Name: **Enrolment No:**	

UPES

End Semester Examination, May 2024

Course: Instrumentation & Control **Semester: IV**
Program: B. Tech- Mechanical Engineering +Mechatronics Engineering **Time : 03 hrs.**
Course Code: ECEG-2041 **Max. Marks: 100**

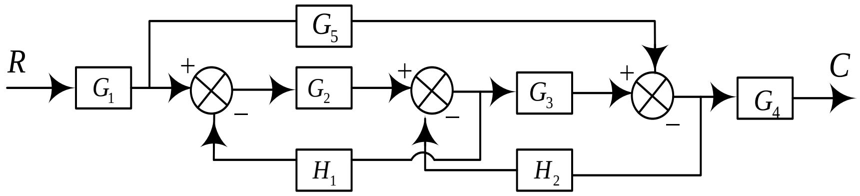
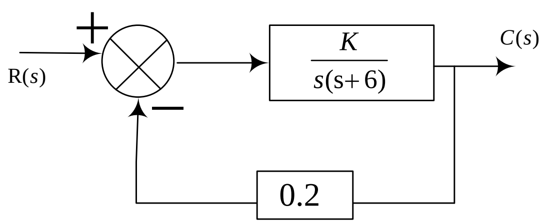
Instructions: Attempt all the sections.

SECTION A
(5Qx4M=20Marks)

S. No.	**Attempt all the questions.**	**Marks**	**CO**
Q 1	Briefly define: **(a)** Observational error **(b)** Gross Error **(c)** Sensitivity **(d)** Hysteresis	**4**	**CO1**
Q2	Describe with the help of neat diagram the mechanical devices used as primary detectors.	**4**	**CO2**
Q3	Analyze the mathematical modelling of translational and rotational mechanical systems.	**4**	**CO2**
Q4	Analyze the (i) settling time (ii) steady state error for transient response of second order control system.	**4**	**CO2**
Q5	What is significance of the controllability and observability of the system in control system applications.	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q 6	**Attempt both parts** (A) Write mathematical analysis when force is applied to deform the original positions of (a) Cantilever (b) Helical Spring. **(B)** A meter reads 143.60V and the true value of the voltage is 143.52V. Determine (a) static error (b) static correction for this instrument.	**8+2**	**CO1**
Q7	**Attempt both parts** (A) Analyze the working principle of thermistors for temperature measurement. Give the applications, where the thermistors are used as well as the range of temperature measurement. (B) A platinum thermometer has a resistance of 100Ω at 25^{o}C. (i)	**4+6**	**CO2**

	Find its resistance at 65°C if the platinum has a resistance temperature co-efficient of 0.00392/°C. (ii) if the thermometer has a resistance of 150Ω, calculate the temperature.		
Q8	Draw the signal flow graph for a control system whose block diagram representation is given in Fig. (1), and determine C/R using Mason's Gain formulae.  Fig. (1)	**10**	**CO3**
Q9	Obtain the state transition matrix (STM) in the form of e^{At} and determine the time response for the system $\overset{o}{X} = Ax$ Where, $A = \begin{bmatrix} 0 & 2 \\ -2 & 1 \end{bmatrix}$ and $x_1(0) = 1,\ x_2(0) = 1$ **OR** Apply cascade decomposing method to obtain state space representation of the transfer function given as, $$G(s) = \frac{s^2 + 6s + 8}{(s+3)(s^2 + 2s + 5)}$$	**10**	**CO5**
SECTION-C (2Qx20M=40 Marks)			
Q 10	**<u>Attempt both the parts</u>** **(A)** A closed loop control system is shown in Fig. (2) as,  Fig. (3) The system is to have a damping ratio of 0.7. Determine the value of K to satisfy this condition and calculate the settling time, peak time, and maximum overshoot for the value of K thus determined. **(B)** A closed loop control system has the characteristics equation given as, $S^3 + 4.5S^2 + 3.5S + 1.5 = 0$. Investigate the stability using Routh-Hurwitz Criterion.	**15+5**	**CO4**

Q11	Check the controllability and observability of a system having following coefficient matrix. $A = \begin{bmatrix} -1 & -2 & -1 \\ 0 & -1 & 1 \\ 1 & 0 & -1 \end{bmatrix}$, $B^T = \begin{bmatrix} 2 & 1 & 1 \end{bmatrix}$ **and** $C = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$ **and D =0** **OR** Determine the transfer matrix for the system given below and draw the block diagram. $\begin{bmatrix} \overset{o}{X}_1 \\ \overset{o}{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 3 \\ -2 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} u(t)$, *and* y= $\begin{bmatrix} 2 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$	**20**	**CO5**