Name: Enrolment No:	UPES

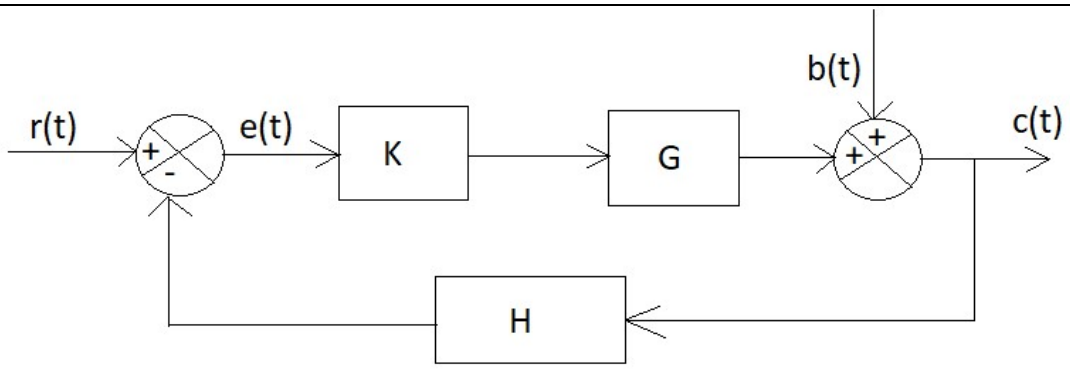
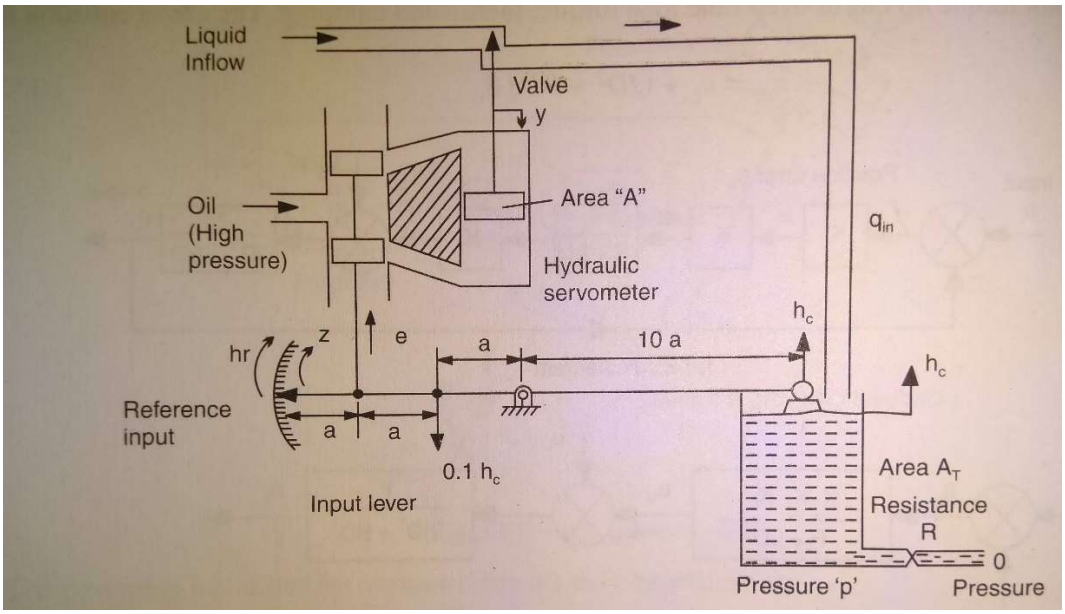
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2020

Programme Name: B.Tech. Mechatronics Engineering **Semester : VII**
Course Name : Mechatronics System Design **Time : 03 hrs.**
Course Code : MECH4001 **Max. Marks : 100**
Nos. of page(s) : 03
Instructions: 1. Assume any missing data
2. Section B has an internal choice in Q.10.
3. Section C has an internal choice.

SECTION A
(Answer in not more than 50 words)

S. No.		Marks	CO
Q 1	Differentiate between closed-loop and open-loop control systems.	5	CO1
Q 2	Describe the methods of performing frequency response analysis of control systems.	5	CO1
Q 3	State Routh criterion of stability.	5	CO1
Q 4	Discuss the steps of Nyquist stability criterion.	5	CO1
Q 5	Define derivative time and integral time.	5	CO1
Q 6	Discuss the various functional elements of a measurement system.	5	CO1
	SECTION B **(Answer in not more than 150 words)**		
Q 7	Describe the working of a field-controlled DC motor.	10	CO2
Q 8	Discuss the various types of controllers that can be used in a feedback control system.	10	CO2
Q 9	Describe the mathematical model of a liquid flow system having two interconnected tanks with capacities C_1 and C_2 respectively. Take two resistances: R_1 and R_2 at the inlet of each tank. The liquid pressure at the bottom of tank 1 is p_1 and at the bottom of tank 2 is p_2. Take inlet pressure as p_0. There is no outlet from tank 2. Derive the mathematical model and draw the block diagram.	10	CO2
Q 10	a) For the system shown in Fig. 1 below, find out the steady state error due to unit ramp reference input. Take $K = \frac{100}{D+10}$, $G = \frac{1}{5D+1}$, b(t) = 0 and H = 1.	10	CO2

	 Fig. 1: Figure for Q. 10 **OR** b) For the system shown in Fig. 1, find the steady state error when r = 2 and b = 0.		
Q 11	Derive the transient response of a second order system subjected to a unit step input. Plot the output and input curves on a single graph. Discuss the results.	**10**	**CO2**
	SECTION-C		
Q 12	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. 12 (first choice)	**20**	**CO2**

	Draw the block diagram for the above system and hence derive the transfer function.		
	OR **(Internal Choice of Q. 12)** Draw the closed-loop frequency response curve (polar plot) for the block diagram shown in Fig. 1. Take the physical parameters of the system as provided in Q. 10. Ignore disturbance b(t).		