CBCS SCHEME

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15MR64

Sixth Semester B.E. Degree Examination, June/July 2018
Heat Transfer

Time: 3 hrs. Max. Marks: 80

Note: *1.* **Answer any FIVE full questions, choosing ONE full question from each module.**
2. Data book is allowed.

Module-1

1 a. Explain boundary condition of first, second and third kind. **(08 Marks)**

b. A 0.8m high and 1.5m wide double pane window consists of two 4mm thick layers of glass (K = 78w/m°C) separated by a 10mm wide stagnant air space(K = 0.026 w/m°C). Determine the rate of heat transfer through this window and the temperature of the inside surface, when the room is maintained at 20°C and the outside air is at –10°C. Take the convection heat transfer co-efficient on inside and outside. Surfaces of the window as 10 and 40w/m°C respectively. **(08 Marks)**

OR

2 a. Derive three dimensional heat conduction equation for Cartesian co-ordinates. **(06 Marks)**

b. Derive an equation for critical thickness of insulation for sphere. **(05 Marks)**

c. A eclectic 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 w/m°K. Take h = 8.5w/m°k. **(05 Marks**

Module-2

3 a. Derive an expression for temperature distribution and heat transfer for a short fin tip is insulated. **(08 Marks)**

b. Fins 12 in number having k = 75w/m°K and 0.75mm thickness protrude 25mm from a cylinder surface of 50mm diameter and 1m length placed in an atmosphere of 40°C. If the cylinder surface is maintained at 150°C and heat transfer co-efficient is 23w/m^{2}K. Calculate: i) rate of heat transfer ii) percentage of increase in heat transfer due to fins. **(08 Marks)**

OR

4 a. A household electric iron has a steel base which weights 1.5kg. The base has an iron surface of 0.06m^2 and is heated from the surface with a 500w heating element. Initially the iron is at a uniform temperature of 25°C. Suddenly the heating starts and the iron dissipates heat by convection from the ironing surface into an ambient at 25°C with a heat transfer co-efficient h = 15w/m^2°C. how long it takes for the iron to reach 110°C. Take (ρ = 2700 kg/m^3 c = 0.896 kJ/kg k, k = 200w/m°C). **(05 Marks)**

b. A person is found dead at 5 pm in a room which is at 20°C the temperature of body was measured to be 25°C when found and estimated heat transfer co-efficient (h) 8w/m^{2}C. Modeling the body as short cylinder of 30cm diameter and 1.7m long. Estimate the time of death of that person by using lumped system assume K = 0.617 w/m°C ρ = 996 kg/m^3 C = 4.817 kJ/kg°C and temperature of the body before dead = 37°C. **(05 Marks)**

c. An ordinary egg can be approximated as a 5cm diameter sphere. The egg is initially at a uniform temperature of 5°C and is dropped into the boiling water at 95°C. Taking the convective heat transfer coefficient of be 1200w/m^2°C, determine how long it will take for the center of the egg to reach 70°C take K = 0.627 w/m°C $\alpha = 0.151 \times 10^{-6}$m^2/sec. **(06 Marks)**

Module-3

5 a. Explain velocity and thermal boundary layer. **(05 Marks)**

b. Using dimensional analysis derives an expression relating Nusselt number, Prandtl and Grashoff numbers for natural convection. **(06 Marks)**

c. A hot plate 1m × 0.5m at 130°C is kept vertically in still air at 20°C. Find : i) heat transfer coefficient ii) heat lost to surroundings. **(05 Marks)**

OR

6 a. Air flows over a flat plate at 20°C, with a velocity of 3m/sec. the length, width and thickness of the plate are 100cm, 50cm and 2cm respectively. The top surface of the plate is maintained at 100°C. Calculate the heat lost by the plate. Take thermal conductivity of plate as 23w/m°K take $Nu_L = 0.664\ Re_L^{1/2}\ Pr^{1/3}$. **(08 Marks)**

b. Explain physical significance of the following dimensionless number :
i) Reynolds number ii) Nusselt number iii) Prandtl number iv) Groshoff number. **(08 Marks)**

Module-4

7 a. A double-pipe parallel–flow heat exchanger is to heat water (c = 4180 J/kg°C) from 25°C 60°C at a rate of 0.2kg/sec. The heating is to be accomplished by geothermal water (c = 4310J/kg°c) available at 140°C at a mass flow rate of 0.3kg/sec. The inner tube is thin-walled and has a diameter of 0.8cm. If the overall heat transfer co-efficient of the heat exchanger is 550w/m^2°C. Determine the length of the heat exchanger required to achieve the desired heating. **(08 Marks)**

b. Derive an expression for effectiveness of parallel flow heat exchanger. **(08 Marks)**

OR

8 a. Explain filmwise condensation and dropwise condensation. Why dropwise condensation is preferred over filmwise condensation **(04 Marks)**

b. A vertical square plate of size 30cm sides is exposed to steam at atmospheric pressure. The plate temperature is maintained at 80°C. Calculates the heat transfer rate and the mass of steam condensed per hour. **(06 Marks)**

c. With a neat sketch, explain the various regions of pool boiling. **(06 Marks**

Module-5

9 a. What is a blackbody, gray body? Does blackbody actually exist? How does gray body differ from blackbody? **(03 Marks)**

b. Prove that emissive power of a blackbody in a hemispherical enclosure is π times the intensity of radiation. **(08 Marks)**

c. Calculate the net radiation exchange per m^2 for two large parallel plates maintained at 800°C and 300°C. The emissivities of two plates are 0.3 and 0.6 respectively. **(05 Marks)**

OR

10 a. Explain the following : i) Plank's law ii) Wein displacement law
iii) Lambert's law iv) Kirchoff's law. **(08 Marks)**

b. A spherical tank with diameter 40cm filled with a cryogenic fluid at T_1= 100°K is placed inside a spherical container of diameter 60cm and is maintained T_2 = 300°K. The emissivities of inner and outer tanks are $\epsilon_1 = 0.15$ and $\epsilon_2 = 0.2$ respectively. A spherical radiation shield of diameter 50cm and having emissivity $\epsilon_3 = 0.05$ on both surfaces is placed between the spheres. Calculate rate of heat loss from the system by radiation also find rate of evaporation of the cryogenic liquid for $h_{fg} = 2.1 \times 10^5$ w sec/kg. **(08 Marks**

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