M.E. MECHANICAL ENGINEERING - FIRST YEAR - SECOND SEMESTER EXAMINATION, 2024
MASTER OF NUCLEAR ENGINEERING 1st Year, 2nd Semester EXAMINATION, 2024
TWO PHASE FLOW, BOILING AND CONDENSATION

Time: Three hours **Full Marks 100**

	All parts of the same question must be answered together. Assume any unfurnished data suitably **Use of Thermodynamic Tables and Charts permitted**	
	Part: I **Answer any two questions**	
1.	(a) Liquid evaporated from an inlet condition at saturated temperature ($x = 0$) to a vapour liquid mixture having a mass quality x. For a linear change of x over length L ($dP/dx = constant$) derive an expression of the pressure drop over length L.	18
	(b) Derive the relationship between void fraction and quality in two-phase flow.	7
2.	(a) Define superficial flow velocity and drift flux in connection with drift flux model. Show that, $j_{12} = \alpha\,(1-\alpha)v_{12}$ where symbols denote their usual meaning.	7
	(b) Determine the flow patterns for vertical of refrigerant R-12 inside a 10 mm internal diameter tube at 0°C (3.09 bar) for a flow rate of 0.04 kg/s and vapour quality of 20%. (Properties: liquid density = 1397 kg/m^3, vapour density = 18.1 kg/m^3, liquid viscosity = 0.267 kN s/m^2 and vapour viscosity = 0.01183 kN s/m^2).	18
3.	A mixture of steam and water flows inside a vertical pipe with a diameter of 3 mm and a length of 10 cm at 100 kPa. The mass flux of the mixture is 100 kg/m^{2}s, and the inlet quality is zero. A uniform heat flux of 30 kW/m^2 is applied to the pipe wall up to the midpoint of the pipe length. The remaining length of the pipe is kept adiabatic. Find the total pressure drop considering separated flow model inside the pipe. Also, compare the frictional pressure drop between the first half and the second half of the pipe.	25

	Part 2 (Full Marks 50) **Answer any two questions** **(Symbols denote their usual meaning)**	
1.	a) What do you mean by contact angle and apparent contact angle? Explain with suitable sketch the role of apparent contact angle in vapour nucleus formation and growth.	4+4
	b) Show that modification of the condensation theory yields the following expression of net condensation mass flux: $j = \left(\frac{2\sigma}{2-\sigma}\right)\left(\frac{M}{2\pi R}\right)^{1/2}\left[\frac{p_g}{T_g^{1/2}} - \frac{p_f}{T_f^{1/2}}\right]$	17
2.	a)Show that the scale of diffusion controlled growth of a bubble radius can be expressed as: $R \sim \frac{k_f \Delta T_{sat}}{\rho_g h_{fg}\sqrt{\alpha_f}} t^{1/2}$	15
	b) What do you mean by Onset of nucleate boiling(ONB)? Explain with suitable graph how 'wall superheat' corresponding to ONB is determined.	
3.	a) Show that the vapour phase heat transfer for a mixture of vapour and non-condensable with a liquid film is given by $q = \frac{K_g h_{fg} \rho_g}{p_{am}}\left(p_{g_o} - p_{g_i}\right) + h_g'\left(T_{g_o} - T_{g_i}\right)$	18
	b) Explain the mechanism of heterogeneous nucleation. Explain why superheat requirement is reduced for heterogeneous nucleation.	7