Code No: R09221401 **R09** **Set No. 2**

II B.Tech II Semester Examinations,April/May 2012
FLUID MECHANICS AND HEAT TRANSFER
Mechatronics

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A vertical plate is heated from one side and is maintained at 96^0C. On the other side is air at 30^0C. Calculate:-
   i. Local value of convective Heat Transfer coefficients at distance of 20 cm from the lower edge.
   ii. Average value of convective Heat transfer coefficient over the whole 20 cm length of plate.

   (b) State the effect of non-condensable gases on condensation. [10+5]

2. A Pelton wheel is to be designed for the following specifications. Power = 735.75 kW S.P. Head = 200m, speed = 800 r.p.m., over all efficiency is 86% and jet diameter is not to exceed one-tenth the wheel diameter. Determine :
   (a) Wheel diameter
   (b) The number of jets required
   (c) Diameter of the jet.

   Take C_v = 0.98 and speed ratio = 0.45. [15]

3. (a) Explain the terms:
   i. Pipes in parallel
   ii. Equivalent pipe
   iii. Equivalent size of the pipe.

   (b) Show that the loss of head due to sudden expansion in pipe line is a function of velocity head. [9+6]

4. (a) In a two-dimensional flow, show that the line integral from one point to another point is equal to the difference between the velocity potential functions between the two points.
   (b) Show that the flow is continuous if the velocity components are u = xy; v = $x^2 - \frac{y^2}{2}$ [8+7]

5. (a) Why is a counter flow heat exchanger more effective than a parallel flow exchanger?
   (b) An oil cooler, of the concentric tube type is used for cooling oil at 65.6^0 C to 54.4^0 C with water at 26.7^0 C with temperature rise of 11.1^0 C. Assuming an overall heat transfer coefficient of 738 W/m^2k based on the outside area of the tubes determine the heat transfer surface area required for a design heat load of 190.5 KW for a single pass

i. parallel flow mode
ii. counter flow mode. [6+9]

6. (a) What are different modes of heat transfer? Explain them with suitable examples.
   (b) A 2000 W heater element of 0.04 m^2 is protected on the backside with insulation 50 mm thick of thermal conductivity 1.4 W/m K and the front side by a plate 100 mm thick with thermal conductivity of 45 W/m K. The backside is exposed to air at 5^0C with convection coefficient of 10 W/m^2 K and the front is exposed to air at 15^0C with convection coefficient of 250 W/m^2 K. Then determine
      i. the temperature of the heater element
      ii. the heat flow into the room. [7+8]

7. Find the pressure between L and M in figure 1. [15]

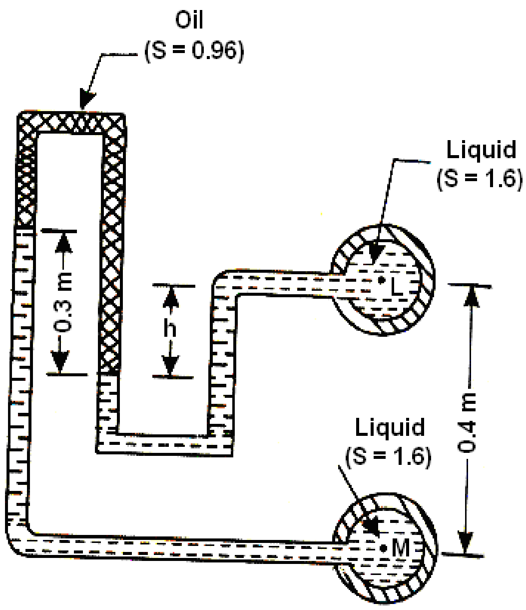

Figure 1:

8. (a) What is radiation shield? Explain the functions and applications.
   (b) Two parallel rectangular surfaces 1 m × 2 m are opposite to each other at a distance of 4 m. The surfaces are black and at 100^0C and 300^0C respectively. Calculate the heat exchange by radiation between the two surfaces. [7+8]

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Code No: R09221401 **R09** **Set No. 4**

II B.Tech II Semester Examinations,April/May 2012
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Mechatronics

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) List the range of dimensional and non dimensional specific speeds for the various types of hydraulic turbines.
   (b) What are the main advantages of model testing?
   (c) What is the function of the casing in the pelton turbines? [5+5+5]

2. (a) A stream function follows the law $\phi = 3$ xy. Show that the flow is irrotational and continuous.
   (b) A Stream function follows the law $\phi = 2(x^2 - y^2)$. Determine the velocity potential function. [8+7]

3. (a) Define the following
      i. Hydraulics
      ii. Fluid mechanics
      iii. Fluid
      iv. Statics.
   (b) The space between two parallel plates 5mm apart is filled with crude oil. A force of 2N is required to drag the upper plate at a constant velocity of 0.8 m/s. The lower plate is stationary. The area of the upper plate is 0.09 m^2. Determine :
      i. The dynamic viscosity
      ii. the kinematic viscosity of the oil in stokes if the specific gravity of oil is 0.9. [8+7]

4. (a) For the two cases of flow in a sudden contraction in a pipeline and flow in a sudden expansion in a pipeline, draw the flow pattern, piezometric grade line and total energy line.
   (b) What do you mean by "equivalent pipe" and "flow through parallel pipes"? [7+8]

5. (a) Explain the concepts of mean temperature difference.
   (b) A horizontal steel pipe of 5.25 cm I.D. and 6.03 cm O.D. is exposed to atmospheric air at 20^0C. Hot water at 98^0C flows through this pipe with a velocity of 15 m/min. Taking the following data calculate the overall heat transfer coefficient, based on the outer area of the pipe. k for steel 54W/mk, h_i = 1961 W/m^2k, h_o = 7.91 W/m^2k. [6+9]

6. (a) Define thermal conductivity and how it can be measured. What is the difference between thermal conductivity and thermal conductance?

   (b) A 0.8 m high and 1.5 m wide double pane window consists of two 4 mm thick layers of glass (78 W/mK) separated by a 10 mm wide stagnant air space (0.026 W/mK). Determine the rate of heat transfer through this window and the temperature of the inner surface, when the room is maintained at 20^0C. Take the convection heat transfer coefficients on the in side and the outside surfaces of the window as 10 and 40 W/m^2K respectively. [7+8]

7. A vertical tube of 60 mm outside diameter and 2.2 m long is exposed to steam at atmospheric pressure. The outer surface of the tube is maintained at a temperature of 50^0C by circulating cold water through the tube. Calculate

   (a) Rate of heat transfer to the coolant.

   (b) Rate of condensation of steam.

   Take properties as:-ρ_l= 975kg/m^3, $u_l = 375 \times 10^{-6}$, NS/m^2 ;K = 0.67 W/mk , ρ_v= 0.59kg/m^3. h_{fg} = 2257 kJ /kg. [15]

8. (a) Define view factor and discuss its importance.

   (b) If the intensity of radiation emitted by a surface covered with lamp back (α = 0.96) in the normal direction is 1.85×10^3 W/m^2. Calculate the temperature of the surface if it follows Lambert's cosine Law. [6+9]

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Code No: R09221401 **R09** **Set No. 1**

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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) The surface of steel plate measuring 0.9m long × 0.6m wide × 0.025m thick is maintained at a uniform temperature of 300^0C, and the plate loses 250 W by radiation. If air at 15^0C temperature and 20 W/m^{2}K convective heat transfer coefficient blows over the plate, calculate the temperature on inside surface of the plate. Take thermal conductivity of plate as 45 W/m K.

   (b) Derive expressions for temperature distribution during steady sate heat conduction in a solid sphere. [9+6]

2. (a) Explain the development of hydrodynamic boundary for flow across a cylinder.

   (b) Air at 27^0C flows across a 30mm diameter pipe (at 77^0C) with a velocity of 1 m/s. Compute the heat transfer rate per unit length of pipe. [7+8]

3. An orifice meter with orifice diameter 15 cm is inserted in a pipe of 25 cm diameter. The pressure gauges fitted upstream and downstream of the orifice gave readings of 19.82 N/cm^2 and 9.86 N/cm^2 respectively. Overall coefficient for the meter is given as 0.6. find the discharge of water through the pipe. [15]

4. (a) A U-tube containing mercury is used to measure the pressure of an oil of specific gravity 0.8 as shown in figure 2. Calculate the pressure of the oil, if the difference of mercury level be 0.5m.

   (b) A simple manometer (U-tube) containing mercury is connected to a pipe in which an oil of specific gravity 0.8 is flowing. The pressure in the pipe is vacuum. The other end of the manometer is open to atmosphere. Find the vacuum pressure in pipe, if the difference of mercury level in the two limbs is 200mm and height of oil in the left-limb from the centre of the pipe is 150 mm below. [8+7]

5. (a) Explain clearly the following terms as they are applied to a Pelton Wheel :

      i. Gross head
      ii. net head

   (b) A Pelton wheel is revolving at a speed of 200 rpm. and develops 5886 kW S.P. When working under a head of 200m with an overall efficiency of 80%, determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.48. Find the speed, discharge and power when this turbine is working under a head of 150 m. [7+8]

6. A counter flow heat exchanger is employed to cool 0.55 kg/s (Cp = 2.45 kJ/kg ^{0}C) of oil from 155^0C to 40^0C by the use of water. The inlet and outlet temperature of

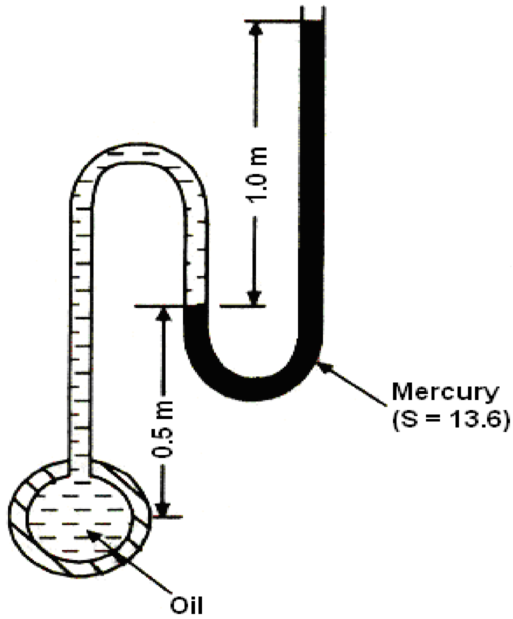

Figure 2:

cooling water are 15^0C and 75^0C respectively. The overall heat transfer coefficient is expected to be 1450 W/m^2 ^{0}C. Using NTU method, calculate the following:

(a) The mass flow rate of water

(b) The effectiveness of heat exchanger

(c) The surface area required. [15]

7. (a) State any three laws of Black body radiation.

   (b) Estimate the rate of solar radiation on a place normal to sun rays. Assume the sun to be a black body at a temperature of 5527^0C.The diameter of the sun is 1.39×10^6 km and its distance from the earth is 1.5×10^8km. [7+8]

8. An oil of specific gravity 0.82 and kinematic viscosity 16×10^{-6} m^2/s flows in a smooth pipe of 8 cm diameter at a rate of 2 l/s. Determine whether the flow is laminar or turbulent. Also calculate the velocity at the centre line and the velocity at a radius of 2.5 cm. What is head loss for a length of 10 m. What will be the entry length? Also determine the wall shear. [15]

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Code No: R09221401 **R09** **Set No. 3**

II B.Tech II Semester Examinations,April/May 2012
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Mechatronics

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. The net radiation from the surface of two parallel plates maintained at T1 and T2 is to be reduced by 99%. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange assuming the emissivities of the screens as 0.05 and that of surface as 0.8. [15]

2. (a) Define and explain hydraulic efficiency, mechanical efficiency and overall efficiency of a turbine.
   (b) Define the terms: specific speed of a turbine, unit speed, unit power and unit rate of flow of a turbine. Derive the expressions for specific speed and unit speed? [7+8]

3. Hot gases enter a finned tube heat exchanger at 300^0C and leave at 100^0C. It is used to heat water at a flow rate of 1 kg/s from 35^0C to 125^0C. The specific heat of exhaust hot gas is 1000 J/kg.K and the overall heat transfer coefficient based on the gas side is $U_h = 100$ W/m^2.K. Determine the required gas surface area using the NTU method. [15]

4. (a) Discuss the different modes by which heat can be transferred. Give suitable examples to illustrate your answer.
   (b) The interior of a refrigeration having inside dimensions of 0.5 m $\times$ 0.5 m base area and 1 m height, is to be maintained at 6^0C. The walls of the refrigerator are constructed of two mild steel sheets 3 mm thick (K = 46.5 W/m K) with 50 mm of glass wool insulation (K = 0.046 W/m K) between them. If the average heat transfer coefficients at the inner and outer surface are 11.6 W/m^2 K and 14.5 W/m^2 K respectively, calculate:
      i. The rate at which heat must be removed from the interior to maintain the specified temperature in the kitchen at 25^0C.
      ii. The temperature on the outer surface of the metal sheet. [7+8]

5. (a) What are the factors that influence the total drag on an aerofoil?
   (b) Explain circulation. What factors influence circulation?
   (c) Explain Magnus effect. [5+5+5]

6. Show that the velocity profile in laminar flow through a circular pipe is parabolic. Find the average velocity in terms of maximum velocity. [15]

7. (a) Derive expression for total pressure and centre of pressure for a vertically immersed surface.

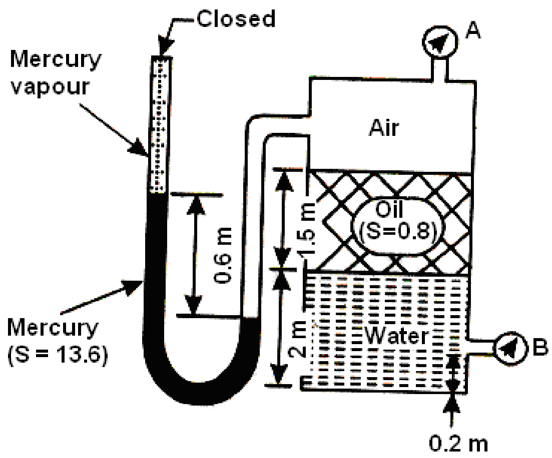

Figure 3:

(b) Find the gauge readings at A and B in figure 3. [7+8]

8. (a) Discuss briefly the effect of turbulence on boundary layers. Under forced flow conditions, how does Prandtl number affect the relative thickness of thermal and hydrodynamic boundary layers?

(b) Air at 20^0C is flowing along a heated flat plate at 150^0C at a velocity of 3 m/sec. The plate is 2 m long and 1.5 m wide. Calculate the thickness of the hydrodynamic boundary layer and the skin friction coefficient at 30 cm from the leading edge of the plate. Kinematic viscosity of air at 20^0C is 15.06×10^{-6} m^2/s. [7+8]

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