Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH (MECHANICAL ENGINEERING)
END SEMESTER EXAMINATION – APRIL 2018
SUBJECT: HEAT TRANSFER (MME 3201)
REVISED CREDIT SYSTEM

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

Note: (i) Answer all the 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 cylinder with convective boundary condition on the inside and outside walls. Also obtain an expression for the overall heat transfer coefficient. 04

1B Calculate the maximum temperature of the plastic insulation permissible for a copper wire of 2 mm diameter carrying 20 amps of current with an electric resistance of 0.005 Ω/m. The insulating plastic material (k = 0.015 W/m^oC) is having an optimum thickness, to allow maximum heat dissipation. Assume the surface heat transfer coefficient to be 10 $W/m^{2o}C$ and the ambient temperature to be 30^oC. 04

1C Explain the significance of Biot number and applicability of lumped system in transient heat transfer analysis. 02

2A Derive an expression for temperature distribution across a plane wall with uniform heat generation in which one-dimensional horizontal heat conduction is taking place under steady state conditions. Assume the two side walls to be maintained at the same temperature T_w. 05

2B Two long rods of the same diameter, one made of brass (k = 85 W/m°C) and other made of copper (k = 375 W/m°C) have one of their ends inserted into the furnace. Both of them are exposed to the same environment. At a distance 105 mm away from the furnace end, the temperature of the brass rod is 120°C. At what distance from the furnace end the same temperature would be reached in the copper rod? 05

3A Explain with suitable sketches and graphs, the boiling regimes, boiling curve, film-wise condensation and drop-wise condensation 04

3B A vertical plate measuring 180 mm x 180 mm and at 50°C is exposed to atmosphere at 10°C. Compare the free convection heat transfer from this plate with that which would result due to forced convection over the plate at a velocity equal to twice the maximum velocity (u_{max}) which would occur in free convection boundary layer.

The thermo-physical properties at 30°C are :

$k = 0.02673\ W/m°C;\ \upsilon = 16\ x\ 10^{-6} m^2/s; Pr = 0.701$

The correlations for free and forced convection are as follows.

For laminar flow, $Nu_L = 0.677\ (Pr)^{1/2}\left(0.952\ + Pr\right)^{-1/4}\left(Gr_L\right)^{1/4}$

$$u_{\max} = 0.766\upsilon\left(0.952+\frac{\upsilon}{\alpha}\right)^{-1/2}\left[\frac{g\beta\left(T_S - T_\infty\right)}{\upsilon^2}\right]^{1/2} x^{1/2}$$

The average Nusselt number with forced convection if velocity is assumed equal to 2 times u_{max}, is given by $Nu = 0.664\left(\mathrm{Re}\right)^{1/2}\left[\mathrm{Pr}\right]^{1/3}$ 04

3C Lubricating oil at a temperature of 60°C enters 10 mm diameter tube with a velocity of 3 m/s. The tube surface is maintained at 40°C. Assuming that the oil has the following average properties calculate the tube length required to cool the oil to 45°C.

$\rho = 865\ kg/m^3 : k = 0.14\ W/m\ °C;\ c_p = 1.78\ kJ/kg°C.$ *Nu = 3.657*

Assume flow to be laminar (and fully developed). Use the log mean temperature difference to calculate the convective heat transfer. 02

4A With suitable figures, derive an expression for rate of heat transfer of a counter flow heat exchanger in terms of log mean temperature difference. 05

4B Hot oil having a mass flow rate of 10000 kg/hr and specific heat of 1900 J/kg K is to be cooled from 200^0C. The mass flow rate of cooling water is 3000 kg/hr and enters the heat exchanger at 20^0C. The overall heat transfer coefficient is 300 W/m^2 ^{0}C. The total area of the exchanger is 17.5 m^2. Calculate the effectiveness of the heat exchanger and exit temperature of cold fluid for both parallel and counter flow arrangements. Take specific heat of water as 4180 J/kg^{o}C. 05

5A Determine the radiation heat loss from each meter of a 200 mm diameter heating pipe, when it is placed centrally in a brick duct of square cross section 320 mm side. Temperature of the pipe surface is 300^0C and the temperature of brick is 20^0C. Emissivity of the pipe surface is 0.8 and emissivity of brick = 0.9. Assume only radiation heat transfer between the pipe and brick duct. 05

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