Name: Enrolment No:	UPES — University of Tomorrow

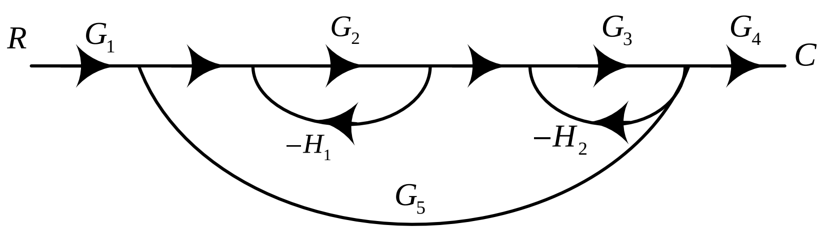
UPES

End Semester Examination, May 2024

Course: Control System Engineering — **Semester: IV**
Program: B. Tech- Electronics and Communication Engineering — **Time : 03 hrs.**
Course Code: ECEG-3048 — **Max. Marks: 100**

Instructions: Attempt all the sections.

SECTION A
(5Qx4M=20Marks)

S. No.	**Attempt all the questions.**	**Marks**	**CO**
Q 1	What is the transfer function of a linear system? How is it useful in control system analysis?	**4**	**CO1**
Q2	Obtain the mathematical model of linear mechanical system and determine the transfer function relating the linear displacement output X(s) and input applied force F(s).	**4**	**CO2**
Q3	The signal flow graph is given in Fig. (1), draw the block diagram relating the output and input for a system.  Fig. (1)	**4**	**CO3**
Q4	Explain the basic principle of operation of a stepper motor. How does it differ from DC motor?	**4**	**CO1**
Q5	Apply Routh Hurwitz criterion (RHC) to determine the stability of the system having the characteristics equation as, $s^3 + 4\times10^2 s^2 + 5\times10^4 s + 2\times10^6 = 0$	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q 6	Obtain the overall transfer function for the block diagram as shown in Fig. (2) as,	**10**	**CO1**

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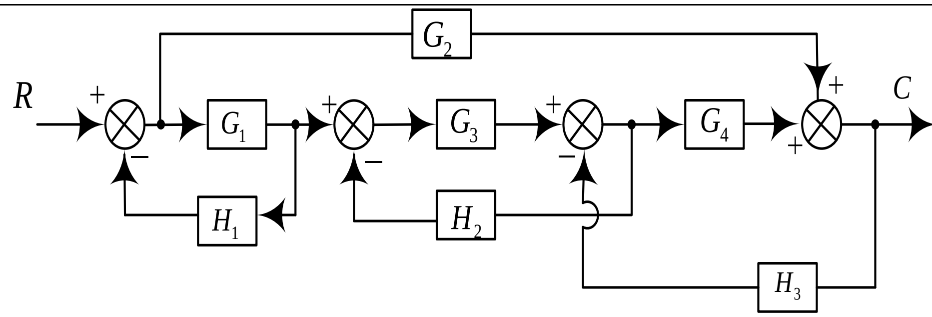
<td>

Fig. (2)</td>
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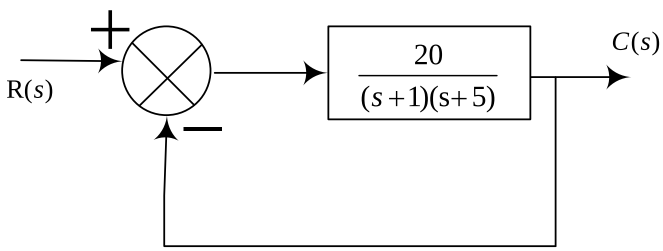
<td>Q7</td>
<td>The block diagram of a unity feedback control system is shown in Fig (3) as,


Fig. (3)
Determine the (i) Characteristics equation of the system (ii) natural frequency (iii) damping ratio (iv) damping (v) peak time (vi) rise time (vii) steady state error.</td>
<td>10</td>
<td>CO2</td>
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<td>Q8</td>
<td>The open loop transfer function of a control system is given by,
$$G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$$
Sketch the root locus and determine (i) The value of K for $\xi = 0.5$ (ii) Break away point (iii) angle of asymptotes.</td>
<td>10</td>
<td>CO3</td>
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<td>Q9</td>
<td>Using state equations as given below. Determine the transfer matrix of the system,
$$\overset{o}{X}_1 = x_1 - 2x_2 + 2u$$
$$\overset{o}{X}_2 = 4x_1 - 5x_2 + u$$
and output equation is given as, $y = x_1 + x_2$
OR
Using cascade method decompose the transfer function,
$\frac{Y(s)}{U(s)} = \frac{(s+3)}{(s+1)(s+2)}$, and design the state model to represent the sate space equations.</td>
<td>10</td>
<td>CO4</td>
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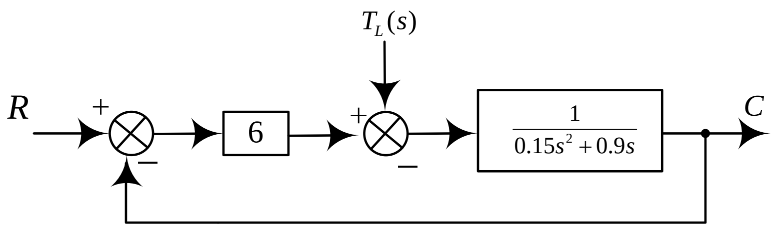
SECTION-C (2Qx20M=40 Marks)			
Q 10	**<u>Attempt both the parts</u>** **(A)** For the control system shown in Fig. (4) as,  Fig. (4) **Determine** (i) M_p for a unit step input (ii) e_{ss} for unit ramp input (iii) Calculate the steady state value of the output when the input shaft is held fixed and a sudden torque $T_L = 1\ Nm$ is applied. **(B)** In the cases of cascade decomposition, the transfer function is given in the following form $\frac{Y(s)}{U(s)} = \frac{1}{(s+2)} \cdot \frac{1}{(s+3)} \cdot \frac{1}{(s+4)}$ Design the state model (Block diagram).	**15+5**	**CO3**
Q11	Check the controllability and observability of a system having following coefficient matrix. $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, \quad B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$ and $C = \begin{bmatrix} 10 & 5 & 1 \end{bmatrix}$ **OR** The transfer function of a system is given by $\frac{Y(s)}{U(s)} = \frac{s^2+3s+2}{s^3+9s^2+26s+24}$ Determine (i) State model using the direct decomposition method (ii) Transfer matrix using state equations	**20**	**CO4**