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Question Paper Code : 40807

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Fourth Semester

Instrumentation and Control Engineering

IC 8451 — CONTROL SYSTEMS

(Common to Electrical and Electronics Engineering/Electronics and Instrumentation Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Semi Log Sheet to be Provided

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the any four advantages of closed loop system.
2. Tabulate the parameters of the translational and rotational mechanical systems.
3. Classify the second order system based on damping ratio.
4. For the loop transfer function $G(s)H(s) = \frac{k(s+6)}{(s+3)(s+5)}$
Calculate the Centroid of the root locus.
5. If the repeated poles of a system lie on the imaginary axis of the s-plane, identify the system stability and sketch its response.
6. What are the implications of negative and positive gain margin?
7. Infer the stability analysis when Nyquist plot crosses $-1 + j0$ point.
8. What is compensation? How the compensators are different from controllers?
9. Mention the advantages of state space analysis.
10. Sketch the general block diagram of state model.

PART B — (5 × 13 = 65 marks)

11. (a) Consider the mechanical system is shown in figure 11a. This system is simplified "one wheeled model" of an automobile suspension system with M_1 : the mass of the automobile, B: the shock absorbers, K_1 : the springs. M_2 : the mass of the wheels and K_2 : elasticity of the tyres. The system objective is to reduce vibrations $y_1(t)$ due to disturbance force $F_w(t)$. Obtain the transfer function of the system.

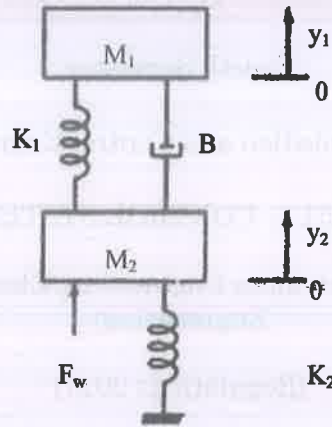


Fig. 11 a

Or

- (b) A system S represented by signal flow graph shown in figures, 11b. Determine the overall gain of the system.

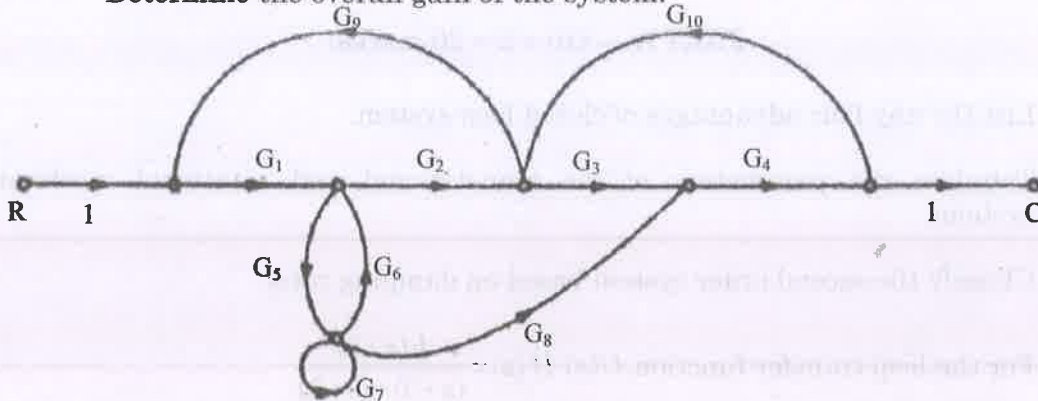


Fig. 11 b

12. (a) The open loop transfer function of a unity feedback system is $G(s) = \frac{K}{s(s+2)}$

Determine the gain k , so that the system will have a damping ratio of 0.5. Find the value of settling time, peak overshoot and time to peak overshoot for a unit step input.

Or

- (b) Illustrate the effects of PI and PID controllers in a servo system with a neat diagram.

13. (a) A servo mechanism has an open loop transfer function of
- $$G(s) = \frac{20(1+0.1s)}{s(1+0.5s)(1+0.3s)}$$

Sketch the bode plot and determine Gain margin and Phase margin.

Or

- (b) Why is correction factor added to the phase margin when it is expected to meet the transient response? Describe the correlation between time response and frequency response constants of the system.
14. (a) The open loop transfer function of a unity feedback system is given by

$$G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}$$

By applying Routh Hurwitz criterion, discuss the stability of the closed loop system as a function of K. Evaluate the value of K which causes sustained oscillations in the closed loop system. What are the corresponding oscillation frequencies?

Or

- (b) How do you select the compensators for designing the control system and discuss about various types of compensators and their frequency characteristics.
15. (a) Consider the following state equations:

$$\dot{x}_1 = x_2(t)$$

$$\dot{x}_2 = x_3(t)$$

$$\dot{x}_3 = -6x_1(t) - 11x_2(t) - 6x_3(t) + 6u(t)$$

$$y = x_1(t)$$

and determine the controllable canonical form.

Or

- (b) A linear time invariant system is characterized by the state variable model,
- $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \quad Y = [1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Comment on the controllability and observability of the system.

PART C — (1 × 15 = 15 marks)

16. (a) Design a suitable lead compensator for the system given by $G(s) = \frac{5}{s(s+1)}$ to meet the following design specifications: $K_p = 10_0^{-1}$, $PM = 40^\circ$ and $GM = 10$ dB.

Or

- (b) Determine the transfer function $C(S)/R(S)$ for the system using block diagram reduction technique. (Fig. 16b)

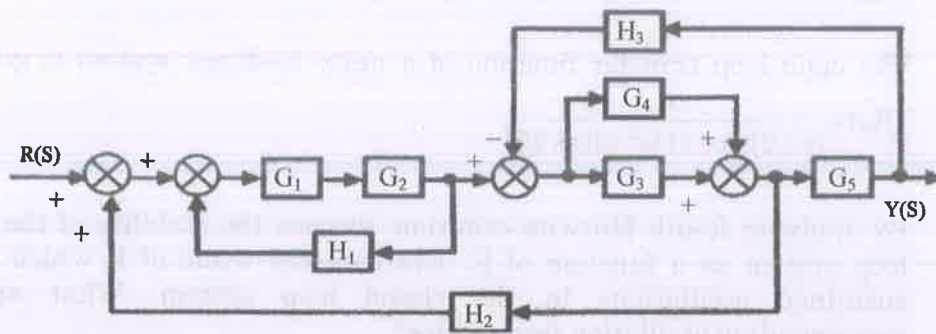


Fig. 16 b