Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VI SEMESTER B. TECH (MECHANICAL ENGINEERING)

END SEMESTER EXAMINATIONS, JUNE 2019

SUBJECT: HEAT TRANSFER [MME 3201]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data if any, may be suitably assumed.

1A. Explain critical thickness of insulation. Derive an expression for critical thickness of insulation for a sphere for maximum heat dissipation. **05**

1B A metal plate of 4mm thickness (k = 95.5 W/m°C) is exposed to vapour at 100 °C on one side and cooling water at 25 °C on the opposite side. The heat transfer coefficients on vapour side and water side are 14500 W/m^2°C and 2250 W/m^2°C respectively. Determine the rate of heat transfer, the overall heat transfer coefficient, and temperature drop at each side of heat transfer. **05**

2A Derive an expression for the temperature distribution across a solid cylinder of radius R and uniform heat generation q W/m^3 which is exposed to convective boundary condition. **05**

2B The installation of fins is under consideration for the purpose of heat dissipation from air cooled cylinder head 300 mm x 100 mm. If the surface temperature is 600°C and the heat transfer coefficient between surface and air at 40 °C is 8 W/m^2°C, compare the heat transfer rate from the surface of the cylinder head without fins, with the heat transfer rate when 10 cast iron thin rectangular fins 25/30 mm and 100 mm long are provided on the surface of the cylinder head. Thermal conductivity of cast iron is 35 W/m°C. **05**

3A Using Buckingham's pi theorem, derive the dimensionless parameters such as Grashoff's numbers, Prandtl number and Nusselt number for a free convection system. **04**

3B Water flows inside a tube of 50 mm diameter and 3 m long at a velocity of 0.8 m/s. If the mean water temperature is 50 ^{o}C and wall temperature is 70 ^{o}C, estimate the rate of heat loss from the surface. Use the correlation

$Nu = 0.023(\mathrm{Re})^{0.8}(\mathrm{Pr})^{0.4}$

Properties of water at mean temperature of 60 ^{o}C are given as **03**

$\rho = 977.8$ kg/m^3, $k = 0.6671$ W/m^{o}C, $c_p = 4.186$ kJ/kg^{o}C, $\mu = 41.4\times10^{-6}$ Ns/m^2,

$\beta = 6.2\times10^{-4}$ /^{o} C

3C With suitable sketches explain the boiling regimes and explain their significance. **03**

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

4B Derive an expression for effectiveness of a counter flow heat exchanger using NTU method. **05**

5A Explain the term Radiocity. Using electrical analogy, derive an expression for radiation heat exchange between two parallel plates. Show the circuit diagram for space and surface resistances. **05**

5B Derive an expression for intensity of radiation (I) in terms of emissive power of a body (E). **05**