T.E. (Elect.) Sem. V (Rev.) 14/1/08

Control System - I

5-07. (REVISED COURSE) CD-5982

(3 Hours) [Total Marks : 100

N.B. (1) Question No. 1 is **compulsory**.
(2) Attempt total **five** questions.
(3) **Figures** to the **right** indicate marks.
(4) Make **suitable** assumptions wherever **required**.

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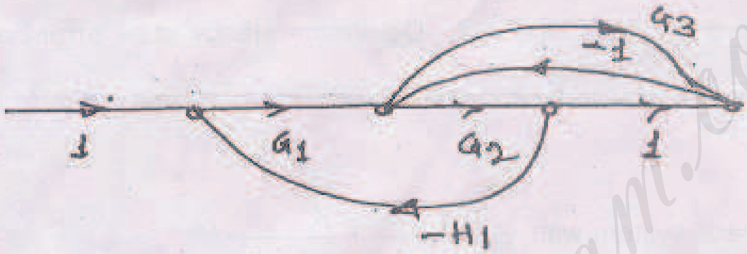
1. (a) A system is governed by the differential equation — **20**

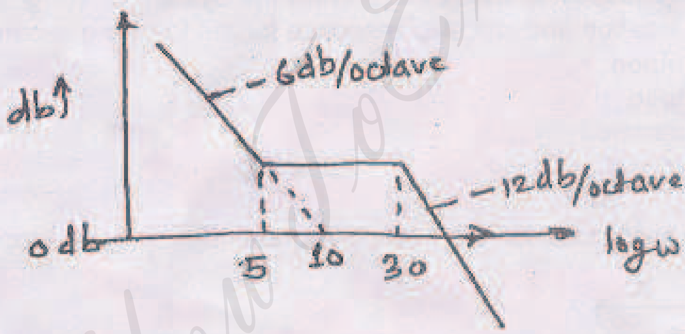
$$\frac{d^3y(t)}{dt^3} + \frac{6d^2y(t)}{dt^2} + \frac{11dy(t)}{dt} + 10y(t) = 8u(t)$$

Where y(t) is the output and u(t) is the input of the system; obtain state space representation of the system.

(b) Find the transfer function for the system represented by flow graph.



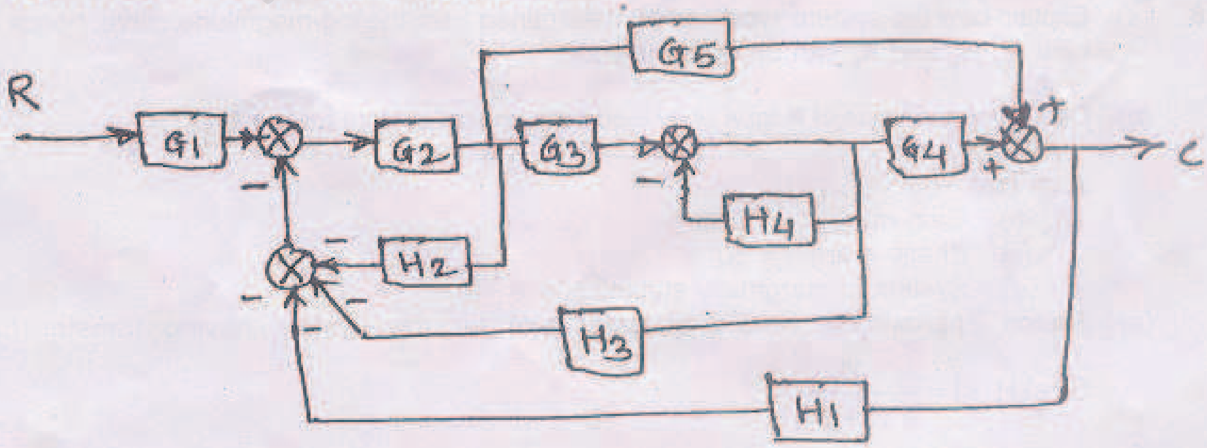
(c) Obtain the transfer function from the log-magnitude plot shown below :—



(d) Applying Routh's criterion, find range of K for stability of a system, whose characteristic equation is given by —

$s^3 + 3K\,s^2 + (K + 2)\,s + 4 = 0.$

2. (a) Determine C/R for the following block diagram. **10**



(b) Derive the transfer function for armature controlled D.C. Servo Motor. **10**

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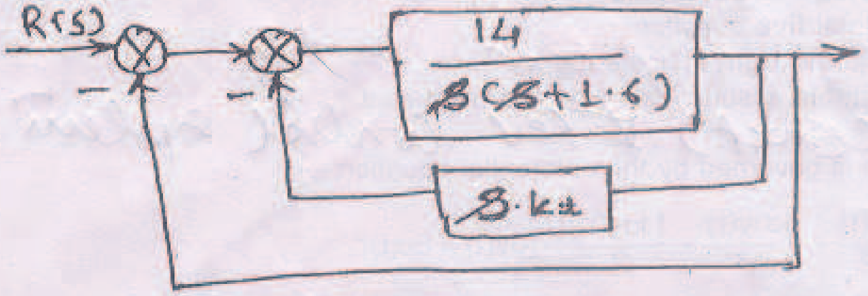
3. (a) The system shown below uses a rate feed back controller. Determine the tachometer constant K_t, so as to obtain the damping ratio of 0·5, calculate corresponding T_p, M_p, W_d and T_s. **10**



(b) A certain feed back control system is described by the transfer function $G(s)=\dfrac{K}{s^2(s+20)(s+30)}$ and $H(s) = 1$, Determine steady state error coefficients and also determine the value of K to limit steady state error to 10 units, due to input $r(t) = 1 + 10\,t + 20\,t^2$. **10**

4. (a) For the unity feed back system with $G(s)=\dfrac{K}{(s+1)^3(s+4)}$. **10**
   - (i) Find the range of K for stability
   - (ii) Find the frequency of oscillations when the system is Marginally stable.

(b) Show the pole zero location and unit step response for the following second order systems :— **10**
   - (i) Under damped
   - (ii) Over damped
   - (iii) Critically damped
   - (iv) Undamped.

5. (a) Draw the complete root locus for the system represented by open loop transfer function, **10**

$$G(s)H(s)=\frac{K}{(s+2)^3}.$$

(b) Draw the complete Nyquist plot for the system whose open loop transfer function is $G(s)H(s)=\dfrac{K}{s(s+2)(s+10)}$ determine the range of K for which close loop system is stable. **10**

6. (a) Explain how the system 'type' can be determined from the log-magnitude curve, hence explain how K_p, K_v and K_a can be determined. **10**

(b) Determine the value of K for a unity feed back control system having $G(s)=\dfrac{K}{s(s+2)(s+10)}$ such that — **10**
   - (i) Gain margin = 10 db
   - (ii) Phase margin = 50°
   - (iii) System is marginally stable.

7. (a) Sketch approximate nature of polar plot for the system having transfer function **20**

$$G(s)H(s)=\frac{K}{s^2(1+sT_1)}.$$

(b) Discuss in detail any one type of damping for a Second Order System.

(c) Derive expression for peak time-up.

(d) Explain the co-relation between time and frequency domain specifications.