Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

VI SEMESTER B.TECH (MECHANICAL ENGINEERING)
END SEMESTER EXAMINATION – JUNE 2017
SUBJECT: HEAT TRANSFER (MME 3201)
REVISED CREDIT SYSTEM

Time: 3 Hour **Max. Marks: 50**

Note: (i) Answer all questions
(ii) Missing data, if any, may be appropriately assumed
(iii) Draw the sketch as applicable
(iv) Assumptions made must be clearly mentioned

1A	Derive an expression for steady state heat transfer through a composite wall.	04
1B	Calculate the admissible current intensity for a 2 mm diameter copper wire covered with plastic insulation of optimum thickness so as to have positive heat transfer on the condition that the maximum temperature of insulation should not exceed 60^{o}C and the temperature of the surrounding to be 30^{o}C. The thermal conductivity of plastic is 0.015 W/m^{o}C and the electrical resistance of the copper wire is 0.005 Ω/m. Assume the surface heat transfer coefficient to be 10 $W/m^{2o}C$.	04
1C	Explain the significance of Biot number in lumped system analysis.	02
2A	Derive an expression for temperature distribution in a solid sphere in which one-dimensional radial conduction is taking place under steady state condition with uniform heat generation.	05
2B	A steel tube carries steam at a temperature of 330°C. A thermometer pocket of iron (*k = 48 W/m°C*) of inside diameter *16 mm* and *0.8 m*m thick is used to measure the temperature. The error to be tolerated is 2 % of maximum. Estimate the length of the pocket necessary to measure the temperature within this error. The diameter of steel tube is 80 mm. Assume $h = 508\ W/m^2\,°C$ and tube wall temperature is *120°C*. Suggest a suitable method of locating the thermometer pocket.	05
3A	Using Buckingham's π theorem, derive all the non-dimensional variables for a forced convection system.	04
3B	Lubricating oil of sp. gravity *0.853* flows at a rate of *120 kg/hr* through a *10 mm* diameter tube maintained at *30 ^{o}C*. Estimate the length of the tube required if the oil enters at *80 ^{o}C* and leaves at *76 ^{o}C*. Take property of oil at mean temperature as follows: $k = 0.13863\,W/m^{o}C,\ \nu = 41.6\times10^{-6} m^2/s,, \Pr = 546, Cp = 2.139\,kJ/kg^{o}C$ $Nu = 1.56(\text{Re}.\Pr)^{0.333}(D/L)^{0.333}$	04
3C	Explain the phenomena of dropwise and film condensation.	02
4A	Derive an expression for calculating the effectiveness of a counter flow heat	05

exchanger in terms of overall heat transfer coefficient, area of heat exchanger and the heat capacity

4B A heat exchanger is to heat water from 20^0C to 60^0C while water is flowing through tubes of 25mm outer diameter and 20mm inner diameter and 4m long. Heat is supplied by steam condensing outside the tubes at 100^0C. The total water flow rate through all the tubes is 680 kg/min and the thermal conductivity of the tube is 325 W/m^{0}C. The inside and outside film coefficient can be taken as being 4100 W/m^2 ^{0}C and 800 W/m^2 ^{0}C. Estimate the total number of tubes required. 05

5A Derive expression for intensity of radiation (I) in terms of emissive power of a body (E) 05

5B 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. 05