Name:

Enrolment No:

UPES

End Semester Examination, May 2023

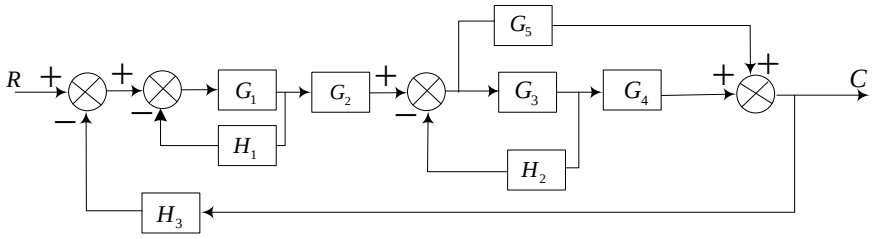
Course: Instrumentation & Control **Semester: IV**

Program: B. Tech- Mechatronics **Time : 03 hrs.**

Course Code: ECEG-2041 **Max. Marks: 100**

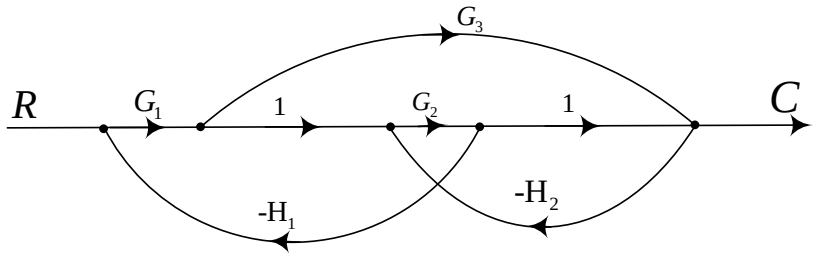
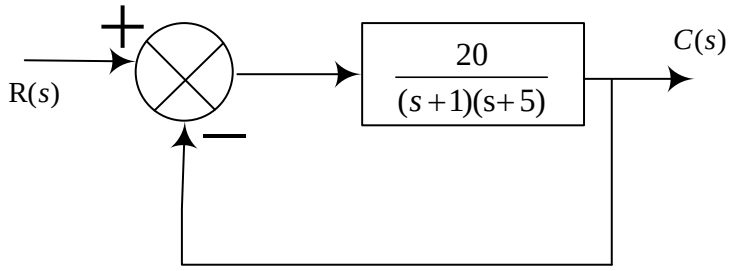
Instructions: Attempt all the sections.

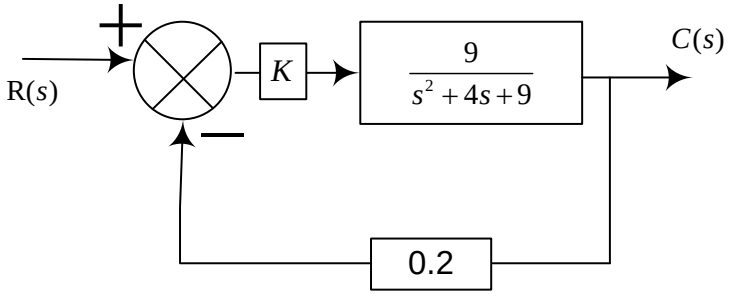
SECTION A
(5Qx4M=20Marks)

S. No.	**Attempt all the questions.**	**Marks**	**CO**
Q 1	Analyze the operation of microprocessor based control system with the suitable automotive industrial application.	**4**	**CO1**
Q2	Differentiate the linear translational and rotational mechanical system with mathematical modeling to determine the transfer function.	**4**	**CO2**
Q3	Determine the overall transfer function relating the output and input for a system represented by Fig (1). Use block diagram reduction method.  Fig. (1)	**4**	**CO3**
Q4	Analyze the (i) settling time (ii) steady state error for transient response of second order control system.	**4**	**CO4**
Q5	Draw the state model and state space representation of the given transfer function $$\frac{Y(S)}{U(S)} = \frac{1}{(s+2)} \cdot \frac{1}{(s+3)} \cdot \frac{1}{(s+4)}$$	**4**	**CO5**

SECTION B
(4Qx10M= 40 Marks)

Q 6	Analyze and sketch the diagrams of the mechanical devices used as primary detectors as, (i) Helical bourdon tube (ii) Spiral tube (iii) cantilever. Also, write mathematical analysis when applied pressure to deform the original positions.	**3+7**	**CO1**
Q7	Analyze the Resistance temperature detector (RTD) and compare it with the thermocouple transducers based on temperature measurement	**8+2**	**CO2**

	ranges and active/passive nature/category of transducers. Also sketch the diagrams for both transducers.		
Q8	The signal flow graph (SFG) is shown in Fig (2). Determine the transfer function using Mason's gain method.  Fig. (2)	**10**	**CO3**
Q9	Obtain the state transition matrix in the form of e^{At} and determine the time response for the system, $$\overset{o}{X} = Ax$$ Where $A = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix}$ and $x_1(0) = 1,\ x_2(0) = 1$ **OR** The transfer function of a system is given below, $$\frac{Y(s)}{U(s)} = \frac{s^2 + 3s + 2}{s^3 + 9s^2 + 26s + 24},$$ Determine the state model, use direct decomposition method.	**10**	**CO5**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	**Attempt both the parts** **(A)** The block diagram of a unity feedback control system is shown in Fig (3) as,  Fig. (3)	**10+10**	**CO4**

	Determine, (i) overall the transfer function (ii) damping ratio (ξ) (iii) rise time (t_r) (iv) peak time (t_p) **(B)** Determine the sensitivity of the overall gain for the system shown in fig. (4), and calculate the value of K such that the sensitivity is 0.2 under steady state conditions.  **Fig. (5)**		
Q11	Check the controllability and observability of a system having following coefficient matrix. $A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}$, $B=\begin{bmatrix}1\\0\\1\end{bmatrix}$ and $C=\begin{bmatrix}10 & 5 & 1\end{bmatrix}$ **OR** A system is represented by the equations given below $\begin{bmatrix}\overset{o}{X}_1\\ \overset{o}{X}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -4 & -5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\1\end{bmatrix}u$ *Given* $x(0)=\begin{bmatrix}1 & 1\end{bmatrix}^T$ Determine (a) state transition matrix $\phi(t)$ (b) Zero input response (c) Zero state response for u=1 (d) total response	**20**	**CO5**