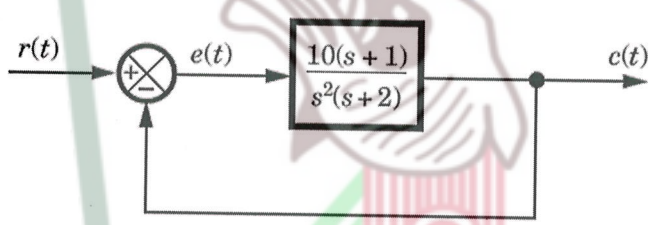## 2023

## CONTROL SYSTEM

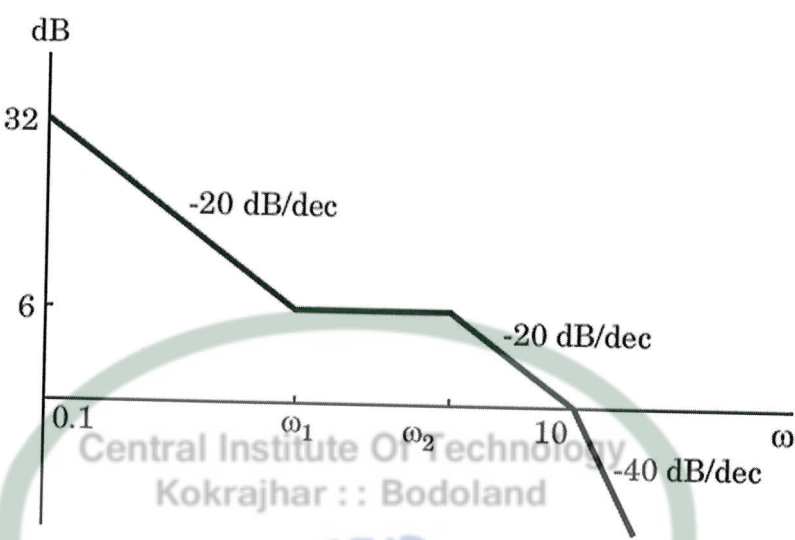*Full Marks : 100*

Time : Three hours

*The figures in the margin indicate full marks for the questions.*

*Utilize graph paper and semi-log paper as needed for the questions in the exam. Please note that these materials will be provided by the invigilator.*

*Answer any five questions.*

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|---|---|---|---|
| 1. | a) | Write a short note on Nicholas Chart. | 10 |
| | b) | With a circuit diagram explain the following in detail<br><br>a) Phase lead compensator<br><br>b) Phase lag compensator<br><br>c) Phase lag-lead compensator | 10 |
| 2. | | Find the range of values of K of a system for which the open loop transfer function is given below<br><br>$$G(s)H(s) = \frac{K(s+0.1)}{s(s-0.2)(s^2+s+0.6)}$$<br><br>is stable. | 20 |
| 3. | a) | Find the state transition matrix of the system for which the state space equation is provided below<br><br>$$\dot{\mathbf{x}} = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}\mathbf{u}$$ | 10 |
| | b) | Highlight the key different in the following methods of stability analysis of a control system<br><br>(a) Time domain stability analysis of control system<br>(b) Nyquist plot<br>(c) Nicholas chart | 10 |

| | | | |
|---|---|---|---|
| | | (d) Bode plot <br> (e) Root Locus | |
| 4. | a) | A unity feedback control system has a open loop transfer function <br><br> G(s)=K/(s(s+1)(s+3)). Obtain the following <br><br> Order and type of the system <br><br> Break away point. <br><br> Location of centroid . <br><br> Angle of asymptotes. <br><br> Using the data obtained draw the root locus. For what value of K damping ratio is 0.6 ? | 10 |
| | b) | For the system shown in the following figure if $r(t)=1+2t, t>0$. Find the steady state error. <br><br>  | 10 |
| 5. | | For a unity feedback system given below <br><br> $$G(s) = \frac{K}{s(s+1)(2s+1)(3s+1)}$$ <br><br> Draw the Nyquist plot. Also explain the important points in the plot. Choose at least five points in $s$-domain and their corresponding values in $G(s)H(s)$-plane. | 20 |

| 6. | (a) | Consider the asymptotic Bode plot of a minimum phase linear system. Find the transfer function of the system. Also comment | 15 |
|---|---|---|---|
| | |  | |
| | | on the stability of the system. | |
| | (b) | Construct the bode-plot of a system for the open loop transfer function is<br><br>$$G(s)H(s) = \frac{100}{s(1+.001s)}$$<br><br>Using the plot find out the gain and the phase margin. | 5 |

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