Name:

Enrolment No:

UPES

End Semester Examination, May 2025

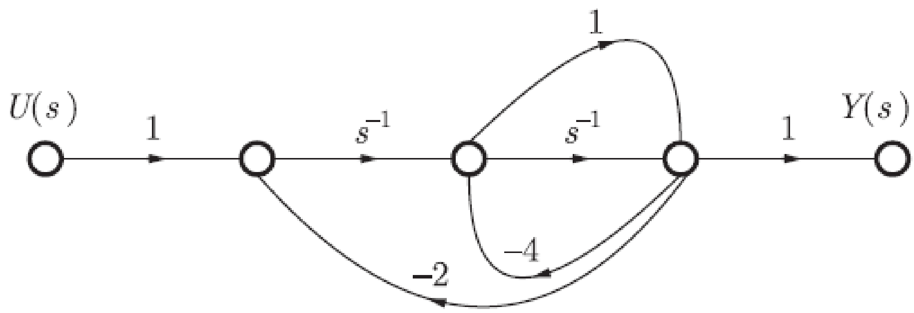
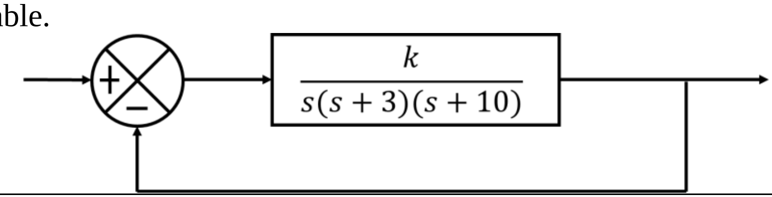
Course: Control System Engineering | **Semester: IV**

Program: B.Tech Electrical Engineering | **Time : 03 hrs.**

Course Code: ECEG2068 | **Max. Marks: 100**

Instructions: Use of Calculator is permitted. Assume any missing values.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	The signal flow graph for a system is given below. Determine the transfer function $\frac{Y(s)}{U(s)}$ for the system.  	**4**	**CO1**
Q 2	A second order real system has the following properties: (a) The damping ratio $\zeta = 0.5$ and undamped natural frequency $\omega_n = 10$ rad/s (b) The steady-state value of the output to a unit step input is 1.02. Determine the transfer function of the system.	**4**	**CO2**
Q 3	An open loop transfer function $G(s)$ of a system is $$G(s) = \frac{K}{s(s+1)(s+2)+K}$$ For a unity feedback system. Determine the breakaway point of the root loci on the real axis.	**4**	**CO3**
Q 4	Determine the range of k where $k > 0$ for which the system given below is stable.  	**4**	**CO2**

<table>
<tr><td>Q 5</td><td>If $x = Re\{G(j\omega)\}$ and $y = Im\{G(j\omega)\}$ then for $\omega \rightarrow 0^+$, determine the value of x from the Nyquist plot for $G(s) = {}^{1}/_{s(s+1)(s+2)}$.</td><td>4</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION B
(4Qx10M= 40 Marks)</td></tr>
<tr><td>Q 6</td><td>An electrical system and its signal-flow graph representations are shown in Figure (A) and (B) respectively. Find out the values of G_2 and H.

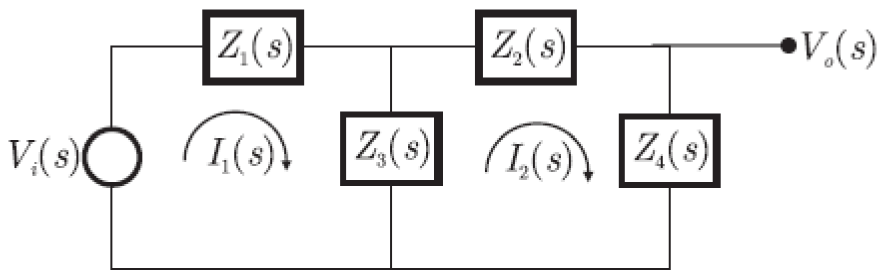


Figure (A)

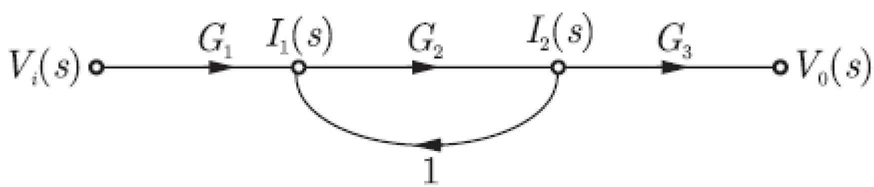


Figure (B)</td><td>10</td><td>CO1</td></tr>
<tr><td>Q 7</td><td>For a second order system with the closed-loop transfer function

$$T(s) = \frac{9}{s^2 + 4s + 9}$$

Evaluate the settling time for 2-percent band.</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 8</td><td>A system with transfer function $\frac{Y(s)}{X(s)} = \frac{s}{s+p}$ has an output $y(t) = \cos\,(2t - \frac{\pi}{3})$ for the input signal $x(t) = p cos(2t - \frac{\pi}{2})$.
Determine, the system parameter p.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 9</td><td>The Bode plot of a transfer function $G(s)$ is shown in the figure below.</td><td>10</td><td>CO4</td></tr>
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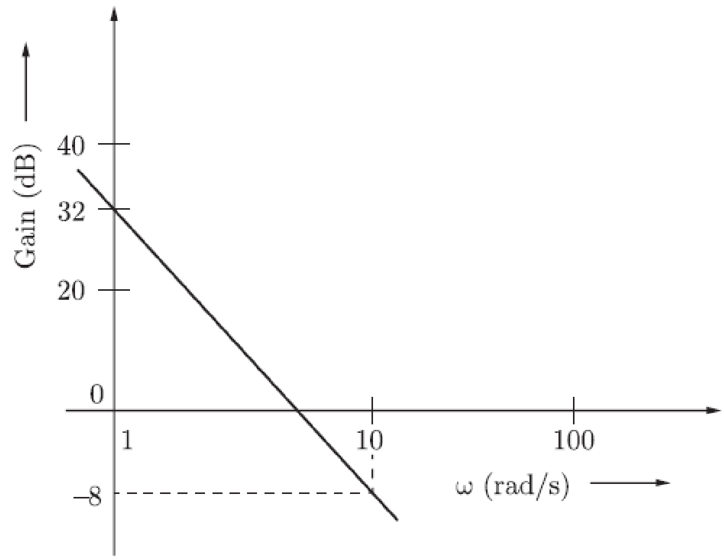

The gain ($20log|G(s)|$) is 32 dB and -8 dB at 1 rad/s and 10 rad/s, respectively. The phase is negative for all ω. Determine the transfer function $G(s)$.
OR
The open loop transfer function of a unity feedback system is given by
$$G(s) = \frac{3e^{-2s}}{s(s+2)}$$
Determine the gain and phase crossover frequencies in rad/sec.
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<td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td>
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<td>Q 10</td>
<td>(a) Find the number of right-hand, left-hand and imaginary axis poles for the following characteristic equations.
(i) $1 + G(s)H(s) = s^4 + s^3 - s - 1$
(ii) $1 + G(s)H(s) = s^3 + s^2 + s + 1$
(iii) $1 + G(s)H(s) = s^3 - s^2 + s - 1$
(b) The open loop transfer function of a unity negative feedback system is given by $\frac{k(s+1)(s+2)}{(s+3)}$. Draw the root locus as the value of k varies from zero to infinity.</td>
<td>20</td>
<td>CO3</td>
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<td>Q 11</td>
<td>(a) Consider the following transfer function:
$$G(s) = \frac{200}{s^3 + 11s^2 + 38s + 4}$$
If the frequency response, is represented by $G(j\omega)$, Develop its rectangular and polar forms for ω = 1rad/sec.
(b) Draw the Root Locus for the open loop transfer function given below.
$$G(s)H(s) = \frac{K(s+0.1)}{s^2(s+1)}$$
OR
(a) A process transfer function is described as follows:</td>
<td>20</td>
<td>CO4</td>
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</table>

	$$G(s) = \frac{10}{s^3 + 4s^2 + 6s + 8}$$ Sketch the polar plot for $G(s)$ by properly labelling the key frequencies in $G(j\omega)$ plane. (b) Draw the Root Locus for the closed loop system given below, where a is the gain of the open loop transfer function, having a range $0 < a < \infty$.