Registration No : | | | | | | | | | | |

Total Number of Pages : 02 **M.Tech**

P2HTCC03

2nd Semester Regular Examination 2018-19
TWO-PHASE FLOW & HEAT TRANSFER
BRANCH : THERMAL ENGG
Max Marks : 100
Time : 3 Hours
Q.CODE : F338

Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.
The figures in the right hand margin indicate marks.

Part- I

Q1 **Only Short Answer Type Questions (Answer All-10)** **(2 x 10)**

a) Give the correct order of the flow regimes as observed in horizontal flow boiling phenomenon. 1. Bubbly flow 2. Droplet flow 3. Annular flow 4. Slug flow 5. Single phase liquid 6. Single phase vapor.

b) What mechanisms are responsible for the very high heat transfer coefficients in nucleate boiling?

c) How is pool boiling different from flow boiling?

d) An operator working in a petroleum industry supervises a gas-liquid vertical column having liquid and gas viscosities as 95.6X10-6 Ns/m^2 and 19X10-6 Ns/m^2 . Using McAdams correlation he found out homogeneous viscosity as 2.96X10-5 Ns/m^2 . What is the average quality of the pipeline?

e) What is the meaning of burnout point in a boiling curve? How is burnout avoided in the design of steam boilers?

f) Does the amount of heat absorbed as 1 kg of saturated liquid water boils at 100ºC have to be equal to the amount of heat released as 1 kg of saturated water vapour condenses at 100ºC?

g) Why is higher heat transfer coefficient generally associated with dropwise condensation than with film condensation?

h) Using concepts of thermodynamics, explain how condensation occurs.

i) What is the difference between subcooled and saturated boiling?

j) Mention a few industrial applications where flow boiling takes place

Part- II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) What is modified latent heat of vaporization? What is the purpose of introducing this quantity

b) Analyze effect of vapor velocity and nature of surface onui8ii two phase flow heat transfer coefficient

c) Analyze physics of Separated flow model and Drift flux model

d) Distinguish between Filmwise condensation and dropwise condensation

e) In case of separated adiabatic two phase flow, evaluate void fraction for quality of 65.2 % at 46.941 bar. Use Martinelli-Nelson model.

f) Illustrate momentum and energy equation for two fluid non equilibrium model for two phase flow .

g) An operator working in a petroleum industry supervises a gas-liquid vertical column having liquid and gas viscosities as 95.6X10-6 Ns/m2 and 19X10-6 Ns/m^2. Using McAdams correlation he found out homogeneous viscosity as 2.96X10-5 Ns/m^2. What is the average quality of the pipeline, he is handling.

h) Consider the Newtonian film flow inside a tube of 2.5 cm diameter, when water flow rate is 0.5 kg/s. Take liquid and gas densities as 1000 kg/m^3 and 1.2 kg/m^3, respectively. Viscosity of liquid is 0.001 kg/m-s. Find the wall shear stress using falling film theory

i) Analyze i) steam quality ii) void fraction iii) superficial velocity in case of two phae flow heat transfer situation.

j) For adiabatic separated flow having both liquid and gas as turbulent, ratio of their individual portion pressure drop, $[(dP/dz),liquid / (dP/dz)_F, gas$ is 10.56. Calculate the ratio of friction correction factor, $\emptyset_g / \emptyset_f$.

k) If the specific volumes of the gas-liquid pair being observed by the operator in the previous question are 1.351X10-3 m 3 /kg and 0.02753 m3 /kg. Calculate gravitational pressure gradient inside his pipe.

l) Substance A at a given pressure poses 1000 kg/m^3 and 1.0 kg/m^3 liquid and gas densities, respectively. Interfacial tension between gaseous and liquid phases of substance A is 0.02 N/m. For conversion of liquid to vapour, substance A requires 2250 kJ/kg energy from outside at saturation condition. Consider C1 = 3, to calculate the critical heat flux for departure from nucleate boiling.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 What do you mean by homogenous equilibrium method (HEM? Derive an expression to obtain the pressure drop in two phase flow using HEM approach. **(16)**

Q4 A 50 mm diameter vertical evaporator tube (k=20 W/mK) carries 1 kg/s of steam at 14.55 bar at a quality of x=0.2. The tube is subjected to a uniform heat flux of 10^6 W/m^2. Identify the regime of flow boiling and calculate the convective heat transfer coefficient and surface temperature of the tube. **(16)**
When quality reaches 0.8, what is the boiling regime and how much is the boiling heat transfer coefficient?

Q5 What is the mechanism of heat transfer in condensation? Using Nusselt's theory, develop an expression for average heat transfer coefficient in condensation over a length of a vertical plate. **(16)**

Q6 Consider the droplet annular flow of air and water inside a vertical tube of 20 mm diameter. The volumetric flow rates of corresponding liquid and gaseous phases are 0.004 m3 /s and 0.006 m3 /s, respectively. Calculate the flow rate of droplets entrained inside the gaseous core. **(16)**