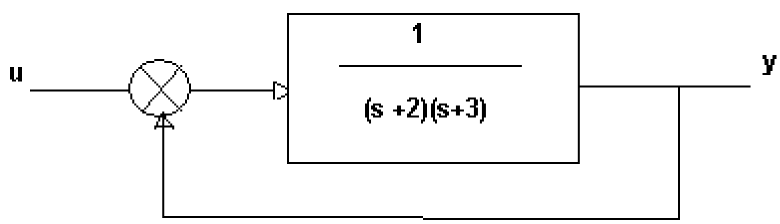
7. (a) The open loop transfer transfer function of a feed back system is $G(s)H(s)= \frac{K(1+s)}{(1-s)}$. Comment on stability using Nyquist Plot.

   (b) The transfer function of a phase advance circuit is $\frac{1+0.2s}{1+0.2s}$. Find the maximum phase lag.

8. (a) A linear time invariant system is denoted by the differential equation D^3 y + 3 D^2 y +3 D y + y = U where D = d y/dt

   i. write the state equations
   ii. find the State Transition matrix
   iii. Find the characteristic equation and eigen values of A.

   (b) Obtain state space model for the following system figure.



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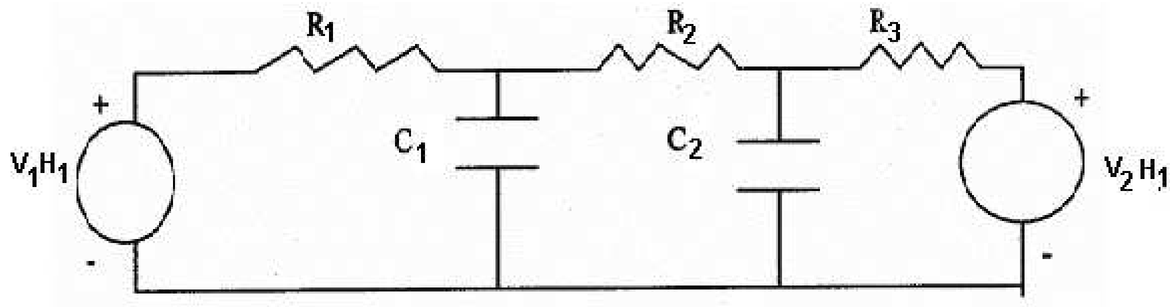
1. (a) Explain about various types of control systems with examples briefly.
   (b) Explain the differences between open loop and closed loop system.
2. (a) Derive the transfer function of an a.c. servomotor and draw its characteristics.
   (b) Explain the Synchro error detector with circuit diagram.
3. (a) Define time constant and explain its importance.
   (b) A unit feedback system is characterized by an open-loop transfer function G(s) = K/s(s+5). 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 times to peak overshoot for a unit-step input.
4. (a) Find the steady-state error to
      i. a unit step input
      ii. a unit ramp input and
      iii. a unit parabolic input ($r = {}^1\!/_2 t^2$) for a unity feedback systems that have the following forward transfer functions. $G(s) = \frac{10}{s^2(s+4)(s^2+3s+12)}$
   (b) The open loop transfer function of a servo system with unity feedback is given by $G(s) = \frac{500}{s(1+0.1s)}$
   Evaluate the error series for the above system and determine the steady state error when the input is $r(t) = 1 + 2t + t^2$.
5. For the function $GH(s) = \frac{K(s+3)}{(s+1)(s+2)}$ prove that part of root locus is circular. Find the center, and radius of the circle. What are the breakaway points?
6. Sketch the Bode Plot for a unity feed back system characterized by the open loop transfer function $G(s) = \frac{K(1+0.2s)(1+0.025s)}{s^2(1+0.001s)(1+0.005s)}$. Show that the system is conditionally stable. Find the range of K for which the system is stable.
7. (a) Explain what is meant by the Relative stability of a system and the manner in which this is specified.
   (b) Construct the complete Nyquist plot for a unity feed back control system whose open loop transfer function is $G(s)\,H(s) = \frac{K}{S(S^2+3S-10)}$. Rind maximum value of K for which the system is stable.



8. (a) Determine the state variable matrix for the circuit shown

   (b) A single input-single output system has the matrix equation, find the transfer function

$$\dot{X} = \begin{pmatrix} 0 & 1 \\ -3 & -4 \end{pmatrix} \begin{pmatrix} X_1 \\ X_2 \end{pmatrix} + \begin{pmatrix} 0 \\ 1 \end{pmatrix} U$$

$$Y = \begin{pmatrix} 1 & 0 \end{pmatrix} \begin{pmatrix} X_1 \\ X_2 \end{pmatrix}$$

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