Answer all questions.

1. Describe about a closed loop control system with an example.

2. Define transfer function of a system.

3. What are the fundamental components of mechanical system and determine a transfer function of mechanical transitional system?

4. Derive the transfer function of an ac tachometer.

5. What is the difference between type and order of a system?

6. Mark the different time domain specifications of a second order under damped system.

7. For a unity feedback system, the open loop transfer function is

   \[ G(s) = \frac{(s + 1)}{s^2(s + 1)(s + 3)} \]

   What is the steady state error if the input, \( r(t) = (2 + 3t + 4t^2) \) \( u(t) \) ?

8. Explain the significance of Gain Margin and Phase Margin.

9. Draw the polar plot of the first order system \( G(s) = \frac{1}{(sT + 1)} \).

10. What are the advantages and disadvantages of frequency domain analysis? (10x4=40 Marks)
PART - B

Answer any one question from each Module.

Module - I

11. a) Derive the transfer function of armature controlled dc motor.
    b) Determine the transfer function of the given mechanical system.

![Signal flow graph]

   c) A system is described by the below equations, draw the signal flow graph and find the gain by Mason's gain formula.

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

12. a) Find C/R of the given block diagram by using block reduction technique.

![Block diagram]

   b) Briefly explain the working of permanent magnet type stepper motor.

Module - II

13. a) Explain the different test signals used in time domain analysis.
    b) Derive the generalized error coefficients and calculate the generalized error series of the closed loop system with \( G(S) = \frac{1}{(s+5)} \) and \( H(s) = 5 \).
14. a) Derive the expression for rise time of an under damped second order system with unit step input.
   
b) A unity-feedback control system has an open loop transfer function
   \[ G(s) = \frac{k(s + 1)}{(s - 1)(s + 2)(s + 4)} \]. Sketch the root locus of the system. Find the value
   of \( k \) so that the system is stable.

Module – III

15. a) The open loop transfer function of a unity feedback system is given by
   \[ G(s) = \frac{1000}{(s - 22.5)(s^2 + 2.45s + 44.4)} \]. Determine the resonance peak and
   resonant frequency of the system by drawing the frequency response curve.
   
b) Briefly explain the Nyquist stability criterion.

16. a) Explain the characteristics of lead compensator. Briefly discuss the criteria
   for selecting the type of compensator for a system.
   
b) The open loop transfer function of the uncompensated system is
   \[ G(s) = \frac{k}{s(s - 1)(s + 4)} \]. Design a suitable compensator for the system so that
   the damping ratio 0.5, settling time 10 sec. and velocity error constant
   is \( \geq 5 \text{ sec}^{-1} \).