Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

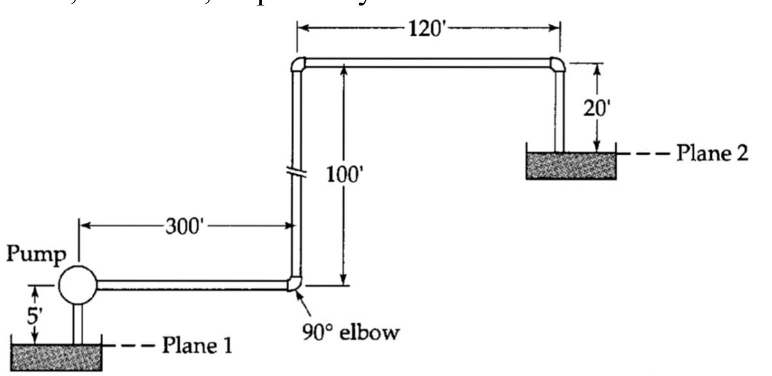
Course: Advanced Transport Phenomena — **Semester : I**
Program: M. Tech Chemical Engineering — **Time : 03 hrs.**
Course Code: CHPD7018 — **Max. Marks: 100**

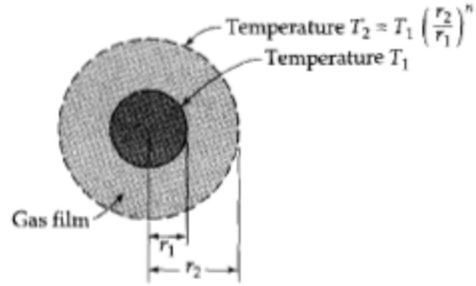
Instructions: 1) Answer the questions section wise in the answer booklet. 2) Assume suitable data wherever necessary. 3) The notations used here have the usual meanings.

SECTION A
(3Qx10M=30Marks)

S. No.		Marks	CO
Q 1	Show the qualitative comparison of laminar and turbulent velocity profiles with a neat diagram.	**10**	**CO1**
Q 2	Develop the generic equation of energy balance and state its importance for chemical engineering applications.	**10**	**CO2**
Q 3	Discuss about the transfer coefficients in one phase.	**10**	**CO3**

SECTION B
(3Qx15M= 45 Marks)

S. No.		Marks	CO
Q 4	What is the required power output from the pump at steady state in the system shown in Fig. 1? Water at 68^0F (ρ = 62.4 lb_m/ft^3; μ = 1.0 cp) is to be delivered to the upper tank at a rate of 12 ft^3/min. All of the piping is 4-in. internal diameter smooth circular pipe. The contribution to E_v from the sudden contraction, the three 90^0 elbows, and the sudden expansion will be 0.45, 0.5 and 1, respectively.  Fig. 1. Pipeline flow with friction losses because of fittings. Planes 1 and 2 are just under the surface of the liquid.	**15**	**CO1**

Q 5	Develop the heat conduction equation for an electrically heated wire using the boundary condition of the heat flux at the wall is given by Newton's law of cooling. Assume that the heat transfer coefficient h and the ambient air temperature T_{air} are known.	**15**	**CO2**
Q 6	A solid material occupying the space from $y = 0$ to $y = \infty$ is initially at temperature T_0. At time $t = 0$, the surface at $y = 0$ is suddenly raised to temperature T_1 and maintained at that temperature for $t > 0$. Find the time-dependent temperature profiles $T(y, t)$.	**15**	**CO2**
SECTION-C **(1Qx25M=25 Marks)**			
Q 7	a) Explain about the macroscopic mass balance equation. b) Derive expressions for diffusion through a spherical shell as shown in Fig. 2. Extend these results to describe the diffusion in a non-isothermal film in which the temperature varies radially according to $\frac{T}{T_1} = \left(\frac{r}{r_1}\right)^n$. Assume as a rough approximation that D_{AB} varies as the 3/2-power of the temperature:  Fig 2. Diffusion through a hypothetical spherical stagnant gas film surrounding a droplet of liquid *A*.	**05** **20**	**CO3**