Duration: 3 Hours Max. Marks 80

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four** 20

a. Write difference between open-loop and closed-loop systems.

b. Define gain margin and phase margin.

c. For a feedback control system with forward path transfer function $G(s)$ and feedback transfer function $H(s)$, define 'Order' and 'Type' of the system.

d. Determine steady state error in unit step response for the system $\frac{Y(s)}{R(s)} = \frac{3}{(s^2+1.5s+2)}$.

e. Write difference between open-loop and closed-loop systems.

f. Define 'time-constant' for the first order system. How much time the first order system response will take to reach at 99% final value?

Q.2 A. For the following system, compute risetime (t_r), peak time (t_p), peak overshoot ($\%M_p$) and settling time (t_s) for 2% tolerable error in response. 10

$$G(s) = \frac{1}{s^2 + 1.414s + 1}$$

B. Define Transfer function. Obtain the transfer function for the system in **Fig.1** using block diagram reduction techniques. 10

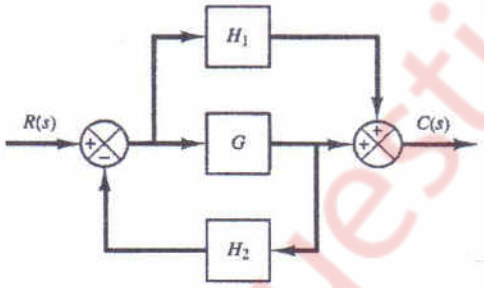

Fig.1

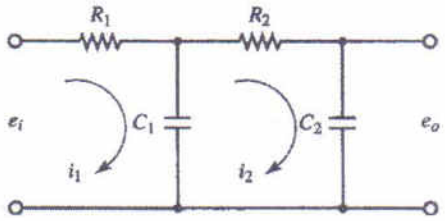

Fig.2

Q.3 A. Obtain the mathematical model of the system in **Fig.2**. What will be the transfer function of this system if $R_1 = R_2 = 1k\Omega$ and $C_1 = C_2 = 0.01\mu F$? 10

B. Determine the stability of the system having a characteristic equation 10

$$P(s) = s^5 + 2.1s^4 + 1.51s^3 + 0.471s^2 + 0.064s + 0.0030 = 0$$

using Routh's criterion.

Turn Over

Q.4 A. Determine the position, velocity and acceleration error constants for unity feedback systems with open loop transfer functions **10**

$$\text{(i) } G(s) = \frac{k}{(T_1 s + 1)(0.5T_1 s + 1)} \qquad \text{(ii) } G(s) = \frac{1}{s(s+2)}$$

Where T_1 is a positive constant.

B. Construct the root locus for the system **10**

$$G(s) = \frac{K}{s^3 + 11.5s^2 + 15.5s + 5}$$

with feedback $H(s) = 1$.

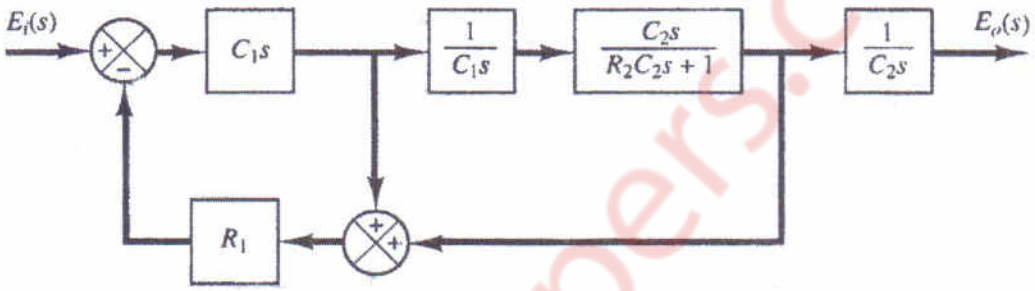

Fig.3

Q.5 A. Construct the signal flow graph and obtain $E_o(s)/E_i(s)$ for the system in **Fig.3** using Mason's gain formula. **10**

B. If the poles of the system are $s = -1 \pm j$. Compute risetime (t_r), peak time (t_p), peak overshoot $(\%M_p)$ and settling time (t_s) for 2% tolerable error in response. **10**

Q.6 A. Draw Nyquist plot for the system, **10**

$$G(s) = \frac{1}{s(T_1 s + 1)(T_2 s + 1)}$$

What frequency does the response will cross the real axis and what will be the magnitude at that frequency?

B. Draw Bode plot for the system, **10**

$$G(s) = \frac{1}{(s+1)(s+100)}$$

and obtain gain and phase margins from plot.