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Question Paper Code : 23489

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fifth Semester

Electronics and Instrumentation Engineering

IC 1251/EE 1253 — CONTROL SYSTEMS

(Common to Fourth Semester, Electrical and Electronics Engineering and Instrumentation and Control Engineering)

(Regulation 2004/2007)

(Common to B.E. (Part-Time) Third Semester, Electrical and Electronics Engineering, Regulation 2005)

Time : Three hours   Maximum : 100 marks

(Semi log and Polar graph sheets are to be provided)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the electrical analog of thermometer.

2. From the torque-speed characteristics of a two-phase AC servomotor, write the dynamic equation relating the motor torque and the speed.

3. Distinguish between 'Type' and 'Order' of a system.

4. Draw the block diagram of a second order control system incorporating PID control.

5. Mention the advantages of Bode plots.

6. Write the relationship between normalized resonant frequency and damping ratio.

7. What are the measures of relative stability of a system?

8. Find the decibel value of gain margin of a unity feedback system whose polar plot cuts the −180° line at 0.25.

9. How is the bandwidth affected by the introduction of lead networks in a system?

10. Draw the s-plane representation of lag-lead compensator.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain open loop and closed loop control systems with examples. (8)

(ii) Derive the transfer function of an armature controlled DC servomotor. (8)

Or

(b) (i) Explain how Synchros can be used for data transmission. (6)

(ii) Obtain signal flow graph representation for a system whose block diagram is shown in Fig. Q. 11. (b) (ii) and determine the control ratio $\frac{C(s)}{R(s)}$ using Mason's gain formula. (10)

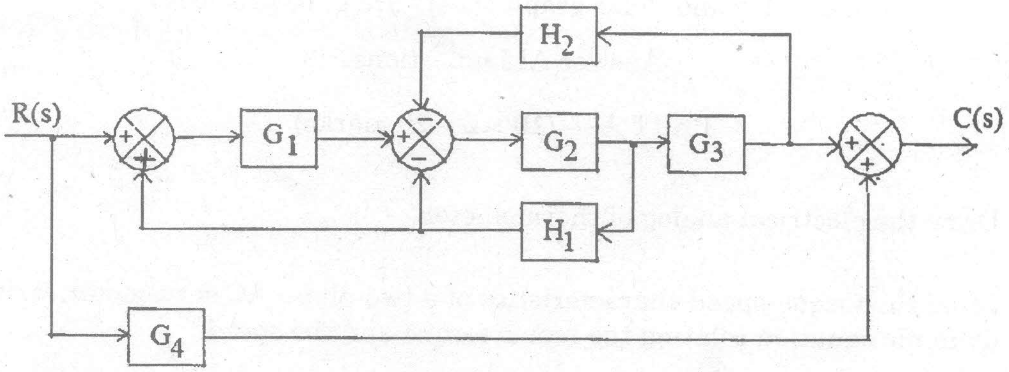

Fig. Q. 11. (b) (ii)

12. (a) (i) Derive the unit step and unit impulse responses of a first order control system. (6 + 4)

(ii) Explain the effect of derivative control action on the time response of a second order control system. (6)

Or

(b) (i) A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{K}{s(s+10)}$. Determine the gain K so that the system will have a damping ratio of 0.5. For this value of K, determine settling time, peak overshoot and peak time for a unit step input. (8)

(ii) Find the dynamic error coefficients of the unity feedback system whose forward path transfer function is $G(s) = \frac{200}{s(s+5)}$. Find the steady state error of the system for the input $r(t) = 1 + 2t + 4t^2$. (8)

13. (a) Draw the Bode plot for the transfer function given below : (16)

$$G(s) = \frac{16(1+0.5s)}{s^2(1+0.125s)(1+0.1s)}.$$

From the graph, determine

(i) Phase crossover frequency,

(ii) Gain crossover frequency,

(iii) Gain margin,

(iv) Phase margin,

(v) Stability of the system.

Or

(b) (i) What are 'Constant M circles and Constant N circles'? Derive the expressions for their radii and centre. (8)

(ii) Describe Nichols chart. Explain its importance in finding the frequency response of systems. (8)

14. (a) (i) Determine the value(s) of the parameter K such that the unity feedback system having the open loop transfer function

$$G(s) = \frac{4}{s^4 + Ks^3 + (K+4)s^2 + (K+3)s}$$

will have sustained oscillations. (8)

(ii) State and explain Nyquist stability criterion. How can the relative stability of a system be studied from the Nyquist criterion? (8)

Or

(b) Sketch the root locus of the unity feedback system having $G(s) = \frac{K}{s(s+2)(s+4)}$ when K is varied from 0 to ∞. Hence obtain the value of K for $\xi = 0.5$. (16)

15. (a) Design a cascade compensation for a system whose open loop transfer function is given by $G(s) = \frac{K}{s(1 + 0.1s)(1 + 0.001s)}$.

It will fulfill the following specifications :

(i) Phase Margin $\geq 45°$, and

(ii) Velocity constant $K_V = 1000 \text{ sec}^{-1}$. (16)

Or

(b) (i) What is the need for compensation in control systems? Describe the different types of compensation schemes. (8)

(ii) Derive the transfer function model of a lag compensator and explain its fundamental frequency-domain features. (8)
