5. a) What portion of electromagnetic spectrum in covered by thermal radiation?
   b) What is a black body? Give examples of some surface which do not appear black but have high value of absorptivity.
   c) Differentiate between film wise and drop wise condensation.
   d) The distance of sun from earth is 150×10^6 km. If the radius of sun is 0.7×10^6 km and temperature 6200 k, estimate approximately the mean temperature of the earth. Assume that the rate of radiation transfer from the sun to the earth is equal to the rate of radiant transfer from the earth to the outer space which is at 0 k. Consider sun and earth as black body.

OR

Two large parallel plates with $\varepsilon = 0.5$ each are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net heat transfer.

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Roll No ....

ME - 605

B.E. VI Semester

Examination, June 2015

Heat and Mass Transfer

Time : Three Hours

Maximum Marks : 70

Note: i) Answer five questions. In each question part A, B, C is compulsory and D part has internal choice.
ii) All parts of each questions are to be attempted at one place.
iii) All questions carry equal marks, out of which part A and B (Max.50 words) carry 2 marks, part C (Max.100 words) carry 3 marks, part D (Max.400 words) carry 7 marks.
iv) Except numericals, Derivation, Design and Drawing etc.
v) Use of standard HMT data book is permitted.

1. a) Define thermal conductivity. How it can be determined?
   b) Explain the resistance concept to illustrate the analogy of heat flow and the flow of electricity.
   c) Show that the temperature variation for heat conduction through a cylindrical wall having uniform k is logarithmic.
   d) A 1 mm dia electric wire is covered with 2 mm thick layer of insulation (k = 0.5 W/mk). Air surrounding the wire is 25°C and h = 25W/m^{2}k. The wire temperature is 100°C. Find out
      i) The rate of heat dissipation from the wire per unit length with and without insulation.
      ii) Critical radius of insulation
      iii) Maximum value of heat dissipation.

OR

A composite slab has two layers of thickness 5cm and 10cm. The thermal conductivities of the materials of these layers are temperature dependent and given by the relations.

$k_1 = 0.05\,(1+0.006\,t)$ W/m -deg

$k_2 = 0.04\,(1+0.007\,t)$ W/m -deg, where t is the temperature in degree centigrade. The inside and outside surface temperatures of the slabs are maintained at 500°C and 200°C respectively. Determine the steady state heat flux through composite slab and the interface temperature.

2. a) What is the utility of extended surface?
   b) What are various types of fins?
   c) A very long copper rod 20 mm in diameter extends horizontally from a plate heated wall maintained at 100°C. The surface of the rod is exposed to an air environment at 20°C with convective heat transfer coefficient of 8.5 W/m²-deg. Workout the heat loss if the thermal conductivity of copper is 400 W/m -deg. Also estimate how long the rod be in order to be considered infinite.
   d) Show that the heat flow rate per unit width from a straight fin of rectangular cross section in governed by the relations.

   $Q = km\,\delta\theta_0 \tan h\ ml$ where k is thermal conductivity, h convective coefficient and δ is fin thickness and θ_0 is temperature excess at the base and l denotes the length of fin.

OR

Find out the amount of heat transferred through an iron fin of length 50 mm, width 100 mm and thickness 5 mm. Assume k = 210 kJ/mh°C and h = 42 kJ/ m²h°C for the material of fin and temperature at the base of the fin as 80°C. Also determine the temperature at tip of the fin if the atmosphere temperature is 20°C.

3. a) Why are heat transfer coefficients for natural convection much less than these of forced convection?
   b) What is the physical significance of Grashof number in heat transfer by natural convection?
   c) Explain the term dimensional homogeneity.
   d) Show by dimensional analysis for forced convection $Nu = \phi(Re\,,\,Pr)$

OR

Two horizontal surfaces separated by a distance of 5 cm have air between them at atmospheric pressure. Make calculation for the heat flux if the upper surface is at 50°C and lower surface is at 26°C.

4. a) Classify heat exchanger on the basis of direction of flow of fluids.
   b) What is LMTD? Draw temperature profile of condenser and find the LMTD value for it.
   c) What is Fick's law?
   d) Water is heated at the rate of 1.4 kg/sec from 40°C to 70°C by an oil (Cp = 1.9 kJ/kg k) entering at 110°C and leaving at 60°C in a counter flow heat exchanger. If U_0 = 350 W/m² k. Calculate the surface area required. Using the same temperature and same oil flow rate, calculate the exit temperatures of oil and water and the rate of heat transfer when the water flow rate is halved.

OR

Steam enters a counter flow heat exchanger dry and saturated at 10 bar and leaves at 350°C. The mass flow of steam is 800 kg/min. The gas enters the heat exchanger at 650°C and mass flow rate is 1350 kg/min. If the tubes are 30 mm diameter and 3 m long, determine the number of tubes required. Use following data.

For steam t_{sat} = 180°C, Cps = 2.71 kJ/ kg°C

hs = 600 W/m² °C

For gas Cpg = 1 kJ/kg°C, hg = 250 W/m² °C