Name: Enrolment No:	

UPES

End Semester Examination, May 2023

Course: Numerical Methods for Multiphase Flows **Semester: II**
Program: M.TECH CFD **Time : 03 hrs.**
Course Code: ASEG 7028 **Max. Marks: 100**

Instructions: Assume suitable value of parameters/variables if not given in the question.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss about the significance of stokes number in multiphase flows.	**4**	**CO2**
Q 2	Explain • One- and two-way coupling • Sub-cooled and saturated boiling • Saturated and Super-heated condensation • - Pool and flow boiling phenomena	**4**	**CO2**
Q 3	How would you distinguish between inertia and viscous domination in micro-scale interfacial flows. Provide relevant non-dimensional numbers used in the analysis of fluid-fluid multiphase flows.	**4**	**CO2**
Q 4	Provide kinematic condition and interfacial boundary conditions applicable at the fluid-fluid interfaces.	**4**	**CO2**
Q 5	Distinguish between evaporation and boiling phenomena. Explain boiling crisis and Leidenfrost phenomena.	**4**	**CO2**

SECTION B

(4Qx10M= 40 Marks)

Q 6	Compare homogeneous, drift flux and separated flow models used in the modeling of two-phase flows.	**10**	**CO3**
Q 7	Provide detailed description of the two-phase flow patterns observed in vertical and horizontal tubes in either adiabatic conditions or diabatic conditions.	**10**	**CO3**

Q 8

Estimate pressure drop per unit length for an adiabatic gas-liquid mixture flowing at the rate of 10 kg/s in a horizontal tube of 50 mm diameter and at 25% volume fraction. (Phase properties are: $\rho_{air} =$ 1.21 kg/m^3, $\rho_{liq.} =$ 1080 kg/m^3, $\mu_{air} = 1.7 \times 10^{-5}$ kg/m-s, $\mu_{liq} = 0.001$ kg/m-s)

Use Lockhart Martinelli correlation with following information, as per requirement,

Friction factor: f = 16/Re for laminar flow and f = 0.079/Re$^{0.25}$ for turbulent flow. Two-phase multipliers are given as

$$\phi_l^2 = 1 + \frac{c}{X} + \frac{1}{X^2} \qquad \phi_g^2 = 1 + cX + X^2$$

Liquid	gas	c
turbulent	turbulent	20
laminar	turbulent	12
turbulent	laminar	10
laminar	laminar	5

10 **CO4**

Q 9

Discuss the prediction of two-phase flow regime/operating point in a pipe based on following drift flux equations,

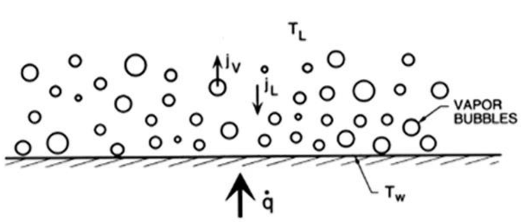
$J_{21} = U_\infty \alpha (1- \alpha)^n$; ($2 < n < 3$), where U_∞ is the velocity of free rising bubble in a pool of liquid

$J_{21} = - \alpha J_1 + (1- \alpha) J_2$

Consider all possible flow configurations of gas-liquid flows (e.g., parallel/counter flows).

OR

Find the expression for critical heat flux based on drift flux model (use equations specified above and assume thermophysical properties, as per requirement, refer figure below)



Where q is applied heat flux and J_L, J_v are volume flux of liquid and gas phase, respectively.

10 **CO4**

SECTION-C
(2Qx20M = 40 Marks)

Q 10	Differentiate between Euler-Lagrange and Euler-Euler modeling approach. Present your arguments for the modeling of following multiphase flow phenomena, (a) Rise of a vapor bubble in the pool of its liquid under gravity at saturated condition (consider thermal effects) (b) Flow of a dispersed phase (~ 10%) in a continuous phase (c) Fluidized bed What modifications shall be considered in the governing equations while modeling these flow phenomena. Also, mentioned if any additional equations are required in the modeling approach.	**20**	**CO5**
Q 11	Describe **any one** of the following systems (Provide complete description of the associated multiphase flow phenomena and their numerical modeling approach): (a) Cavitation phenomena (b) Mechanics of thermal transport in heat pipes (Provide detailed explanation for any one type of Heat pipes) (c) Hydrodynamic instabilities and tracking of interfaces. (Provide detailed explanation for any one type of Instability) (d) Phase change phenomena (Boiling and Condensation)	**20**	**CO5**