

**K 1104**

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2004.

Fifth Semester

Electronics and Communication Engineering

EC 334 — CONTROL SYSTEMS

Time : Three hours

Maximum : 100 marks

Ordinary graph sheet, semilog graph sheet, polar graph sheet will be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Resonant Peak and Resonant frequency.
2. What is the relationship between resonant peak and damping factor?
3. Define rise time and write the expression for rise time with respect to second order under damped system.
4. What is expression for the unit step response of the standard second order under damped system?
5. The Nyquist plot of a certain feed back system crosses the negative real axis at (-0.1, 0) point, the gain margin of the system. What is the gain margin of the system?
6. The total response of the system is given by  $c(t) = \frac{1}{2}(2 - e^{-3t})$ . What are expressions for the steady state and transient responses?
7. What is the need for compensation?
8. Draw the bode plot of a lag compensator.
9. What are M and N circles?
10. What is the Force-Voltage analogy of mechanical spring?

PART B — (5 × 16 = 80 marks)

11. For a unity feed back system with open loop transfer function  $G(s) = \frac{k(s + 0.5)}{s^2(s + 4.5)}$ . Mark the following on the graph sheet and hence plot the root locus.
  - (i) Plot open loop poles and zeros
  - (ii) Break away points
  - (iii) Centroid
  - (iv) Asymptotes.

12. (a) (i) Write the simultaneous differential equations for the translational mechanical system shown in Fig. 12 (a) (i) and hence find  $X_1(s)$ .

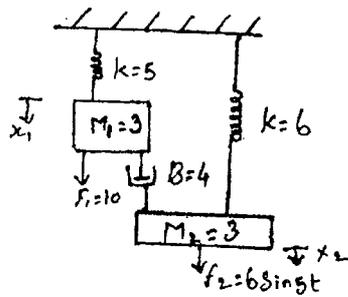


Fig. 12 (a) (i)

- (ii) State and explain the Mason's Gain formula.

Or

- (b) (i) The solenoid shown in Fig. 12 (b) (i) produces a magnetic force proportional to the current in the coil  $f = k_2 i$ . The coil has resistance ( $R$ ) and inductance ( $L$ ). Write the differential equation.

Determine the transfer function  $\frac{X_2(S)}{E(S)}$ .

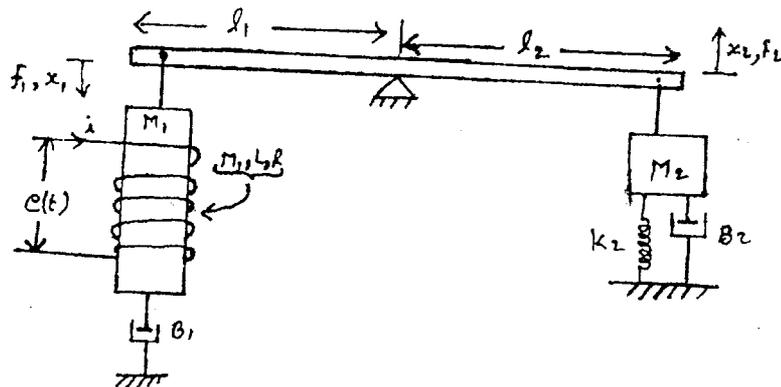


Fig. 12 (b) (i)

- (ii) Find the transfer function  $\frac{C(S)}{R(S)}$  of the block diagram shown in Fig. 12 (b) (ii).

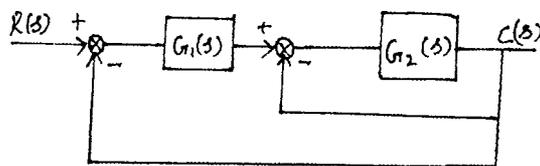


Fig. 12 (b) (ii)

3. (a) (i) The parameters of a mechanical system as shown in Fig. 13 (a) (i) are  $M = 100 \text{ kg}$ ,  $f = 1000 \text{ N/m/sec.}$  and  $k = 10000 \text{ N/m.}$  A step force of 100 Newton is applied to the mass at  $t = 0$ . The initial conditions are  $y(0) = \frac{dy(0)}{dt} = 0$ . Find

- (1) Damping factor
- (2) Undamped natural frequency
- (3) Damped natural frequency
- (4) Step response as function of time.

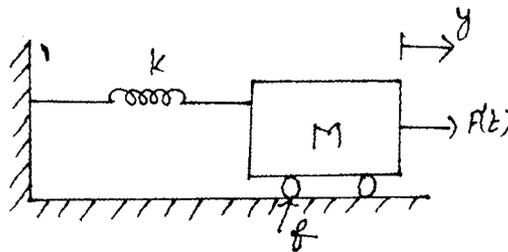


Fig. 13 (a) (i)

- (ii) Derive the expression for peak time from the expression for step response of second order under damped system.

Or

- (b) (i) For a Unity feedback second order system, the open loop transfer function  $G(s) = \frac{\omega_n^2}{s(s + 2\zeta\omega_n)}$ . Calculate the generalized error coefficients and find error series.

- (ii) With the help of a neat diagram, explain the working of a stepper motor.

14. (a) Check the stability of the system whose open loop transfer function is

$$G(s) = \frac{10}{s^2(1 + 0.2s)(1 + 0.5s)} \text{ by Nyquist criterion.} \quad (16)$$

Or

- (b) For the Bode plot shown in Fig. 14 (b) find the transfer function.

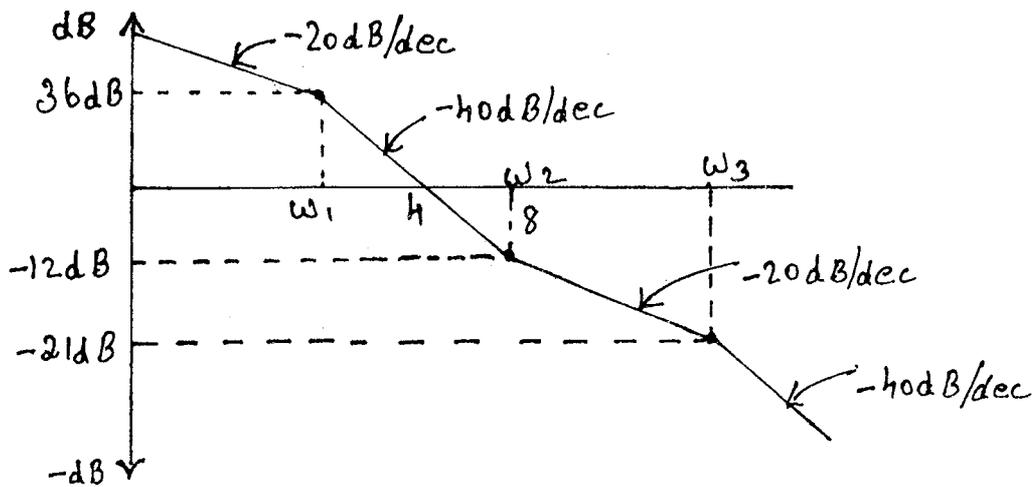


Fig. 14 (b)

15. (a) Consider the unity feedback system whose open loop transfer function is  $G(s) = \frac{4}{s(s+2)}$ . Design a lead compensator for the system so that the static velocity error constant  $K_v$  is  $20 \text{ sec}^{-1}$ , the phase margin is at least  $50^\circ$ , and the gain margin is at least 10 dB.

Or

- (b) Consider the unity feedback system whose open loop transfer function is  $G(s) = \frac{1}{s(s+1)(0.5s+1)}$ . Design a lag compensator for the system so that the static velocity error constant  $K_v$  is  $5 \text{ sec}^{-1}$ , the phase margin is at least  $40^\circ$ , and the gain margin is at least 10 dB.