

GUJARAT TECHNOLOGICAL UNIVERSITY**B. E. - SEMESTER – VI • EXAMINATION – WINTER 2012****Subject code: 160202****Date: 03/01/2013****Subject Name: Automobile Heat Transfer****Time: 02.30 pm - 05.00 pm****Total Marks: 70****Instructions:**

1. Attempt any five questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Discuss the various regimes of boiling and explain the condition for the growth of bubbles. What is the effect of bubble size on boiling? **07**
- (b) Explain the concept of critical thickness of insulation. How to decide the thickness of insulation for electrical wires and steam pipes. **07**

- Q.2** (a) Explain the following with reference to a heat exchanger: **07**
1. Fouling factor
 2. Effectiveness of heat exchanger
 3. Correction factor for multipass arrangement
- (b) A tubular heat exchanger is to be designed for cooling oil from a temperature of 80°C to 30°C by stagnant water which may be assumed to remain constant at a temperature of 20°C. The heat transfer surface consists of 30 m long straight tube of 20 mm inside diameter. The oil (specific heat = 2.5 kJ / kg K and specific gravity = 0.8) flows through the cylindrical tube with an average velocity of 50 cm / s. Calculate the overall heat transfer coefficient for the oil cooler. **07**

OR

- (b) What is the function of radiator in an automobile? Explain with a neat sketch construction of a radiator. Which are the main parameters that affect the performance of a radiator? **07**

- Q.3** (a) Explain how is the performance of fin assessed in dissipating the heat? Derive the expression for fin efficiency for a fin insulated at the tip. **07**
- (b) The inner and outer surface temperatures of a plain brick wall of dimension 5m long x 3 m high x 250 mm thick are 800°C and 20°C respectively. Calculate (a) the average thermal conductivity (b) thermal resistance and (c) the heat loss from the wall. Also calculate the temperature at 100 mm distance from the hot surface. Assume $k(\text{brick}) = (1 + 0.001 t) \text{ W/m K}$ where t is in °C. **07**

OR

- Q.3** (a) What are boundary and initial conditions? How many boundary conditions are needed to solve a second order differential equation for heat conduction? State and explain the different types of boundary conditions applied to heat conduction problems. **07**
- (b) An electrical cable of 5 mm radius is applied a uniform sheathing of plastic insulation ($k = 0.16 \text{ W/m-deg}$). The convective film coefficient on the surface of bare cable as well as insulated cable was estimated as $8 \text{ W/m}^2\text{-deg}$ and a surface temperature of 70 °C was noted when the cable was directly exposed to ambient air at 20°C. Calculate the most economical thickness and the corresponding increase in heat dissipation due to insulation. Also find out the **07**

increase in current carrying capacity of the cable by providing critical thickness of insulation.

- Q.4 (a)** By dimensional analysis show that for forced convection heat transfer, Nusselt number can be expressed as a function of Prandtl number and Reynolds number. **07**
- (b)** A steam pipe 6cm in diameter is covered with 2cm thick layer of insulation which has a surface emissivity of 0.92. The insulation surface temperature is 75°C and the pipe is placed in atmospheric air at 25°C. Considering heat loss by both radiation and convection, estimate the heat loss from 5m length of the pipe. Also calculate the overall heat transfer coefficient and the heat transfer coefficient due to radiation alone. The thermo physical properties of air at 50°C are $\rho = 1.092 \text{ kg / m}^3$, $c_p = 1.007 \text{ kJ / kg-deg}$, $\mu = 19.57 \times 10^{-6}$ and $k = 27.81 \times 10^{-3} \text{ W / m deg}$. Following co relation may be used $Nu = 0.53 (Gr Pr)^{0.25}$ **07**

OR

- Q.4 (a)** What do you understand by hydrodynamic and thermal boundary layers? Derive Von-Karman integral momentum equation for hydrodynamic boundary layer over a flat plate. **07**
- Q.4 (b)** A plate 0.3 m long is placed at zero angle of incidence in a stream of 15°C water moving at 1m/s. Find out the stream wise velocity component at the mid point of the boundary layer, the maximum boundary layer thickness and the maximum value of the normal component of velocity at the trailing edge of the plate. For water at 15°C, $\rho = 998.9 \text{ kg/m}^3$ and $\mu = 415.85 \times 10^{-2} \text{ kg/hr-m}$. **07**
- Q.5 (a)** Differentiate between : **07**
- (i) Emissive power and intensity of radiation
 - (ii) Absorptivity and emissivity of a surface
 - (iii) Gray and real surface.
- (b)** A furnace emits radiation at 2000K. Treating it as a black body radiation, calculate (i) monochromatic radiant flux density at 1μ wavelength (ii) wavelength at which emission is maximum and the corresponding radiant flux density. (iii) total emissive power **07**

OR

- Q.5 (a)** Prove that the temperature of a body at any time τ during Newtonian heating or cooling is given by the relation $(t - t_a) / (t_i - t_a) = \exp(-Bi Fo)$ where Bi and Fo are the Biot and Fourier numbers, t_a is the ambient temperature and t_i is the initial temperature of the body. **07**
- (b)** Two opposed parallel infinite planes are maintained at 420K and 480K respectively. Calculate the net heat flux between these planes if one has an emissivity of 0.8 and other an emissivity of 0.7. Does it matter which plate has which emissivity? How this heat flux will be affected if (i) the temperature difference is doubled by raising the temperature 480K to 540K (ii) the planes are assumed to be black. **07**
