# APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

**C**

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2015

**Mechanical Engineering**

**(Common to Thermal Engineering & Thermal Science)**

**01ME6203 Advanced Heat Transfer**

Max. Marks : 60                              Duration: 3 Hrs

*HMT data book may be permitted*

*Answer any two questions from each module*

## Part A

1. An aluminium sphere weighing 1 kg, initially at a temperature of 300°Cis suddenly immersed in a fluid at 10°C. If h= 10 W/m$^2$K, compute the time required to cool the sphere to 100°C. For aluminium, $\rho$=2700 kg/m$^3$, c=8900 J/kg°C, k=220W/mK          (9)

2. A Stainless Steel slab having an initial temperature 400 °C and of width 40 cm is dropped in a pool of oil having temperature 30 °C. Estimate the temperature at the mid plane of the slab after 100 sec. Assume a heat transfer coeff. at the interface of 15 W/m$^2$K.          (9)

3. a) What are the significances of Biot number and Fourier number?          (4.5)

   b) What are Heisler charts? How these charts can be used to solve transient conduction problems?          (4.5)

## Part B

4. a) State and derive Chilton Colburn analogy          (4.5)

   b) What are the significances of Nusselt, Grashoff, Prandtl and Stanton numbers?     (4.5)

5. Water is being heated from an inlet temperature of 30 °C to 60 °C by passing through a pipe having diameter 2 cm whose surface is maintained at 120 °C. Find the length of the pipe required, if the flow rate of water is 1 kg/min.          (9)

6. Derive the integral energy equation.          (9)

Part C

7. a) What are the significances of Wein-Displacement law? (6)
   b) How is mass transfer related to heat transfer? (6)
8. State and prove the reciprocity theorem. (12)
9. Estimate the diffusion rate of water at 30 °C from the bottom of a test tube 15 mm in diameter and 5 cm long into dry air at 30 °C. Take the diffusion coefficient of water in air as $0.35 \times 10^{-4}$ m$^2$/s. (12)