Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec 2024

Course: Momentum Transfer **Semester: III**
Program: B. Tech Chemical Engg. **Time: 3 hrs**
Course Code: CHCE 2033 **Max. Marks: 100**

Instructions: (1) Answer **ALL** questions
(2) Assume the appropriate value of missing data, if any.

SECTION A (20 M)

S. No.		Marks	CO
Q1	How do you calculate total head loss in a pipeline with multiple bends and fittings? Discuss how minor losses are incorporated into the calculation.	**4**	**CO1**
Q2	Explain the term "cavitation damage" and discuss how it impacts pump life and efficiency. Provide an example from the chemical industry.	**4**	**CO1**
Q3	Explain the measures that can be taken to avoid cavitation in centrifugal pumps.	**4**	**CO1**
Q4	What are the consequences of not maintaining the required NPSH in a pump? Illustrate with an example.	**4**	**CO1**
Q5	Derive an expression for the excess pressure inside a soap bubble due to surface tension. Discuss the Young-Laplace equation.	**4**	**CO1**

SECTION B (40 M)

Q6	A doctor is using a manometer to measure the blood pressure of a patient. The manometer is connected to a sphygmomanometer cuff inflated around the patient's arm. The pressure reading on the manometer shows that when the cuff pressure is increased to 180 mmHg, the blood flow is temporarily stopped, and no pulse is detectable. As the cuff pressure is gradually released, the pulse starts to return at 120 mmHg. The doctor records the systolic and diastolic pressures. Given the following data: • **Systolic pressure**: 180 mmHg • **Diastolic pressure**: 120 mmHg • **Area of the artery wall (circular cross-section)**: 2 cm^2 • **Density of mercury** : 13,600 kg/m^3 (a) The pressure in Pascals for systolic and diastolic readings. (b) The force exerted on the artery wall at the systolic and diastolic pressure levels. (c) The pressure difference in Pascals between systolic and diastolic readings.	**10**	**CO3**

Q7	A fluid flows through a nozzle where the velocity (u) and density (ρ) of the fluid vary along the length of the nozzle as: $u = u_0\left(1+\frac{x}{L}\right), \rho = \rho_0\left(1-\frac{x}{L}\right)$ where u_0, ρ_o, and L are constants. Derive the expression for the rate of change of density in the Lagrangian frame of reference.	**10**	**CO2**
Q8	The velocity distribution for a fully developed laminar flow in a circular pipe of radius, R, is given by, $u = -\frac{R^2}{4\mu}\frac{dP}{dx}\left[1-\left(\frac{r}{R}\right)^2\right]$. Determine the expressions for total discharge and pressure drop through the pipe of length L. The terms have their usual meanings.	**10**	**CO3**
Q9	A metal plate with dimensions 1.00 m × 1.00 m × 10 mm thick and weighing 150 N is positioned midway between two parallel horizontal surfaces. The gap between the surfaces is 40 mm, and the gap is filled with an oil having a specific gravity of 0.90 and a dynamic viscosity of 5.0 $N.s/m^2$. Determine the force required to lift the plate with a constant velocity of 0.12 m/s.	**10**	**CO2**
SECTION C (40 M)			
Q10	A liquid (ρ=900 kg/m^3, μ=0.005 Pa·s) is pumped through a 300m-long pipe with an inner diameter of 0.1m. The flow rate is 0.02m^3/s, and the friction factor is 0.02. Minor losses due to fittings add an equivalent length of 50m. The pipe discharges the fluid to an elevated tank 10m above the pump. a) Calculate the frictional head loss using the Darcy-Weisbach equation. b) Include the equivalent minor losses and elevation to find the total head required. c) If the pump efficiency is 60%, calculate the total power input required.	**20**	**CO4**
Q11	A pipeline system is used to measure the flow rate of water using a Venturimeter and an orifice meter installed at different sections along the same pipeline. The diameter of the pipe is 0.10 m in both sections. For the Venturimeter, the throat diameter is 0.08 m, and for the orifice meter, the orifice diameter is 0.12 m. The Venturimeter has a discharge coefficient of 0.98, while the orifice meter has a discharge coefficient of 0.6. In a steady flow, the differential pressure across the Venturimeter is measured to be 3000 Pa, and across the orifice meter, it is measured to be 1600 Pa. The density of water is 1000 kg/m^3. Calculate the flow rate (discharge) of water through the pipeline as measured by each device (venturi meter and orifice meter). Compare the results and explain any difference in the calculated flow rates.	**20**	**CO4**