

Sixth Semester B.E. Degree Examination, Dec.2013/Jan.2014
Heat and Mass Transfer

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer FIVE full questions, selecting at least TWO questions from each part.
2. Use of heat transfer data book is permitted.

PART - A

1. a. Explain briefly the mechanism of conduction, convection and radiation heat transfer. (06 Marks)
 b. With sketches, write down the mathematical representation of three commonly used different types of boundary conditions for one dimensional heat equation in rectangular coordinates. (08 Marks)
 c. A plate of thickness 'L' whose one side is insulated and the other side is maintained at a temperature T_1 is exchanging heat by convection to the surrounding area at a temperature T_2 , with atmospheric air being the outside medium. Write mathematical formulation for one dimensional, steady state heat transfer, without heat generation. (06 Marks)
2. a. An electric cable of 10mm diameter is to be laid in atmosphere at 20°C . The estimated surface temperature of the cable due to heat generation is 65°C . Find the maximum percentage increase in heat dissipation, when the wire is insulated with rubber having $K = 0.155 \text{ W/mK}$. Take $h = 8.5 \text{ W/m}^2\text{K}$. (06 Marks)
 b. Differentiate between the effectiveness and efficiency of fins. (04 Marks)
 c. In order to reduce the thermal resistance at the surface of a vertical plane wall ($50 \times 50\text{cm}$), 100 pin fins (1 cm diameter, 10cm long) are attached. If the pin fins are made of copper having a thermal conductivity of 300 W/mK and the value of the surface heat transfer coefficient is $15 \text{ W/m}^2\text{K}$, calculate the decrease in the thermal resistance. Also calculate the consequent increase in heat transfer rate from the wall if it is maintained at a temperature of 200°C and the surroundings are at 30°C . (10 Marks)
3. a. Show that the temperature distribution in a body during Newtonian heating or cooling is given by $\frac{T - T_\infty}{T_i - T_\infty} = \frac{\theta}{\theta_i} = \text{Exp}\left(\frac{-h A_s t}{\rho C V}\right)$. (06 Marks)
 b. The steel ball bearings ($K = 50 \text{ W/mK}$, $\alpha = 1.3 \times 10^{-5} \text{ m}^2/\text{sec}$), 40mm diameter are heated to a temperature of 650°C . It is then quenched in a oil bath at 50°C , where the heat transfer coefficient is estimated to be $300 \text{ W/m}^2\text{K}$. Calculate:
 i) The time required for bearings to reach 200°C .
 ii) The total amount of heat removed from a bearing during this time and
 iii) The instantaneous heat transfer rate from the bearings, when they are first immersed in oil bath and when they reach 200°C . (14 Marks)
4. a. With reference to fluid flow over a flat plate, discuss the concept of velocity boundary and thermal boundary layer, with necessary sketches. (05 Marks)
 b. The exact expression for local Nusselt number for the laminar flow along a surface is given by $\text{Nu}_x = \frac{h_x x}{k} = 0.332 \text{ Re}_x^{1/2} \text{ Pr}^{1/3}$. Show that the average heat transfer coefficient from $x = 0$ to $x = L$ over the length 'L' of the surface is given by $2h_L$ where h_L is the local heat transfer coefficient at $x = L$. (05 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and/or equations written eg. $4 \times 4 = 50$, will be treated as malpractice.

Mechanical Engineering 6 Th Semester With File

David Kirk



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