Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

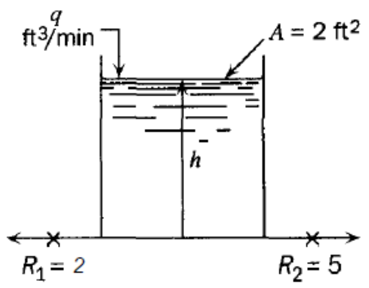
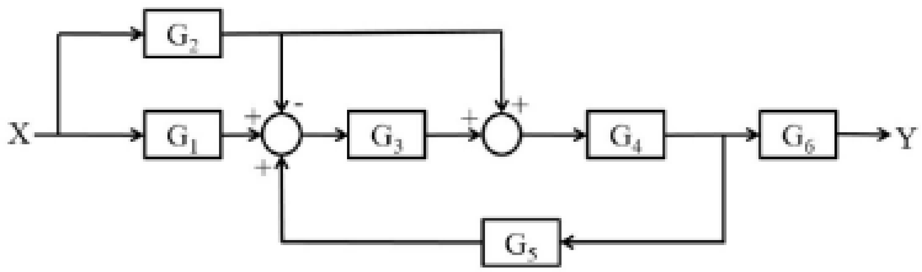
End Semester Examination, May 2023

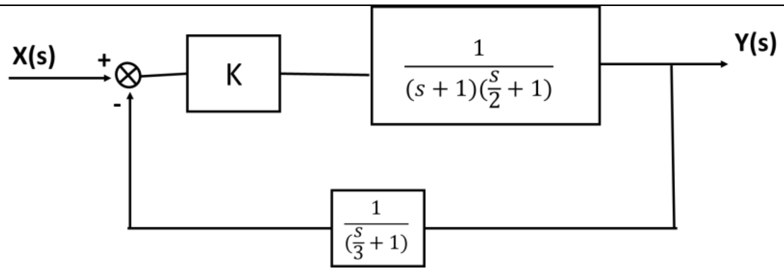
Program Name : M Tech Chemical Engineering | **Semester : II**
Course Name : Advanced Process Control | **Time : 3 hours**
Course Code : CHPD 7013 | **Max. Marks: 100**
Nos. of page(s) : 03

Instructions : Assume any missing data. Draw the diagrams, wherever necessary. Write roll number and name on any additional sheet that you use.

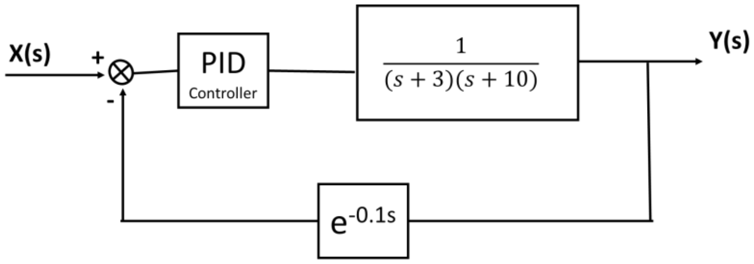
SECTION A

(6X10=60 marks)

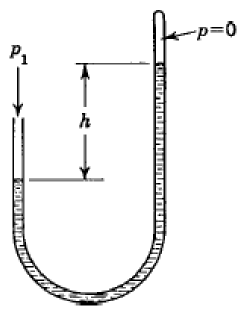
S. No.		Marks	CO
1	***Outline*** in detail LVDT with a neat diagram. State various applications of LVDT in the industry.	**10**	**CO1**
2	***Recall*** about the inherent characteristics of control valves	**10**	**CO1**
3	 **Demonstrate** expression for H(s)/Q(s). For a unit step change in Q, ie Q(s) =1/s, what is the change in height of the tank after 1 minute?	**10**	**CO2**
4	 **Connect** Y(s) and X(s) as a transfer function.	**10**	**CO3**

<table>
<tr><td>5</td><td>


In the control system shown above, ***interpret*** the value of K for which the system is stable. The controller is replaced by a PI controller with transfer function $K\left(1+\frac{1}{\tau_I s}\right)$. If K = 10, determine the range of τ_I for which the system is stable.
</td><td>10</td><td>CO3</td></tr>
<tr><td>6</td><td>
Using Ziegler-Nichols rules, ***analyze*** proportional gain, derivative and integral time for the system shown below. (Do not plot the bode diagram and use Bode stability criterion)



OR

With a neat diagram explain the distillation column control system by explaining the types of controllers that could be used.
</td><td>10</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION B
(2 X 20=40 marks)</td></tr>
<tr><td>7</td><td>


A mercury manometer is depicted below. Assuming the flow in the manometer to be laminar and the steady-state friction law for drag force in laminar flow to apply at each instant, determine a transfer function between the applied pressure p_t and the manometer reading h. It will simplify the calculations if, for inertial terms, the velocity profile is assumed to be flat. From your transfer function, written in standard second-order form, list (a) the steady-state gain, τ, and ξ. **Comment** on these parameters as they are related to the physical nature of the problem.

OR

Sketch the root locus *diagram* for the open loop transfer function

$$\frac{K(s+6)}{s(s+2)(s+4)(s+9)}$$
</td><td>20</td><td>CO3</td></tr>
</table>

8	**Answer both the questions. Each question carries 10 marks** a. There are N storage tank of volume V Arranged so that when water is fed into the first tank into the second tank and so on. Each tank initially contains component A at some concentration Co and is equipped with a perfect stirrer. A time zero, a stream of zero concentration is fed into the first tank at volumetric rate q. **Predict** the resulting concentration in each tank as a function of time. b. Three identical tanks are operated in series in a non-interacting fashion. For each tank R=1, $\tau = 1$. If the deviation in flow rate to the first tank in an impulse function of magnitude 2, **Predict** an expression for H(s) where H is the deviation in level in the third tank and obtain the deviation value at time t=1.5.	**20**	**CO2**