Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (MECHANICAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: HEAT TRANSFER [MME 302]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A.	Derive an expression for the temperature distribution and heat transfer in case of a solid sphere subjected to internal heat generation and with specified surface temperature.	5
1B.	A hot acid storage tank is to be constructed with 4 mm thick lead lining, an insulating brick layer and a 5 mm thick steel outer casing. The inside surface of the lead is at 95^{0}C and outside temperature at 30^{0}C (room temp). The temperature of outer surface of steel is to be not higher than 55^{0}C. Determine the necessary thickness of the insulating brick, if the surface conductance at the outer surface is 12 W/m^{2}K. Take k for lead as 40 W/m^{o}C, k for brick = 0.866 W/m^{o}C and K for steel = 45 W/m^{o}C.	5
2A.	Define Radiation intensity and prove that total emissive power is equal to π times its intensity of radiation.	5
2B.	A rectangular fin of cross-section 4mm x 80 mm and 1.0 m long is attached to an evaporating chamber maintained at -10^oC. The ambient temperature is at 20^oC. The conductivity of the fin material is 40 W/m^oC and the film coefficient of heat transfer is 20 $W/m^{2o}C$. Estimate the length up to which there will be ice formation. Assume the end of the fin to be completely insulated.	5
3A.	With neat sketch discuss the various regimes in boiling heat transfer.	5
3B.	A sheet metal air duct carries air conditioned air at an average temperature of 10°C. The duct size is 320mm x 200mm and the length of the duct exposed to the surrounding air at 30°C is 15m long. Find the heat gain by the air in the duct. Assume 200mm side is vertical. Use the following properties: $Nu = 0.60(Gr.\Pr)^{1/4}$ for the vertical surface, $Nu = 0.27(Gr.\Pr)^{1/4}$ for the	5

horizontal surface.

Take the properties of the air at the mean temperature (20°C) as given below: $\rho = 1.204 kg/m^3$, $\mu = 18.2\times10^{-6} kg/ms$, $k = 0.256 W/m^0C$, $\Pr = 0.71$

4A. Derive the expression for temperature distribution and heat transfer rate from an extended surface with insulated tip. **5**

4B. A vertical tube of 60mm outside diameter and 1.2m long is exposed to steam at atmospheric pressure. The outer surface of the tube is maintained at a temperature of 50°C by circulating cold water through the tube. Calculate (i) The rate of heat transfer to the coolant, (ii) The rate of condensation of steam.

Take the thermo-physical properties of water at mean temperature as follows: $\rho_l = 975 kg/m^3$, $\mu = 375\times10^{-6} kg/ms$, $k = 0.67 W/m^0C$. **5**

Take the properties of vapor at saturation temperature as follows: $\rho_v = 0.596 kg/m^3$, $h_{fg} = 2257 kJ/kg$. The correlation for condensation on a vertical surface is given by $h = 1.13\left[\frac{\rho_l(\rho_l-\rho_v)k^3 g h_{fg}}{\mu L(t_{sat}-t_s)}\right]^{1/4}$

5A. Show by means of dimensional analysis for forced convection heat transfer, the Nusselt number is a function of Reynolds number and Prandtl number. **5**

5B. An oil is to be cooled to 100ºC in a concurrent heat exchanger by transferring its heat to cooling water that leaves the exchanger at 30ºC. However, it is now required that the oil must be cooled down to 75ºC by increasing the length of heat exchanger, while oil and water flow rates, their inlet temperature and other dimensions of the exchanger keeping constant. The inlet temperature of water and oil being 15ºC and 150ºC respectively. If the original cooler was 1 m long, Calculate: Outlet temperature of water in new cooler and Length of new cooler. **5**

6A. Derive an expression for effectiveness by NTU method for parallel flow heat exchanger. **5**

6B. A cryogenic fluid flows through a long tube of 20 mm diameter, the outer surface of which is diffuse and gray (ϵ_1=0.02) at 77K. This tube is concentric with a larger tube of 50 mm diameter, the inner surface of which is diffuse and gray (ϵ_2=0.05) and at 300K. The space between the surfaces is evacuated. Calculate the heat gain by cryogenic fluid per unit length of tube. If a thin radiation shield of 35 mm diameter (ϵ_3=0.02) both sides is inserted midway between the inner and outer surfaces, calculate the percentage change in heat gain per unit length of the tube. **5**