[This question paper contains 4 printed pages.]

Your Roll No................

Sr. No. of Question Paper : 1771 **L**

Unique Paper Code : 2512043603

Name of the Paper : Control systems

Name of the Course : **B.Sc. (H) Instrumentation (DSC)**

Semester : VI

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. **1** is compulsory. **All** questions carry equal marks. Attempt any **5** questions in all. Use of Scientific calculator is allowed.

Q.1 (a) The open-loop transfer function of a control system is given below: (3)

$$G(s)H(s) = \frac{2(s^2+3s+20)}{s(s+2)(s^2+4s+10)}$$

Determine the static error coefficients and steady state error for input as 4t.

(b) Determine the position, velocity and acceleration error coefficients for a system given by: (3)

$$G(s)H(s) = \frac{100(s+2)(s+40)}{s^3(s^2\ +4s+200)}$$

(c) What is meant by transient response and steady state response? (3)

(d) The scheme in figure-1 represents a voltage regulator, determine the value of the reference voltage. Given that $R_f = 100\Omega$ (3)

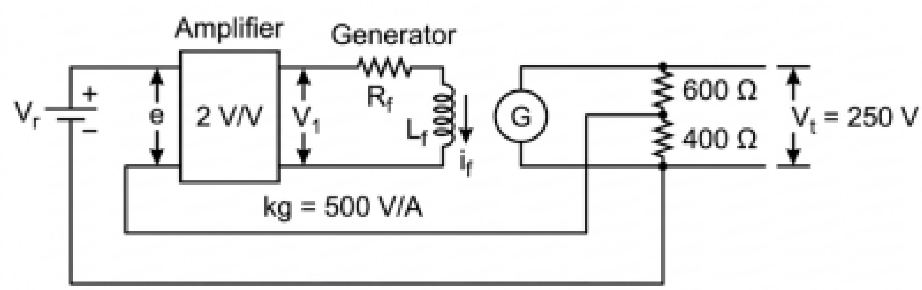

Figure-1

(e) Define the terms absolute and relative stability. (3)

(f) The transfer function of a system is given by; (3)

$$G(s) = \frac{K(s+8)}{s(s+4)(s+5)(s^2+13s+42)}$$

Determine the poles and zeros of the transfer function and plot the pole-zero configuration in s-plane.

Q.2 (a) Reduce the system in figure-2 to a single block representation. (6)

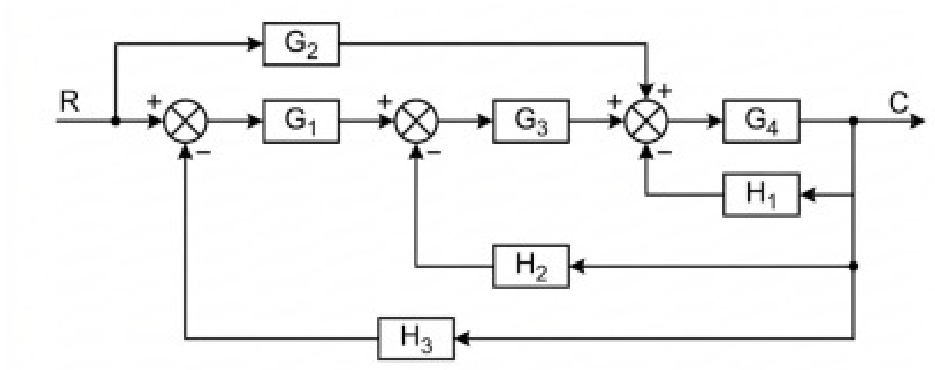

Figure-2

(b) Using Routh -Hurwitz criterion determine the relation between K and T so that unity feedback control system whose open-loop transfer function given below is stable. (6)

$$G(s) = \frac{K}{s[s(s+10)+T]}$$

(c) The block diagram representation of a control system is given in figure-3; (6)

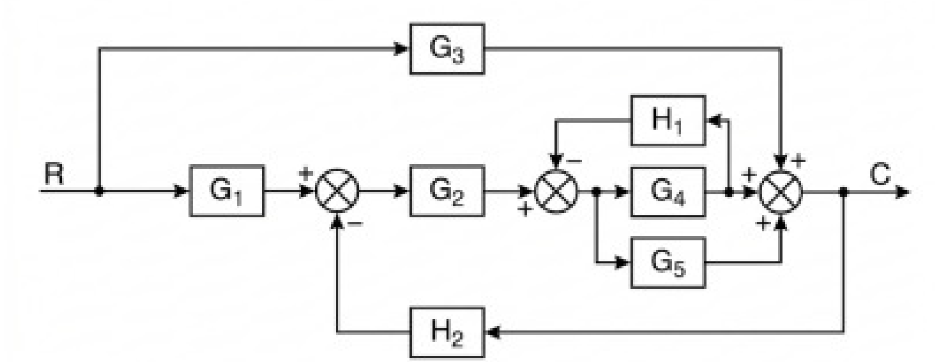

Figure-3

Draw the signal flow graph to determine the overall transfer function.

Q.3 (a) Derive and plot the expressions for the output response c(t) for a first order control system when subjected to the following inputs; (6)

i)Unit step function

ii)Unit ramp function

(b) Define the peak time (t_p) , rise time (t_r) , maximum overshoot (M_p) and settling time (t_s) along with their respective expressions. Also, mark these parameters in the output response of a second order control system when subjected to unit step input. (4)

(c) The block diagram of a unity feedback control system is shown in figure-4; (8)

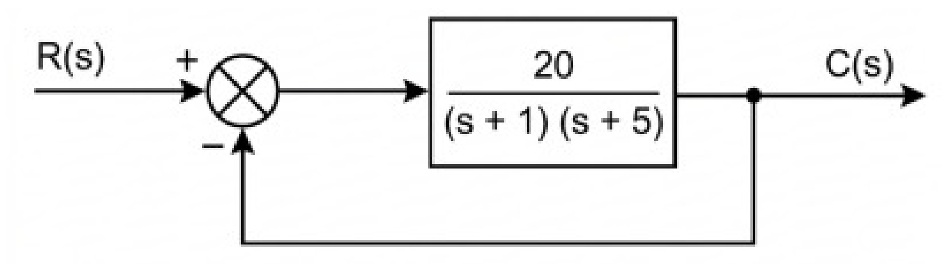

Figure-4

Determine the characteristic equation of the system, ω_n, ζ, ω_d, t_p, M_p, the time at which the first undershoot occurs, the time period of oscillations and the number of cycles completed before reaching the steady state.

Q.4 (a) Using Nyquist criterion investigate the closed loop stability of the system whose open-loop transfer function is given below for K=1.25. (8)

$$G(s)H(s) = \frac{K(s+1)}{(s+0.5)(s-2)}$$

Also, determine the limiting value of K for stability.

(b) Determine the value of gain K for the open loop transfer function given below so that i) the gain margin is 15dB and ii) the phase margin is 60°. (6)

$$G(j\omega)H(j\omega) = \frac{K}{j\omega(j0.1\omega+1)(j\omega+1)}$$

(c) Explain force-voltage analogy using RLC circuit (4)

Q.5 (a) Define state variables, state and state vector. (6)

(b) Obtain the state space equations for the transfer function given as; (6)

$$G(s) = \frac{10(s+1)}{(s+4)(s+2)^2}$$

(c) For the electrical network shown in figure-5, determine the state model. Consider i_1, i_2 and v_c as state variables. The output variables are i_1 and i_2. (6)

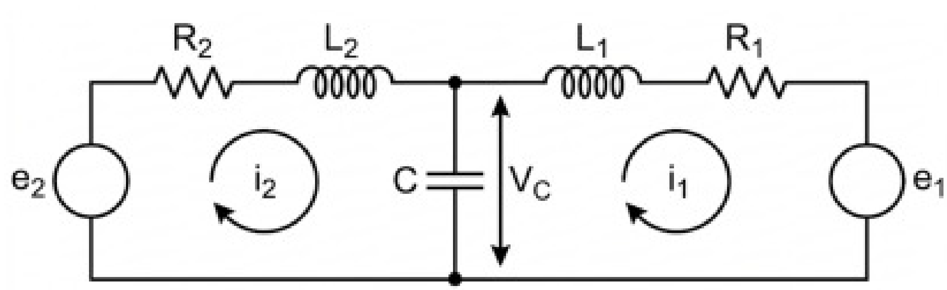

Figure-5

Q.6 (a) Differentiate between derivative control and derivative feedback control. (4)

(b) The overall transfer function of a control system is given by; (8)

$$\frac{C(s)}{R(s)} = \frac{16}{s^2 + 1.6s + 16}$$

The desired damping ratio is 0.8. Determine the derivative rate feedback constant K_t and compare the rise time (t_r),peak time (t_p),maximum overshoot (M_p) and steady state error for unit ramp input without and with derivative feedback control.

(c) Sketch the polar plot of $G(s) = \frac{10}{s(1+s)}$ (6)

Q.7 (a) Draw the electrical equivalent circuit of lag compensation and obtain its transfer function. Draw the pole-zero plot for the response also. (6)

(b) For the system represented by the given equations, find the transfer function x_5/x_1 with the help of signal flow graph technique. (6)

$$x_2 = a_{12}x_1 + a_{32}x_3 + a_{42}x_4 + a_{52}x_5$$
$$x_3 = a_{23}x_2$$
$$x_4 = a_{34}x_3 + a_{44}x_4$$
$$x_5 = a_{35}x_3 + a_{45}x_4$$

Where x_1 is input variable and x_5 is output variable.

(c) The forward path transfer function of a unity feedback control system is given by; (6)

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

Obtain an expression for unit step response of the system.