Question Paper Code : R 3679

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Fourth Semester

Electrical and Electronics Engineering

EE 235 — CONTROL SYSTEMS .

(Common to Mechatronics Engineering)

(Regulation 2001)

Time : Three hours

Maximum : 100 marks

(Semilog, Nichol's, XY graph sheets should be provided)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define state and state variable of a system.

2. What are the basic components of an automatic control system?

3. List out the time domain specifications.

4. What is the effect of PI controller on the system performance?

5. Define corner frequency.

6. What are M and N circles?

7. What is Routh's stability criterion?

8. What is Nyquist's stability criterion?

9. Write down the general form of the transfer function of the lag-lead compensator.

10. List out the frequency domain specifications in compensator design.

11. (a) (i) Obtain the transfer function of the mechanical system shown in Fig. 1 below (10)
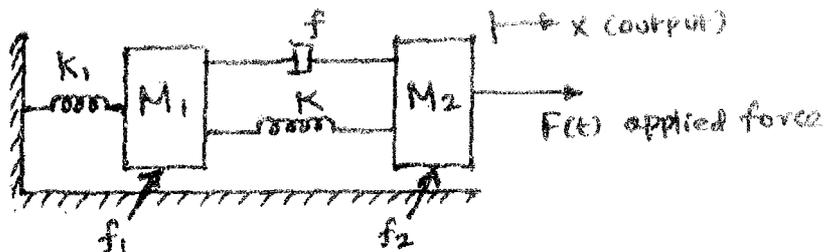

Fig. 1

(ii) List out the potentiometer specifications. Also draw the potentiometer characteristics. (6)

Or

(b) Draw a signal flow graph and evaluate the closed loop transfer function of a system whose block diagram is given below in Fig. 2. (16)
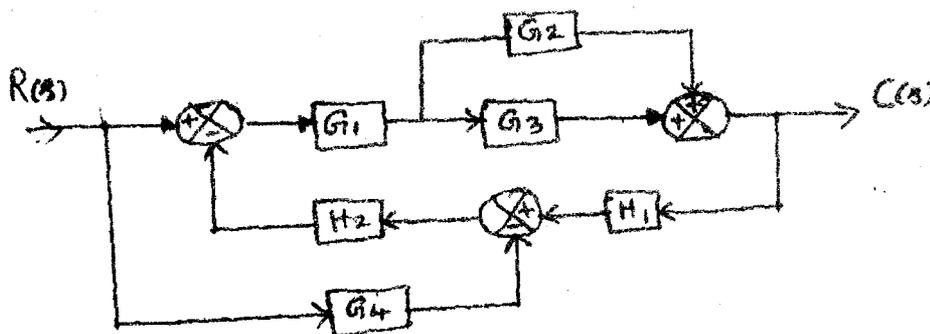

Fig. 2

12. (a) A unity feedback (negative) system has open loop transfer function

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

(i) Calculate the value of gain K so that the closed loop system has a steady state unit ramp error of 0.1. What are the corresponding damping factor and percentage peak overshoot to unit step input. (8)

(ii) The system is now modified to include a forward path zero at S = –6. What is the new value of K for the same steady state error as in part (i). Also calculate the damping factor and find the percentage peak overshoot corresponding to this damping factor. (8)

Or

(b) A unity feedback control system has an open loop transfer fun $G(s) = \dfrac{K}{s(s^2 + 6s + 10)}$. Sketch the root locus.

13. (a) Sketch the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies $G(s) = \dfrac{10}{s(1 + 0.4s)(1 + 0.1s)}$ (16)

Or

(b) The open loop transfer function of a unity feedback system is given by $G(s) = \dfrac{1}{s(1 + s)(1 + 2s)}$. Sketch the Polar plot and determine the gain margin and phase margin. (16)

14. (a) The characteristic equation of a system is given as $s^4 + 5s^3 + 5s^2 + 4s + K = 0$. By applying Routh's criterion, find the value of K which will cause sustained oscillations and corresponding oscillation frequency. (16)

Or

(b) Draw the Nyquist plot for the system whose open loop transfer function is $G(s)H(s) = \dfrac{K}{s(s^2 + s + 4)}$. Determine the range of K for which the closed loop system is stable. (16)

15. (a) (i) Write the steps for lag compensator design. (8)

(ii) Derive the transfer function of electric lag lead network and show the S-plane representation for the same. (8)

Or

(b) Design a lead compensator for a type 2 system with an open loop transfer function $G(jw) = \dfrac{K}{(j\omega)^2(0.2j\omega + 1)}$ to meet the following specifications

(i) acceleration error constant $K_a = 10$

(ii) phase margin = 35° (16)