Reg. No. :

**Question Paper Code : 90467**

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Third/Fourth/Fifth Semester

Electronics and Communication Engineering

EC 8391 — CONTROL SYSTEMS ENGINEERING

(Common to Electronics and Telecommunication Engineering/Mechatronics Engineering/Medical Electronics)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

(Polar Chart, Semi-log graph, ordinary graph to be provided).



Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List any two characteristics of negative feedback system.

2. Determine the transfer function $\frac{C(S)}{R_2(S)}$ of the block diagram shown in Fig. Q.2

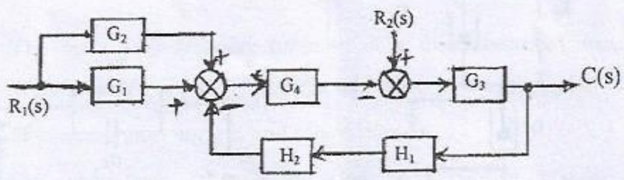


Fig. Q. 2

3. A single loop negative feedback system has an open loop transfer function $G(s)\,H(s)=\frac{K}{s^4+7s^3+22s^2+30s}$. Determine the type and order of the open loop system.

4. Assume $r(t)=0.5$ t and it is desired that steady state error is $e_{ss} \leq 0.1$ for the system $G(s)=\frac{K}{s(s+50)}$ with unity feedback. Determine the values of K for the error to be within specified limit.

5. An underdamped second order system has a peak response $M_r=2.5$. Determine damping ratio of the system.

6. What is the need of a compensator?

7. State Nyquist stability criterion.

8. Consider a system with the characteristic equation $S^5+3s^4+6s^3+6s^2+5s+3=0$. Find the number of poles does the system have on the imaginary axis.

9. Determine the transfer-function for the state model equation,

$$\dot{x}=\begin{bmatrix}0 & 1 & 0\\ -1 & -1 & 0\\ 1 & 0 & 0\end{bmatrix}x+\begin{bmatrix}0\\ 1\\ 0\end{bmatrix}u \quad y=\begin{bmatrix}0 & 0 & 1\end{bmatrix}x.$$

10. What is the need for controllability test?



PART B — (5 × 13 = 65 marks)

11. (a) Obtain the transfer function of the mechanical system shown in Fig. Q. 11 a (i). Also obtain the transfer function of the electrical system shown in Fig Q. 11 a(ii). Show that the two systems are analogous systems.

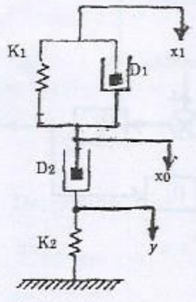

Fig. Q. 11 (a)-i

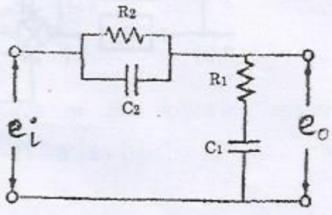

Fig. Q. 11a (ii)

Or

(b) For the signal flow graph shown Fig. Q. 11 (b) compute the transfer function using Mason's gain formulae and verify the same using block diagram reduction technique.

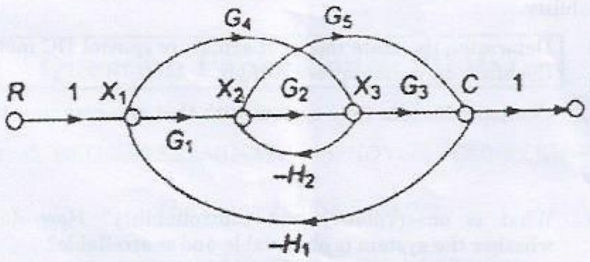


Fig. Q. 11 (b)

12. (a) (i) Determine unit step, ramp and impulse responses for first order system (9)

(ii) Explain the effect of adding poles and zeros to a system on the time domain response. (4)

Or

(b) (i) Realize PI, PD and PID controllers and determine their transfer function. (9)



(ii) Discuss the relationship between static error constants, steady state error and type of the system for any three standard test signals. (4)

13. (a) The open loop transfer function of a unity feedback control system is given by $G(s)=\dfrac{5}{s(1+0.5s)(1+0.05\,s)}$. Sketch the Bode plot for the system. Determine gain margin and phase margin.

Or

(b) The open loop transfer function of a unit feedback control is given by $G(s)=\dfrac{5}{s(1+0.5s)(1+0.05s)}$. Sketch the polar plot for the system. Determine gain margin and phase margin.

14. (a) The open loop transfer function of a control system is given as $G(s)\,H(s)=\dfrac{K}{(s^2+4s+5)s}$. Draw the root locus and comment on the stability of the system.

Or

(b) Draw the Nyquist plot for the open loop transfer function $G(s)H(s)=\frac{1}{s(1+s)(1+2s)}$. Determine gain margin and comment on its stability.

15. (a) (i) Determine the state model of armature control DC motor and draw the block diagram representation. (9)

(ii) Compare discrete time system with that of continuous time system. (4)

Or

(b) (i) What is observability and controllability? How do you verify whether the system is observable and controllable? (9)

(ii) What is meant by digital control system? Explain the block schematic with a suitable example. (4)

PART C — (1 × 15 = 15 marks)

16. (a) Design a lag compensator for a unity feedback system with open loop transfer function, $G(s)=\frac{5}{s(s+2)}$ such that the compensated system has static velocity error constant $K_v=20\sec^{-1}$, phase margin is 55° and gain margin is 12 dB.

Or

(b) (i) For the circuit shown in Fig. Q. 16 b (i) choose state variables $x_1, x_2, x_3$ to be $i_{L1}(t), V_{c2}(t), i_{L3}(t)$. Determine the state equation

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=A\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+B[e(t)].$$ (10)

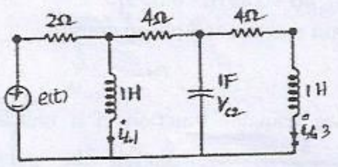


Fig. Q. 16 b (i)

(ii) Determine the poles and zeros of the following systems $\dot{x}=\begin{bmatrix}0 & 1\\ -20 & -9\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}r$ and $y=[-17\ -5\ ]x+[1]r$. (5)

---