Ref. No.EX/PG/ME/T/128F/2017

M.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2017

MASTER OF NUCLEAR ENGINEERING EXAMINATION, 2017

Two Phase Flow, Boiling and Condensation

Time: 3 hours Full Marks: 100

Answer two questions from each part
Use separate answer script for each part.
Part-I (Answer any two questions from this part)

1. a) Derive the expression for minimum superheat for vapour nucleus formation as a function of relevant thermo-physical parameters. 15
(b) Explain why superheating requirement is less for heterogeneous nucleation? 10

2. (a) Develop Rohsenow's correlation for nucleate boiling with proper non-dimensionalization. 15
(b) How the onset of nucleate boiling temperature is determined? 10

3.(a) Derive Rayleigh equation of bubble dynamics. 12
(b) What do you mean by subcooled film boiling? Derive the expression of Nusselt number for 'subcooled film boiling under forced convection' for a heated vertical plate. 13

Part - II
Answer any TWO questions
All parts of the same question must be answered together.

Q:1(a) Derive Reynolds Transport Theorem for a control volume containing a single fluid. 20
(b) What is a material volume? What is the velocity of the control surface of a material volume 5

Q:2(a) Assuming equations for conservation of mass and momentum for single phase fluids and Reynolds Transport Theorem for a control volume containing a discontinuity, derive the expressions for mass and momentum balance across an interface between two dissimilar fluids. Neglect surface tension effects. 20
(b) Write a short note on multifluid model. 5

Q:3 a) Assuming the following expression for the pressure gradient of a homogeneous steady one-dimensional two phase flow

$$-\frac{dp}{dz}=\frac{\frac{2C_f}{D}G^2(v_1+xv_{12})+G^2v_{12}\frac{dx}{dz}-G^2(v_1+xv_{12})\frac{1}{A}\frac{dA}{dz}+\frac{gSin\theta}{v_1+xv_{12}}}{1+G^2\left[x\frac{dv_2}{dp}+(1-x)\frac{dv_1}{dp}\right]}$$

where the symbols have usual meaning, deduce the expression for velocity of sound in a two-phase medium in terms of velocities of sound in the components and volume fraction of the components. Show that in the limit of $\rho_1 >> \rho_2$ and $\rho_1 c_1^2 >> \rho_2 c_2^2$, the velocity of sound in two phase medium can be expressed as

$$c^2=\frac{\rho_2}{\rho_1}\frac{c_2^2}{\alpha(1-\alpha)}$$ 15

b) Define the following terms: (a) volume fraction (b) mass fraction (c) drift flux (d) drift velocity 10