T.E. (SEM.-V) (CBSGS) (MECHANICAL ENGG.) 2nd June 2016

HEAT TRANSFER 3.00 pm to 6.00 pm

Mechanical/Automobile

QP Code : 31207

(3HOURS) [TOTAL MARKS 80

Question no.1 is compulsory.
Attempt any **THREE** from question no. 2 to 6.
Use of steam table is permitted.

Q1) Solve any **Four** 20

a) What is the radiation shield?

b) What is heat exchanger? Define 'heat exchanger effectiveness'.

c) Discuss 'Electrical analogy' of combined heat conduction and convection in a composite wall.

d) Explain briefly the condensation mechanism.

e) A solid copper sphere of 10 cm diameter ($\rho = 8954$ kg/m^3, $C_p = 383$ J/kg K, $k = 386$ W/m K), initially at uniform temperature $t_i = 250^0$C, is suddenly immersed in a fluid which is maintained at a uniform temperature $t_a = 50^0$C. The heat transfer coefficient between the sphere and the fluid is $h = 200$ W/m^2 K. Determine the temperature of the copper block at $\tau = 5$ min after the immersion.

Q2) a) Derive expression for temperature distribution and heat dissipation in a straight fin of rectangular profile for infinitely long fin. 08

b) In a straight tube of 60 mm diameter, water is flowing at a velocity of 12 m/s. The tube surface temperature is maintained at 70^{0}C and the flowing water is heated from the inlet temperature 15^{0}C to an outlet temperature of 45^{0}C. Calculate the following: 08

(i) The heat transfer coefficient from the tube surface to the water,
(ii) The heat transferred, and
(iii) The length of the tube.

Take the physical properties of water at its mean bulk temperature of 30^{0}C,
$\rho = 995.7$ kg/m^3, $C_p = 4.174$ kJ/kg K, $k = 61.718 \times 10^{-2}$ W/m K,
$\nu = 0.805 \times 10^{-6}$ m^2/s, Pr = 5.42

c) Define the natural convection and state few practical examples of it. 04

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Q3) a) Show by dimensional analysis for forced convection, $Nu = \varphi (Re, Pr)$ 08

b) A refrigerant suction line having outer diameter 30 mm is required to be thermally insulated. The outside air film coefficient of heat transfer is 12 W/m^2 K. The thermal conductivity of insulation is 0.3 W/m K, 06

(i) Determine whether the insulation will be effective;

(ii) Estimate the maximum value of thermal conductivity of insulating material to reduce heat transfer;

(iii) Determine the thickness of cork insulation to reduce the heat transfer to 22% if the thermal conductivity of cork is 0.038 W/mK.

c) What are Fourier and Biot Numbers? What is physical significance of these numbers? 06

Q4) a) Derive expression for effectiveness by NTU method for parallel flow. 08

b) Determine heat lost by radiation per meter length of 80 mm diameter pipe at 300^0C, if 08

(i) Located in a large room with red brick wall at a temperature of 27^0C;

(ii) Enclosed in a 160 mm diameter red brick conduit at a temperature of 27^0C.

Take ε (pipe) = 0.79 and ε (brick conduit) = 0.93

c) One side of metallic plate absorbs a heat flux of 1000 W/m^2. Its other side is insulated. The emissivity of surface is 0.8 and the convective heat transfer coefficient is 20 W/m^2 K. Ambient is maintained at 300 K. Determine the temperature of plate under steady state conditions. ($\sigma = 5.67 \times 10^{-8}$) 04

Q5) a) Derive an expression for shape factor in the following cases:
i) Hemispherical shape of radius R
ii) Two concentric cylinders 08

b) Hot air at 66^0C is cooled up to 38^0C by means of cold air at 15^0C. Mass flow rate of hot and cold air are 1.25 kg/s and 1.6 kg/s respectively. Specific heat of hot and cold air are 1.05 kJ/kg K, U = 80 W/m^2 K, find the area of the heat exchanger for parallel and counter flow configuration. 08

c) Explain Reynold's Analogy. 04

Q6) Write short note (any three) 20

a) Radiosity and Irradiation

b) Discuss in brief various modes of Boiling.

c) Significance of dimensionless numbers used in heat transfer by convection.

d) Lump system analysis.