

**II B.Tech II Semester Supplementary Examinations, Apr/May 2008
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**

1. (a) For the mechanical system Figure 1a given, write down the differential equations of motion and hence determine the $Y_2(s)/F(s)$

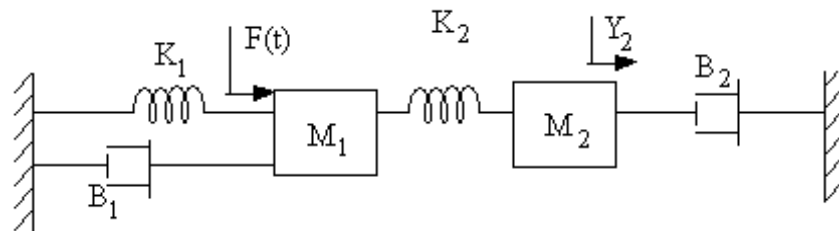


Figure 1a

- (b) Describe the analogy between electrical and mechanical systems. [10+6]
2. Derive the Transfer Function for a.c. servomotor. Explain about torque-speed characteristics. [8+8]
3. (a) Explain the important time ? response specification of a standard second ordered system to a unit step input.
- (b) Derive expressions for time domain specifications of a standard second ordered system to a step input. [8+8]
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 4b. it is required that :
- the steady-state error due to a unit-ramp function input be equal to 1.5.
 - 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. [6+10]

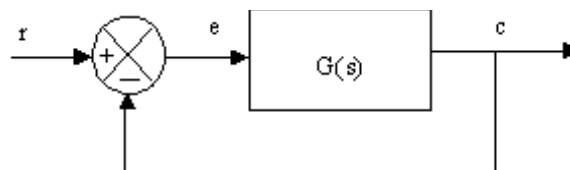


Figure 4b

5. A unity feedback system has a plant $G(s) = K (s+0.5) / s(s+1)(s^2+2s+2)$ sketch the root locus and find the roots when $\zeta = 0.5$. [8+8]

6. (a) Explain the frequency response specifications.
 (b) Draw the Bode Plot for the system having $G(s)H(s) = \frac{100(0.02s+1)}{(s+1)(0.1s)(0.01s+1)}$. Find gain and phase cross over frequency. [8+8]
7. The open loop transfer function of a unity feedback control system is $G(s) = \frac{10}{s(s+1)s+5}$. Draw its polar plot and hence determine its phase margin and gain margin. [8+4+4]
8. (a) Write the state equations for the block diagram given figure 8a.

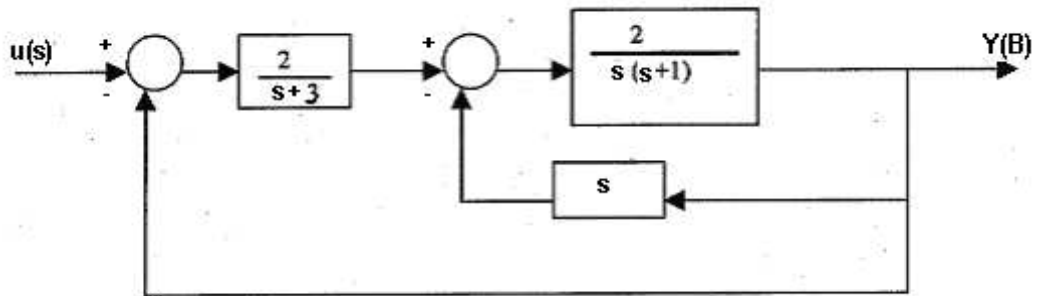


Figure 8a

- (b) For the given plant transfer function construct the signal flow diagram and determine the state space model. [8+8]

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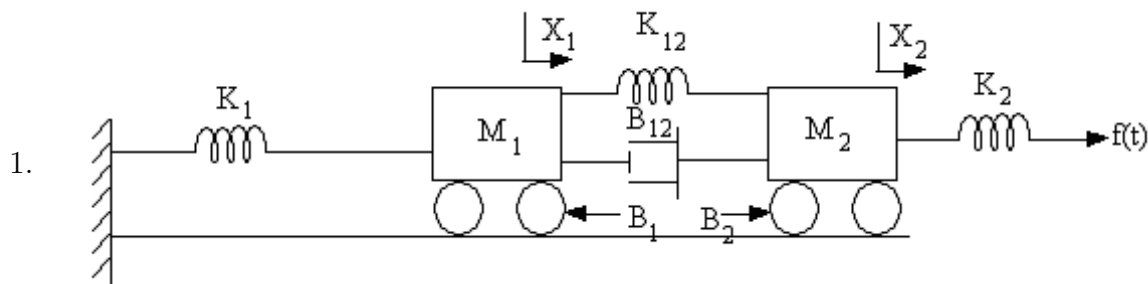


Figure 1

For the mechanical system given, Figure 1 write down

- (a) Mathematical model
 - (b) Obtain the transfer function $X_1(s)/F(s)$ and $X_2(s)/F(s)$ [10+6]
2. (a) Explain how the potentiometers are used as error sensing devices. Give a typical application of it with single line diagram.
 - (b) Discuss the effect of disturbance signal of the speed control system for a gaso-lineengine as shown in Figure 2b assuming $K=10$. [8+8]

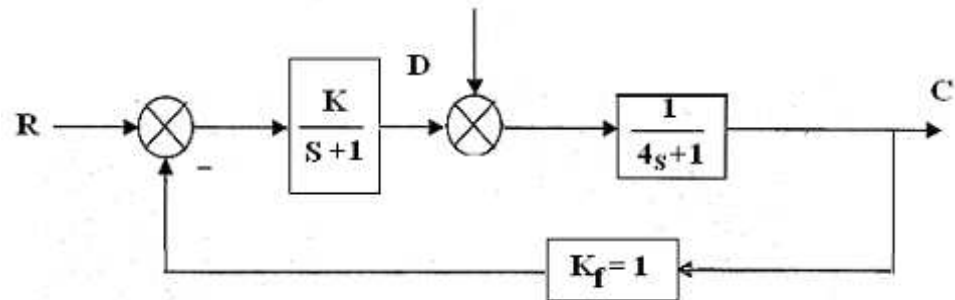


Figure 2b

3. (a) Explain the important time ? response specification of a standard second ordered system to a unit step input.
 - (b) Derive expressions for time domain specifications of a standard second ordered system to a step input. [8+8]
4. (a) Find the roots of the characteristic equation for systems whose open-loop transfer functions are given below. Locate the roots in the s-plane and indicate the stability of each system.

- i. $G(s)H(s) = \frac{1}{(s+2)(s+4)}$
 ii. $G(s)H(s) = \frac{5(s+3)}{s(s+3)(s+8)}$
- (b) A feedback system has an open-loop transfer function of $G(s)H(s) = \frac{Ke^{-s}}{s(s^2+5s+9)}$. Determine the use of Routh criterion, the maximum value of K for the closed-loop system to be stable. [8+8]
5. (a) Show that the breakaway 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) By a step by step procedure draw the root locus diagram for a unity negative feedback system with open loop transfer function $G(s) = \frac{K(s+1)}{s^2(s+9)}$. Mark all the salient points on the diagram. Is the system stable for all the values of K? [8+8]
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. [4+12]
7. (a) Construct the complete Nyquist plot for a unity feed back control system whose open loop transfer function is $G(s)H(s) = \frac{K}{s(s^2+2s+2)}$. Find maximum value of K for which the system is stable.
 (b) The open loop transfer function of a unity feed back system is $G(s) = \frac{1}{s(1+0.5s)(1+0.1s)}$. Find gain and phase margin. If a phase lag element with transfer function of $\left(\frac{1+2s}{1+5s}\right)$ is added in the forward path, find how much the gain must be changed to keep the margin same. [8+8]
8. (a) Obtain state space mode for given mechanical system. Figure 8a

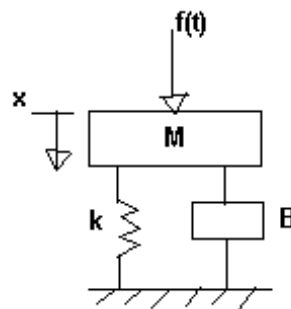


Figure 8a

- (b) Obtain the state equations in canonical form for transfer function given $\frac{Y(s)}{U(s)} = (3s^2 + 5s + 13)/(s + 2)(s^2 + 4s + 8)$. [8+8]

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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 shown in Figure 1b given, derive the transfer function

[8+8]

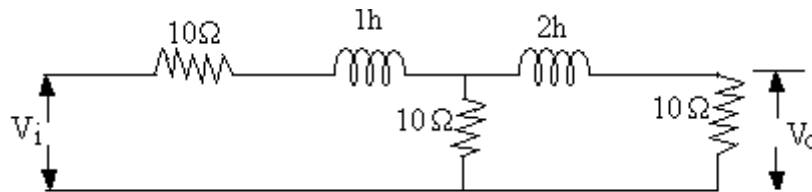


Figure 1b

2. Derive the Transfer Function for the field controlled d.c. servomotor with neat sketch. [8+8]
3. (a) Derive the expression for rise time, peak time peak overshoot and settling time of second order system subjected to a step input.
- (b) A unity feedback control system has a loop transfer function.

$$G(s) = \frac{10}{s(s+2)}$$

 Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units. [8+8]

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 4b. 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. [6+10]

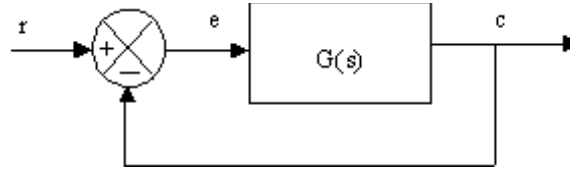


Figure 4b

5. (a) Show that the breakaway 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) By a step by step procedure draw the root locus diagram for a unity negative feedback system with open loop transfer function $G(s) = \frac{K(s+1)}{s^2(s+9)}$. Mark all the salient points on the diagram. Is the system stable for all the values of K ? [8+8]
6. (a) The open loop transfer function of a feed back control system is $G(s)H(s) = \frac{K(1+2s)}{s(1+s)(1+s+s^2)}$. Find the restrictions on K for stability. Find the values of K for the system to have a gain margin of 3 db. With this value of K , find the phase cross over frequency and phase margin.
- (b) Explain how Bode plot is used to find gain margin and phase margin. [8+8]
7. (a) Explain gain margin and phase margin.
- (b) The open loop transfer function of a feed back system is $G(s)H(s) = \frac{K(1+s)}{(1-s)}$. Comment on stability. [6+10]
8. Find the unit step response for the following system with the initial conditions
- $$x(0) = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$
- $$\dot{X} = \begin{bmatrix} 0 & 1 \\ -6 & -2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + u(t) \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$
- $$Y(t) = [3 \ 0] X(t)$$
- [16]

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1. Find the transfer function matrix for the two input and output system shown in the given Figure 1 [8+8]

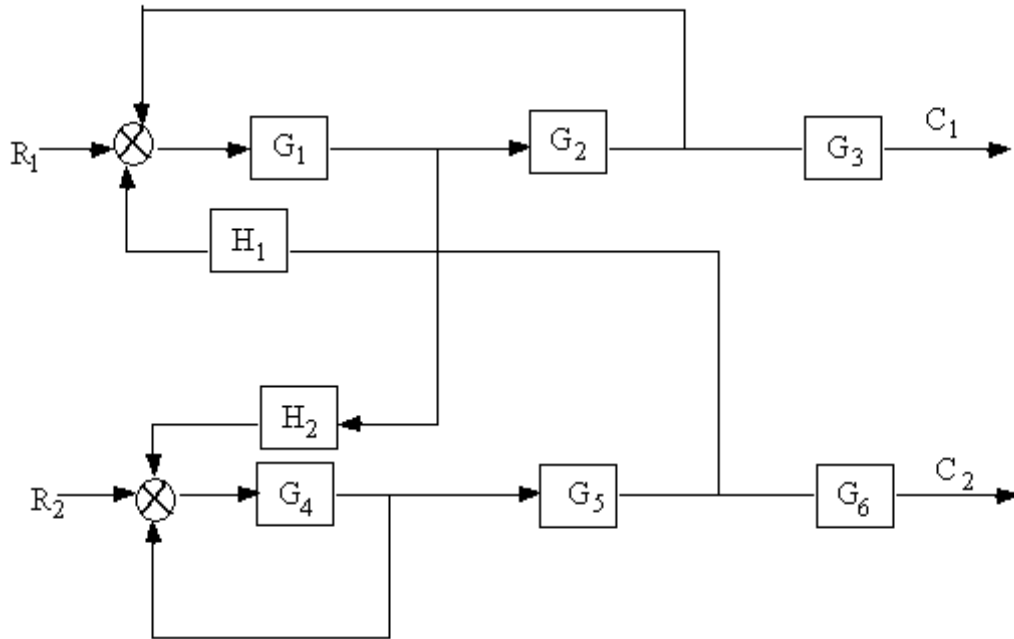


Figure 1

2. Derive the Transfer Function for the field controlled d.c. servomotor with neat sketch. [8+8]
3. (a) Determine whether the largest time constant of the characteristic equation given below is greater than, less than, or equal to 1.0 sec. $s^3 + 4s^2 + 6s + 4 = 0$
- (b) Figure3. is a block diagram of a space-vehicle attitude-control system. Assuming the time constant T of the controller to be 3 sec., and the ratio K/J to be $\frac{2}{9} \text{ rad}^2/\text{sec}^2$, find the damping ratio and natural frequency of the system. [6+10]

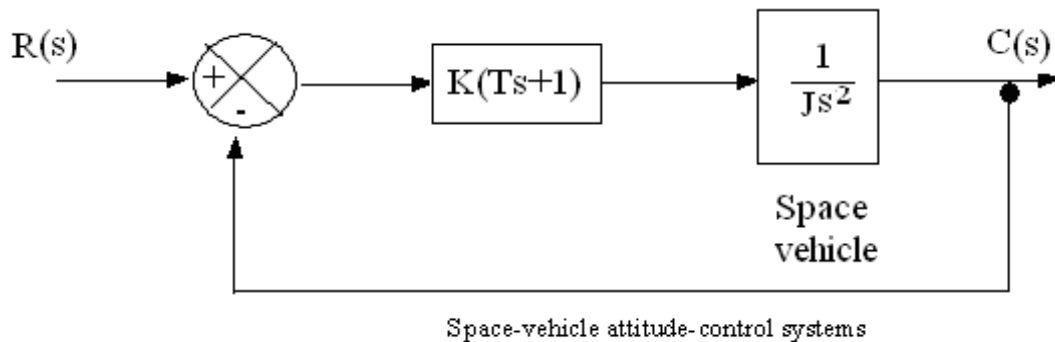


Figure 3

4. (a) Show that the Routh's stability criterion and Hurwitz stability criterion are equivalent.
 (b) Consider a unity-feedback control system whose open-loop transfer function is $G(s) = \frac{K}{s(Js+B)}$. Discuss the effects that varying the values of K and B has on the steady-state error in unit-ramp response. [8+8]
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. [8+8]
6. (a) The open loop transfer function of a feed back control system is $G(s)H(s) = \frac{K(1+2s)}{s(1+s)(1+s+s^2)}$. Find the restrictions on K for stability. Find the values of K for the system to have a gain margin of 3 db. With this value of K, find the phase cross over frequency and phase margin.
 (b) Explain how Bode plot is used to find gain margin and phase margin. [8+8]
7. (a) Explain the Relative stability.
 (b) The open loop transfer function of a unity feed back system is $G(s)H(s) = \frac{s+2}{(s+1)(s-1)}$
 Comment on the stability. [6+10]
8. (a) Explain properties of state transition matrix
 (b) Consider the transfer function

$$Y(s) / U(s) = (2s^2 + s + 5) / (s^3 + 6s^2 + 11s + 4)$$
 Obtain the state equation by direct decomposition method and also find state transition matrix. [6+10]
