**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI**
**(END SEMESTER EXAMINATION SP/2025)**

**CLASS: BTECH** **SEMESTER : VI**
**BRANCH: ECE** **SESSION : SP/2025**

**SUBJECT: EC353 CONTROL SYSTEMS**

**TIME: 03 Hours** **FULL MARKS: 50**

**INSTRUCTIONS:**
**1. The question paper contains 5 questions each of 10 marks and total 50 marks.**
**2. Attempt all questions.**
**3. The missing data, if any, may be assumed suitably.**
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

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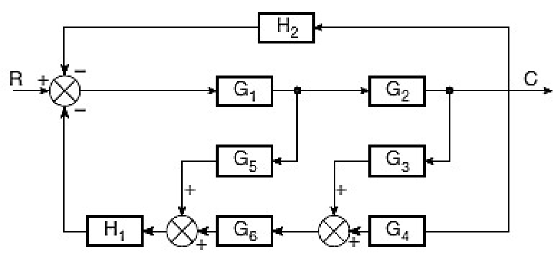
| | | Marks | CO | BL |
|---|---|---|---|---|
| Q.1(a) | Define with examples (i) closed loop systems, (ii) minimum phase and non-minimum phase systems, (iii) time invariant systems. Explain the effect of feedback on gain and stability. | [5] | 1 | 1,2 |
| Q.1(b) | An open-loop control system has a gain $G = 200$. A feedback path with gain $H = 0.02$ is added to convert it into a closed-loop system.<br>(i) Calculate the closed-loop gain<br>(ii) If the open-loop gain $G$ decreases by 15% due to external disturbances, find the new closed-loop gain and the percentage change in its value | [5] | 1,2 | 2 |
| Q.2(a) | a) Explain the working principle of a potentiometer as a position sensor. What are its limitations in high-precision applications?<br>b) Compare incremental encoders and synchros in terms of:<br>Output signal type, Suitability for angular vs. linear displacement measurement, and Noise immunity. | [5] | 1,2 | 1,2 |
| Q.2(b) | Determine the overall transfer function for the block diagram shown below | [5] | 2 | 2,3 |




| | | Marks | CO | BL |
|---|---|---|---|---|
| Q.3(a) | A unity feedback system has<br>$G(s) = \frac{K}{s\,(s+1)(0.1\,s+1)}$ and $r(t) = 10t$.<br>(i) If $K = 2\,s^{-1}$, determine $e_{ss}(t)$.<br>(ii) Find the minimum value of K for $e_{ss}(t) < 0.1$, for a unit-ramp input. | [5] | 2,4 | 3 |
| Q.3(b) | A unity feedback system has an open-loop transfer function<br>$G(s)H(s) = \frac{k}{s^2(s+2)}$<br>By sketching the root locus plot, show that the system is unstable for all values of K. | [5] | 4 | 3,4 |
| Q.4(a) | A unity feedback system is shown in the figure below. By using derivative control the damping ratio is to be made 0.8. Determine the value of $T_d$ and compare the rise time, peak time and maximum overshoot for the system<br>(i) Without derivative control<br>(ii) With derivative control.<br><br>The input to the system being unit-step. | [5] | 3,4 | 4 |

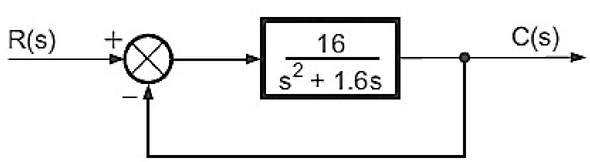


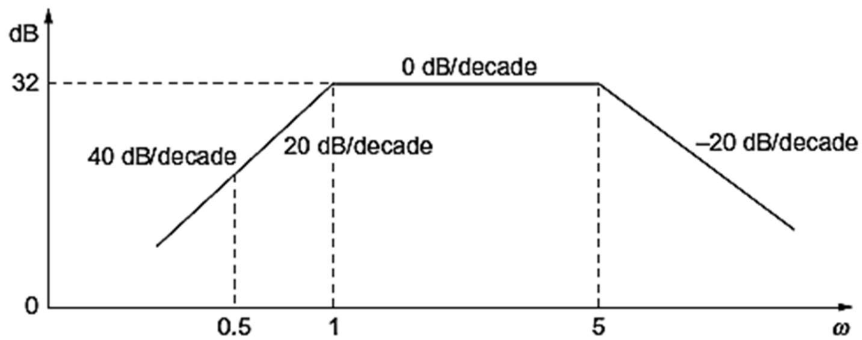

Figure: Closed-loop control system without derivative control

Q.4(b) Explain the concept of Controllability and observability. The state equations of a system are given as: $\dot{x_1} = x_1 + x_2 + u$ and [5] 3,4 4

$$\dot{x_2} = \quad -x_2$$

Check for controllability of the system.

Q.5(a) Bode magnitude asymptotic plot of a certain system is sketched with dB/decade slopes indicated therein. Determine the open-loop transfer function from the given Bode plot. [5] 5 3




Q.5(b) Sketch the Nyquist plot and comment on the stability of the closed-loop system whose open-loop transfer function is. [5] 5 2,3

$$G(s)H(s) = \frac{k(s+3)}{s(s-1)}$$

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