Code.No: 45106 | R07 | SET-1

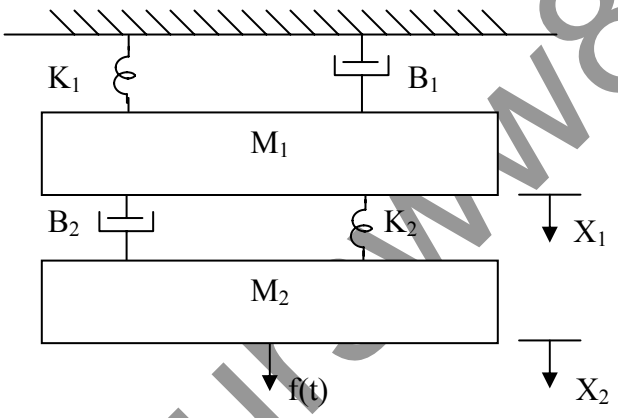
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
III.B.TECH - I SEMESTER REGULAR EXAMINATIONS NOVEMBER, 2009
CONTROL SYSTEMS
(Common to EIE, AE)

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

Answer any FIVE questions
All questions carry equal marks

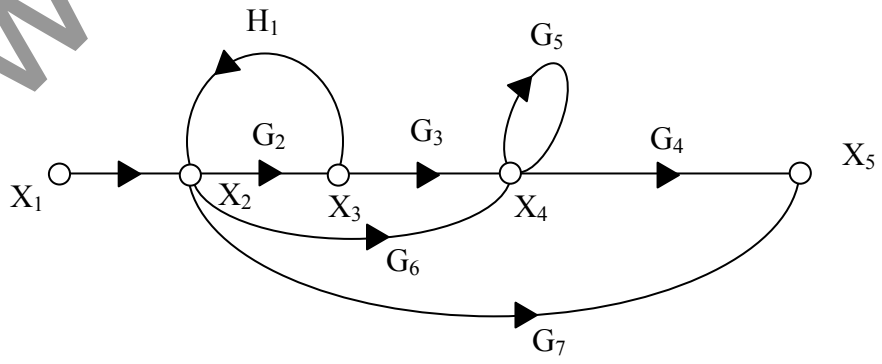
- - -

1.a) Mention the merits and demerits of an open-loop and closed-loop control systems.
b) Obtain the transfer function $X_1(s)/F(s)$ for the mechanical system shown below:



c) Obtain the transfer function of a field controlled D.C. motor. [5+5+6]

2.a) Explain the working of synchro transmitter and receiver system. Derive its transfer function.
b) For the signal flow graph shown below, determine the gain X_5/X_1 using Mason's gain formula: [8+8]



3.a) Derive output responses of the standard second order system and draw step response of the system.

b) Find the Error coefficients for step, ramp and parabolic inputs for unity feed-back system having the forward transfer function [8+8]

$$G(s)=\frac{14(s+3)}{s(s+5)(s^2+2s+2)}$$

4. A unity feedback system has the following open- loop transfer function:

$$G(s)=\frac{K(s+3)}{s(s^2+2s+2)(s+5)(s+6)}$$

Sketch the root-locus diagram. Calculate the value of K corresponding to the damping ratio equal to 0.42. Give the steps followed for construction of Root locus. [16]

5.a) Explain clearly the steps involved in the construction of Bode plots of a system with loop transfer function consisting of

i. An open loop gain K
ii. One pole at the origin
iii. One quadratic factor

b) Given $G(s)=\frac{(s-5)}{(s+5)}$. Determine the phase angle at 0, 5 & 1 frequencies. [12+4]

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 3to 30? [6+10]

7.a) Explain the need of lead compensator and obtain the transfer function of lead- lag compensator.

b) Explain the significance of compensation? [10+6]

8.a) Considering the vector matrix differential equation describe the dynamics of the system as $X=\begin{bmatrix}0 & 1\\ -6 & -5\end{bmatrix}$. Determine state transition matrix?

b) What are the properties of state transition matrix? [10+6]

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CONTROL SYSTEMS
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Time: 3hours **Max.Marks:80**

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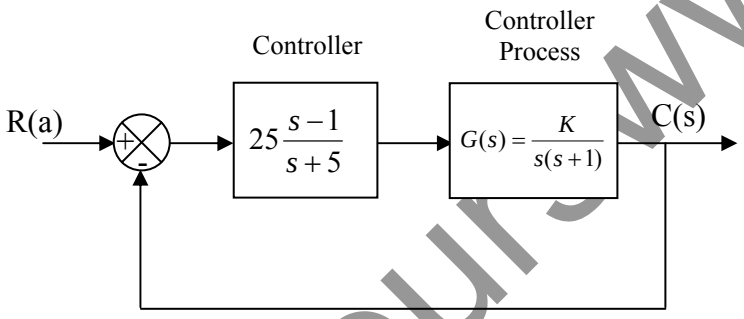
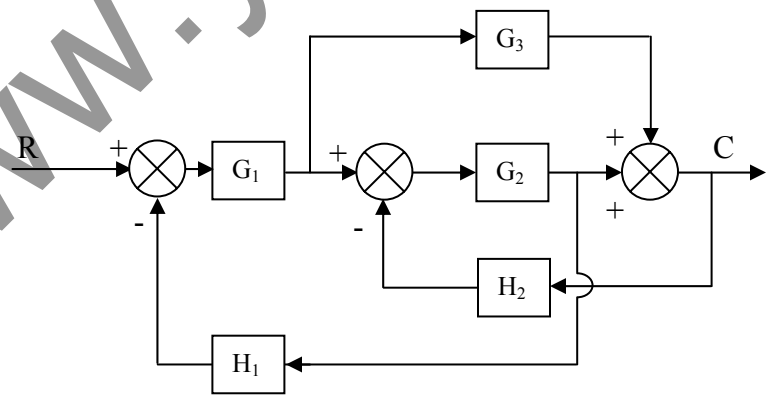
- - -

1.a) Explain regenerative feedback?

b) Determine the sensitivity of the closed loop transfer function $T(s) = \frac{C(s)}{R(s)}$ to variations in parameter K at w = 5 rad/sec. Assume the normal value of K is 1 Shown in figure. [8+8]

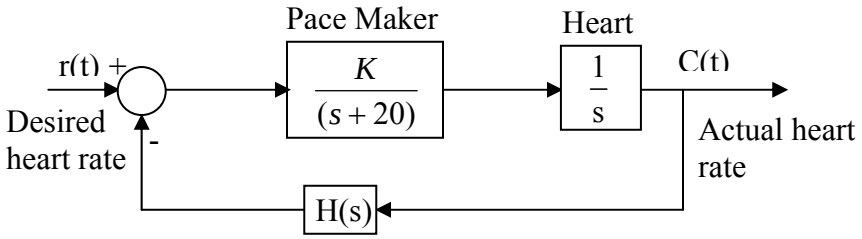


2.a) Determine the overall transfer function relating C and R for the system whose block diagram is given in figure.



b) Explain the properties of block diagrams. [8+8]

3.a) A block diagram of an electric pace maker for controlling rate of heart beat is shown below:



Determine the sensitivity of the closed loop system transfer function to small changes in K at the normal heart rate of 72 beats per minute if H(s) = 1 and the nominal value of K = 400.

b) Consider the standard second order system transfer function. From it, derive damping factor for critically, under damped and over damped cases. [8+8]

4.a) The characteristic equation of a certain control system is $s^3 + (2K+3)s^2 + (6K+7)s + (7K+8.5) = 0$ Determine the range of 'K', (K > 0), such that the roots of the equation are more negative than -1

.

b) Find the stability of the system whose characteristic equation is given below using R-H criterion $s^8 + s^7 + 4s^6 + 3s^5 + 14s^4 + 11s^3 + 20s^2 + 9s + 9 = 0$ [8+8]

5.a) Explain why it is important to conduct frequency domain analysis of linear control systems.

b) Sketch the Bode Magnitude plot for the transfer function

$$G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}.$$

Hence find 'K' such that gain cross over frequency is 5 r/s. [6+10]

6.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]

7. The open loop transfer function of certain unity feedback control system is given by G(S) $= \frac{K}{S(S+4)(S+80)}$. It is desired to have the phase margin to be at least 33^0 and velocity error constant $K_V = 30\ Sec^{-1}$. Design a phase lag series compensator? [16]

8.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) Explain the significance of state space Analysis. [10+6]

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CONTROL SYSTEMS
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Time: 3hours **Max.Marks:80**

Answer any FIVE questions
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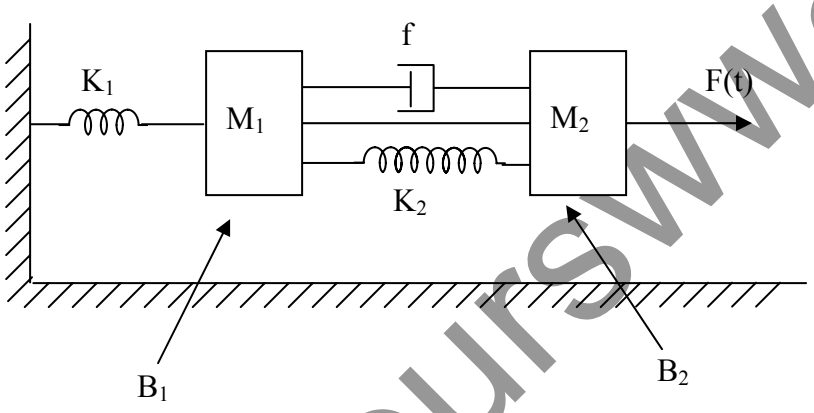
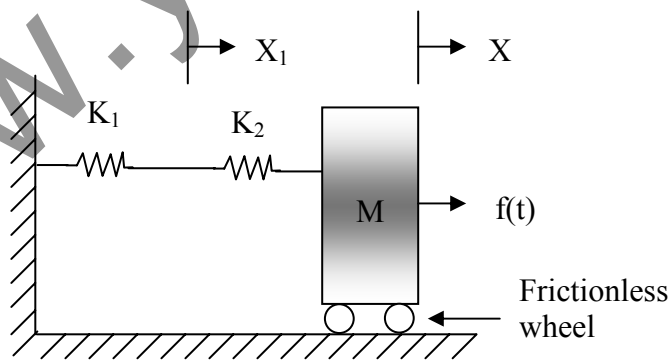
- - -

1.a) Explain Regenerative feedback system with an example.
b) Obtain the transfer function of the mechanical system shown and draw the force-voltage analogy circuit. [8+8]



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



b) Explain the advantages and features of transfer function. [8+8]

3.a) The open-loop transfer function of a unity feedback system is given by.

$$G(s)=\frac{500}{s(1+0.1s)}$$

Find the peak overshoot and time peak overshoot. If peak overshoot is to be reduced by 20%, what is the change in the gain ?

b) Find the Error coefficients for step, ramp and parabolic inputs for unity feed-back system having the forward transfer function [8+8]

$$G(s)=\frac{14(s+3)}{s(s+5)(s^2+2s+2)}$$

4. Obtain the root locus plot for the system whose open loop transfer function is

$$G(s)=\frac{K}{s(s+1)(s^2+2s+2)}$$

For what range of 'K' the system is stable? Give the steps followed for construction of Root locus. [16]

5.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+8]

6.a) What is "Nyquist Contour"?

b) A system is given by $G(s) = \frac{4s+1}{s^2(s+1)(2s+1)}$ Sketch the Nyquist plot & hence determine the stability of the system. [4+12]

7. Design a lead compensator for unity feed back system whose open loop transfer function $G(S) = \frac{K}{s(s+1)(s+5)}$ to satisfy the following specifications.

i) Velocity error constant $K_V \geq 50$

ii) Phase margin $\geq 20^0$. [16]

8.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 . Compute e^{At}?

$$A=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}$$ [8+8]

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CONTROL SYSTEMS
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Time: 3hours **Max.Marks:80**

Answer any FIVE questions
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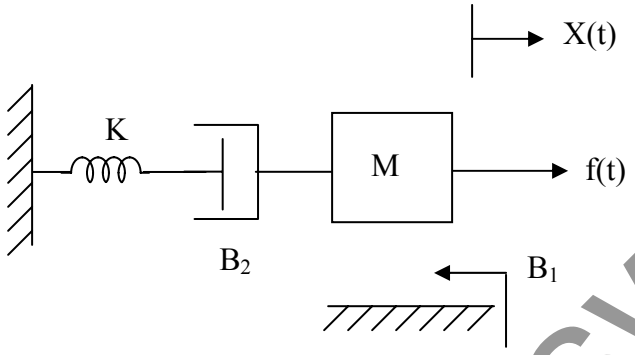
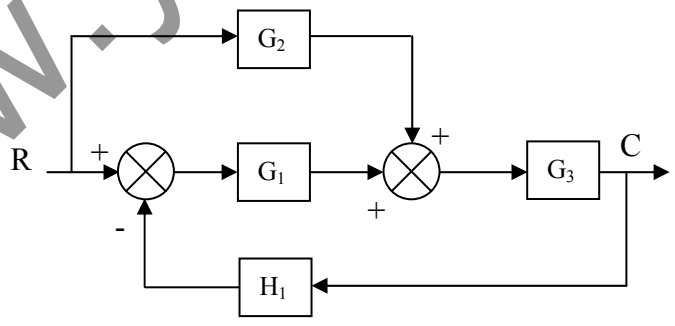
1.a) Draw the force-voltage analogous circuit for the system given below.



b) Give the difference between order and type of a system.
c) Explain the concept of control system with suitable example. [5+5+6]

2.a) Determine the transfer function $\frac{C(s)}{R(s)}$ for the following block diagram



b) Explain the properties of signal flow graphs. [8+8]

3.a) A unity feedback system has forward path transfer function

$$G(s) = \frac{20}{(s+1)}$$

Determine and compare the response of open-loop and closed-loop systems for a unit step input.

b) For a negative feedback control system having forward path transfer function:

$$G(s) = \frac{k}{s(s+6)} \text{ and } H(s) = 1$$

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. [8+8]

4.a) Investigate the stability of a control system whose characteristic equation is given by:

$$s^4 + 3s^3 + 5s^2 + 2s + 10 = 0$$

b) Explain the steps followed for construction of Root locus by taking an example. [8+8]

5.a) Bandwidth is directly proportional to ω_n. Justify.

b) The forward path transfer function of a unity feed back system is $G(s) = \frac{K}{s(s+6.54)}$. Find the resonant peak, resonant frequency & Bandwidth of closed loop system for

i. K = 5
ii. K = 21.39
iii. K = 100.

Comment on the result. [6+10]

6.a) Explain frequency domain specifications.

b) Determine gain margin and phase margin of a system, whose transfer function is given by $G(s) = \frac{3000}{s(s+10)(s+100)}$. [8+8]

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

8.a) Discuss the significance of State Space Analysis?

b) Define state variables.

c) Obtain the state variable representation of an armature controlled D.C motor? [4+4+8]

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