Reg. No: ……………………
Name : ……………….

SIXTH SEMESTER B.TECH DEGREE EXAMINATION,

(2013 Scheme)

Branch: Mechanical Engineering

13.604. HEAT AND MASS TRANSFER (MSU)

Time: 3 Hours | Max. Marks: 100

Part A

*(Answer **all** questions; each carries **2** marks)*

1. State and explain Fourier law of heat transfer.
2. What is conduction shape factor? How it is related to thermal resistance?
3. Define Biot number and give its significance in Newtonian heating.
4. State Buckingham's Pi theorem.
5. Distinguish between thermal and hydrodynamic boundary layer.
6. Define effectiveness of the fin.
7. What is LMTD and discuss its importance in heat exchanger problem?
8. Draw boiling curve for water and show different regimes.
9. Define Wien's distribution law.
10. Define the terms (a) Mass concentration (b) Molar concentration

(10 X 2 = 20 Marks)

Part B

*(Answer any **ONE** question from each Module; each carries **20** marks)*

Module - I

11. (a) Derive the general heat conduction equation for cylindrical co-ordinates.
    (b) A furnace wall is made up of three layers of thicknesses 250 mm, 100 mm and 150 mm with thermal conductivities of 1.65, K and 9.2 W/m.K respectively. The inside is exposed to gases at 1250 ^{o}C with a convection coefficient of 25 W/m^{2}.K. and the inside surface is at 1100 ^{o}C, the outside surface is exposed to air at 25 ^{o}C with convection coefficient of 12 W/m^{2}.K. Determine (a) the unknown thermal conductivity K (b) the overall heat transfer coefficient (c) all the intermediate temperatures.

OR

12. (a) Derive an expression for steady state temperature distribution in a slab with internal heat generation.
    (b) A steel ball (specific heat = 0.46 kJ/kgK, and thermal conductivity 35W/mK) having 5 cm diameter and initially at a uniform temperature of 450 ^{o}C is suddenly placed in a control environment in which the temperature is maintained at 100 ^{o}C. Calculate the time required for the ball to attain a temperature of 150 ^{o}C.

Module - II

13. (a) Air at 20 ^{o}C at atmosphere pressure flows over a flat plate at a velocity of 3.5m/s. If the plate is 5m long and 2m wide. Calculate the following

(i) Length of the plate over which the boundary layer is laminar
(ii) Thickness of the boundary layer
(iii) Shear stress on the location where boundary layer is laminar
(iv) Total drag force on the both sides of the plate where boundary layer is laminar

(Take, Density = 1.205 kg/m^3; kinematic viscosity= $15.06x10^{-6}$ m^2/s)

(b) When 0.6kg of water/min is passed through a tube of 2cm diameter. It is found to be heated from 20 ^oC to 60 ^oC. The heating is achieved by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 90 ^oC. Determine the length of the tube required for fully developed flow.

OR

14. (a) Air at 40 ^oC flows over a tube with a velocity of 30 m/s. The tube surface temperature is 120 ^oC. Calculate the heat transfer coefficient for the following cases:
   (i) Tube is square with a side of 6cm
   (ii) Tube is circular cylinder with a diameter of 6cm.

(b) Show by dimensional analysis tha in free convection heat transfer the Nusselt number is a function of Grashoff number and Prandtl number.

Module - III

15. (a) In a counter flow double pipe heat exchanger, water is heated from 25 ^oC to 65 ^oC by an oil with a specific heat of 1.45 kJ/kg.K and mass flow rate of 0.9 kg/sec. The oil is cooled from 230 ^oC to 160 ^oC. If the overall heat transfer coefficient is 420 W/m^2.K. Calculate the following. (a) Rate of heat transfer, (b) Mass flow rate of water, (c) Surface area of the heat exchanger.

(b) Derive an expression for temperature distribution in long fin.

OR

16. (a) Derive the expression for LMTD in counter flow heat exchanger.

(b) Write a note on Heat pipe.

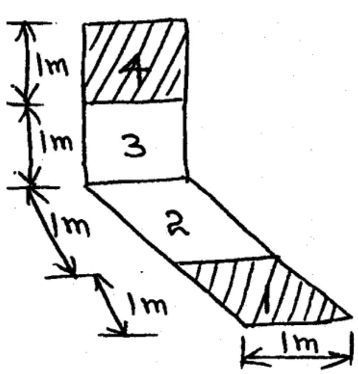
Module - IV

17. (a) Two parallel, infinite grey surfaces are maintained at temperature of 127 ^oC and 227 ^oC respectively. If the temperature of the hot surface is increased to 327 °C, by what factor is the net radiation exchange per unit area increased? Assume the emissivities of cold and hot surface to be 0.9 and 0.7 respectively.

(b) Explain the analogy between heat and mass transfer

OR

18. (a) Determine the view factor (F_{1-4}) for the figure shown below



(b) Explain the phenomenon of equimolar counter diffusion. Derive an expression for equimolar counter diffusion between two gases or liquids.