Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, Nov-Dec 2021

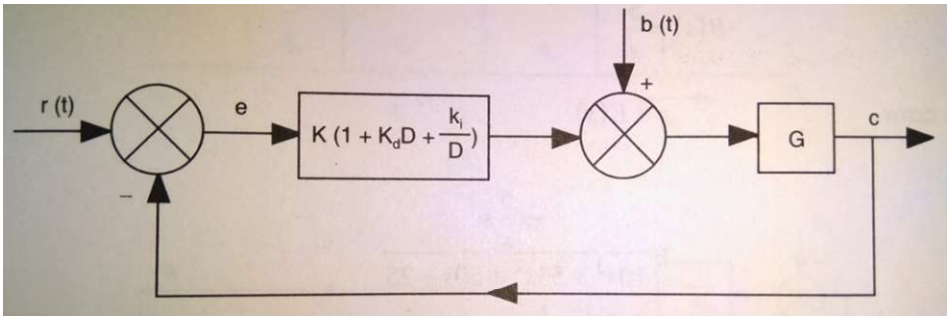
Programme Name: B.Tech. Mechanical Engineering **Semester : V**
Course Name : Instrumentation and Control **Time : 03 hrs.**
Course Code : ECEG3011 **Max. Marks : 100**
Nos. of page(s) : 03

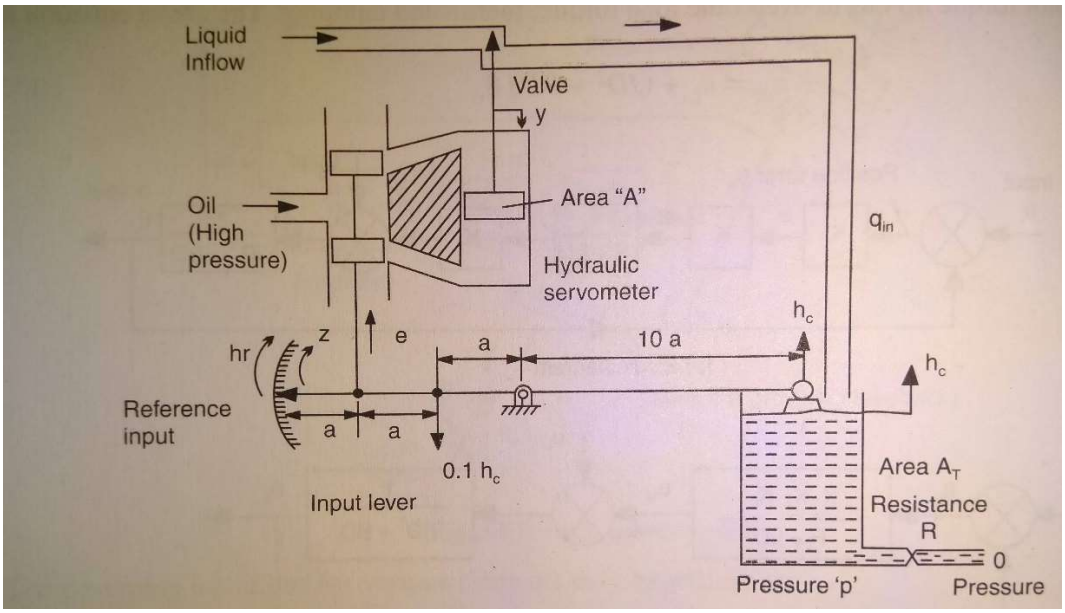
Instructions: 1. Assume any missing data
2. Section B has an internal choice in Q.9.
3. Section C has an internal choice in Q.10.

SECTION A
(Answer in not more than 50 words)

S. No.		Marks	CO
Q 1	Discuss the components of a closed-loop control system.	4	CO1
Q 2	Describe the methods for performing frequency response analysis of control systems.	4	CO4
Q 3	Describe any four static characteristics of a measurement instruments.	4	CO1
Q 4	Discuss the significance of dynamic characteristics of an instrument. Describe the methods to obtain these characteristics.	4	CO2
Q 5	Discuss the various methods for performing stability analysis of closed-loop control systems.	4	CO5

SECTION B
(Answer in not more than 150 words)

Q 6	Perform the mathematical modelling of a liquid flow system and hence obtain the transfer function and draw the block diagram.	10	CO2
Q 7	Discuss the various types of controllers that can be used in a feedback control system.	10	CO2
Q 8	Derive the transfer function of a first order system and hence find out its dynamic response to a periodic harmonic input.	10	CO3
Q 9	a) For the system with block diagram as in Fig. 1, $G = \frac{1}{10D^2+3D}$. If K = 50, K_d = 1, K_i = 0.5, find the steady state error when r = 0 and b = 5.  Fig. 1: Figure for Q. 9	10	CO4

	OR b) For the system shown in Fig. 1, find the steady state error when r = 2 and b = 0.		
	SECTION-C		
Q 10	In the system of Fig. 2, the controlled variable is h_c, the level in the tank. Input motion *'z' = 0.1h_r*, Port constant *'b'* of hydraulic servomotor = 400 cm^2/sec. Area *A* = 25 cm^2. Area A_T = 1.2 m^2, Inflow rate $q_{in} = Ky$, K = 2.0 m/s^2. Mass density *'ρ'* of liquid = 1000 kg/m^3. Fluid resistance *'R'* = 10000 Ns/m^5.  Fig. 2: Diagram for Q. 10 (first choice) Draw the block diagram for the above system and hence derive the transfer function.	**20**	**CO4**
	OR **(Internal Choice of Q. 10)** Draw the closed-loop frequency response curve (polar plot) for the block diagram shown in Fig. 1. Take K = 1, K_d = 0, K_i = 0, and $G = \frac{1}{10D^2+3D}$. Ignore disturbance b(t).		
Q 11	A rectangular steel rod width *b* and depth *d* is supported at its ends and loaded at its centre by load *W*. If the length of the rod between the supports is *l* and y_c is the deflection at the centre, then $y_c = \frac{Wl^3}{4Ebd^3}$ where *E* is the modulus of elasticity of elasticity. Measurement give $b = 4.942 \pm 0.042\ cm$ $d = 5.250 \pm 0.025\ cm$ $l = 1.000\ \pm 0.5\ cm$ $y_c = 2.622 \pm 0.25\%\ of\ y_c\ mm$	**20**	**CO2**

	$W = 15000\ N\ (exact)$ (a) Determine the nominal value of the modulus of elasticity. (b) Determine the percentage uncertainties in the various measured quantities. (c) Compute the percentage uncertainty in the modulus of elasticity.		