Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (MECHANICAL ENGINEERING)

END SEMESTER EXAMINATIONS, JUNE/JULY 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 suitably assumed.

1A. Define critical thickness of insulation. Derive an expression for critical thickness of insulation for a sphere. **5**

1B. Find the steady state heat flux through a composite slab made of two materials A and B. Thermal conductivities of the materials vary with the temperature linearly as k_a = 0.4 (1+0.008 T), k_b = 0.5 (1+0.001 T) Where T expressed in °C. Thickness L_a = 10 cm and L_b = 5 cm. Inner side temperature of the slab A is 600°C and the outside temperature of the slab B is 30 °C. **5**

2A. Derive an expression for rate of heat transfer between two infinite parallel gray plates. **5**

2B. Two long rods of the same diameter, one made of brass (k = 85 W/mK) and other made of copper (k = 375 W/mK) have one of their ends inserted into a furnace. Both the rods are exposed to same environment. At a distance of 105 mm away from the furnace, the temperature of brass rod is 120°C. At what distance from the furnace, the same temperature would be reached in the copper rod? **5**

3A. Differentiate between (i) Nucleate and Film Boiling (ii) Film wise condensation and Drop wise condensation **5**

3B. The water in a tank at 20^0C is heated by passing the steam through a pipe of 50 cm long and 5 cm in diameter. If the pipe surface temperature is maintained at 80^0C find the heat loss from the pipe per hour. If the pipe is **5**

kept vertical, then find out heat loss from the pipe per hour. Properties of water at 50^0C : ρ = 988.1 kg/m^3, C_p = 4.2 KJ/kg-K, K = 0.64 W/m ^{0}C, v = 0.556 x 10^{-6} m^2/s, μ= 0.55 x 10^{-3} kg/m-s, β = 5.1 x 10^{-4} /K. Use the following correlation $Nu_a = h_aL/K = 0.13\ (Gr.\ Pr)^{1/3}$

4A. Derive the equation for temperature distribution and heat transfer rate through a fin connected to two heat sources maintained at different temperatures. **5**

4B. 100 tubes of 12 mm diameter are arranged in a square array and are exposed to steam at atmospheric pressure. Calculate mass of steam condensed per unit length of tube if the tube wall is maintained at 98 °C. Properties of water film at mean temperature are ρ = 960 kg/m^3, μ = 282 × 10^{-6} kg/ms, h_{fg} = 2255 kJ/kg, k = 0.61 W/m C, T_{sat} = 100°C for water. Use the equation, h = 0.725 $\left[\frac{\rho^2 g h_{fg} k^3}{\mu N d (T_{sat} - T_w)}\right]^{1/4}$ **5**

5A. Show by dimensional analysis that free convection heat transfer phenomenon, the Nusselt number is a function of Prandtl number and Grashoff number. **5**

5B. Engine lubricating oil is cooled from 150 °C to 80°C in a parallel flow heat exchanger using water. The water temperature passing through the exchanger increases from 25°C to 60°C. Find the effectiveness and NTU. If the fluid flow rates and inlet conditions remain unchanged find the lowest temperature to which the oil can be cooled by increasing the length of the heat exchanger. **5**

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

6B. The inner surface of Dewar Flask is 30 cm diameter and outer sphere is 36 cm diameter. Both the spheres are plated for which emissivity is 0.05. Estimate the rate at which liquid oxygen would evaporate. Liquid oxygen is at -183 °C. The outer sphere temperature is 20 °C. Assume latent heat of oxygen as 218.5 kJ/kg **5**