3 Hours/100 Marks   Seat No. ☐☐☐☐☐☐☐☐

Instructions :   *(1)* ***All*** *questions are* ***compulsory***.

                (2) Illustrate your answers with ***neat*** *sketches* ***wherever*** *necessary.*

                (3) Figures to the ***right*** *indicate* ***full*** *marks.*

MARKS

1. A) Attempt **any three** :   **12**

     a) Distinguish open loop and closed loop system (any four points).   **4**

     b) Draw graphical representation of following test signal and give their Laplace representation.

        i) Step input

       ii) Impulse input

      iii) Ramp input

      iv) Parabolic input   **4**

     c) Define the term stability and relative stability.   **4**

     d) Explain ON-OFF controller. Give example.   **4**

   B) Attempt **any one** :   **6**

     a) Define transfer function. Derive the equation of transfer function for closed loop system.

     b) For the unity feedback control system $G(S) = \dfrac{10}{S(S+1)(S+5)}$. Sketch the Bode plot.

2. Attempt **any two** : **16**

  a) Consider fifth order system with characteristics equation given by

   $S^5 + S^4 + 2S^3 + 2S^2 + 3S + 5 = 0$.

   Determine stability of system using Routh's criterion.

  b) Define servo system. Draw block diagram of it. Compare AC servomotor with DC servomotor (any four points).
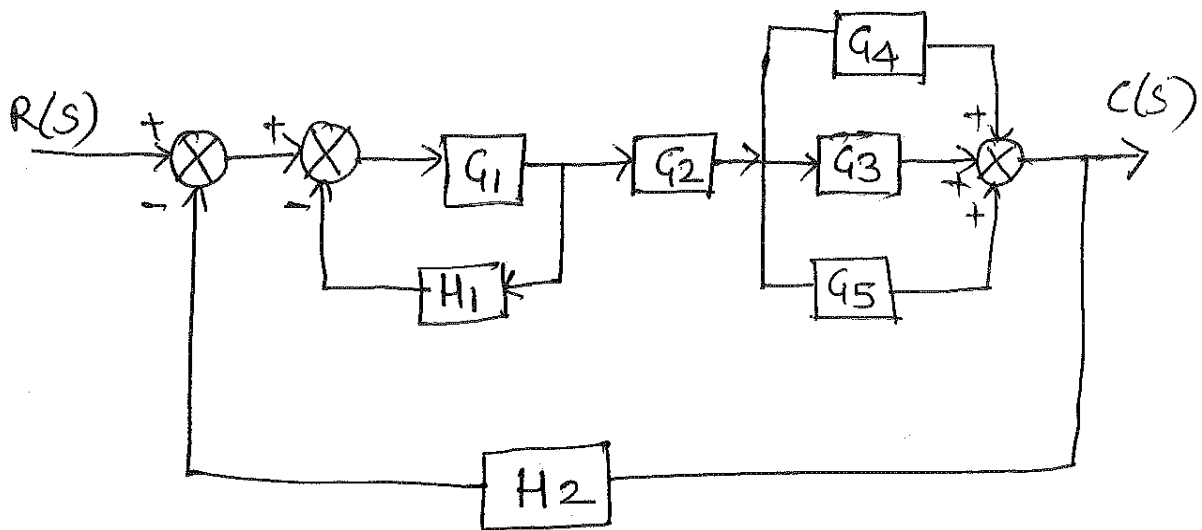
  c) Find transfer function of given block diagram.

Fig. 1

3. Attempt **any four** : **16**

  a) Find the transfer function of network given in figure.
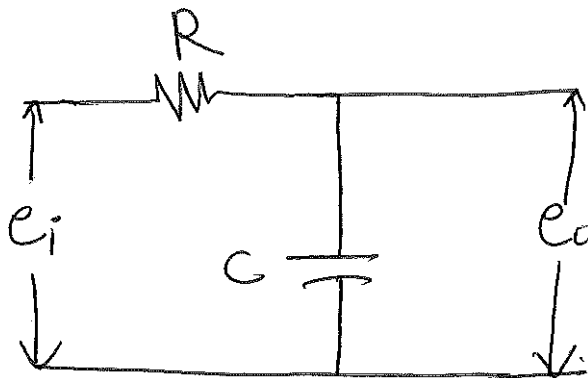

Fig. 2

b) For give transfer function.

$$T.F = \frac{40\ (S+2)}{S(S+1)\ (S+4)}, \text{ find :}$$

  i) Poles

  ii) Zeros

  iii) Characteristic equation

c) State Routh's stability criterion. How will you determine whether system is stable or unstable.

d) Explain synchro as error detector with diagram.

e) Draw the neat diagram of electronics PID controller using OP-Amp. List its two advantages.

4. A) Attempt **any three** :   **12**

  a) Draw block diagram of process control system and explain each block.

  b) List any two advantages and two disadvantages of frequency response analysis.

  c) Transfer function of second order system is given by $\dfrac{C(S)}{R(S)} = \dfrac{25}{S^2 + 6S + 25}$

    Find Tr, Tp, Ts and % Mp for unit step input.

  d) Explain construction of variable reluctance stepper motor with diagram.

B) Attempt **any one** :   **6**

  a) Identify which servo component can be used as error detector in AC servo system. Draw and explain it.

  b) A unity feedback system has $G(S) = \dfrac{10\ (S+1)}{S^2\ (S+2)\ (S+10)}$ find error coefficient Kp, Kv, Ka.

5. Attempt **any four** :   **16**

   a) Explain how AC servomotor is different from two phase induction motor.

   b) Illustrate PI control action with output equation and nature of output response.

   c) For unity feedback system $G(S) = \dfrac{K}{S\,(1+0.4s)\,(1+0.25s)}$, find range of values of 'K'. Calculate marginal value of 'K'.

   d) A second order system is given by $\dfrac{C(S)}{R(S)} = \dfrac{25}{S^2 + 6S + 25}$, find

      i) Damping ratio

      ii) Natural frequency

      iii) Peak time

      iv) Settling time

   e) Define transient response and steady state response.

   f) Define gain margin and phase margin.

6. Attempt **any four** :   **16**

   a) Draw the transient response of second order system for different value of ζ (zeta).

   b) What is ON-OFF controller ? Explain the neutral zone in ON-OFF controller.

   c) Derive the unit step response of first order system.

   d) List any four applications of PID controller.

   e) Determine the stability of a system having characteristics equation as $S^4 + 4S^3 + S^2 + 8S + 1 = 0$.

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