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

II B.Tech II Semester Examinations,APRIL 2011
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 Francis turbine with an overall efficiency of 70% is required to produce 147.15 kW. It is working under a head of 8m. the peripheral velocity = $0.30\sqrt{2gh}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gh}$. The wheel runs at 200 rpm. and hydraulic losses in the turbine are 20% of the available energy. Assume radial discharge, determine :
   (a) The guide blade angle
   (b) The wheel vane angle at inlet
   (c) Diameter of the wheel at inlet
   (d) Width of wheel at inlet. [15]

2. (a) Derive an expression to evaluate the mean temperature difference in a single pass counterflow shell and tube heat exchanger.
   (b) A heat exchanger heats 25,000 kg/hr of water entering at 30^0C while cooling 20,000 kg/hr of water from 100^0C to 80^0C. Determine the area necessary for
      i. Parallel flow arrangement
      ii. Counter flow arrangement.

   Overall heat transfer coefficient may be assumed as 1,600 W/m^2K. [7+8]

3. A fire hose of 75 mm dia. and 180 m length ends in a nozzle of 25 mm dia. The discharge coefficient of the nozzle is 0.94. The tip of the nozzle is 9 m above pump outlet. Calculate the head to be developed by the pump for a flow rate of 480 l/min, f = 0.048. [15]

4. (a) Distinguish between conduction, convection and radiation modes of heat transfer.
   (b) A composite slab consists of 250 mm fire clay brick (k = 1.09 W/mK) inside, 100 mm fired earth brick(0.26 W/mK) and outer layer of common brick (0.6 W/mK) of thickness 50 mm. If inside surface is at 1200^0C and outside surface is at 100^0 C, find:
      i. heat flux
      ii. the temperature of the junctions
      iii. the temperature at 200 mm from the outer surface of the wall. [6+9]

5. Find the difference in pressure between points A and B in figure 1. Neglect weight of air. [15]

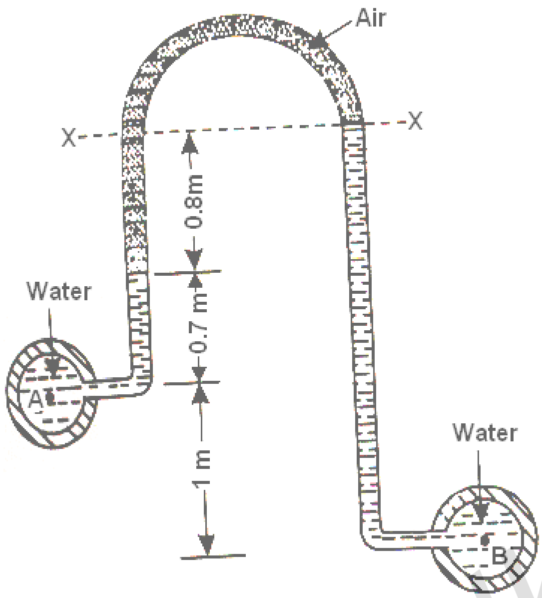

Figure 1:

6. (a) What are the factors that influence the total drag on an aerofoil?
   (b) Explain circulation. What factors influences circulation?
   (c) Explain Magnus effect. [5+5+5]
7. (a) Define view factor and discuss its importance.
   (b) If the intensity of radiation emitted by a surface covered with lamp back ($\alpha = 0.96$) 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]
8. (a) A horizontal fluorescent tube which is 3.8 cm in diameter and 120 cm long stands in still air at 1 atm. and 20^0C. If the surface temperature of the tube is 40^0C and radiation is neglected, what percentage of power is being dissipated by convection? Take properties of air as $v = 16.19 \times 10^{-6} m^2/sec.$, K air = 0.02652 W/mk, Pr = 0.706, ρ= 1.02 kg/m^3, Cp = 1.004 kJ/kg K
   (b) Explain with neat sketch development of velocity boundary layer on hot and cold vertical plate subjected to Natural Convection. [9+6]

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II B.Tech II Semester Examinations,APRIL 2011
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Mechatronics

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

Answer any FIVE Questions
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1. (a) A stream function follows the law $\phi = a \log\frac{x}{y}$. State If the flow is continuous or not. Also state if the flow is rotational or irrotational.
   (b) Calculate the velocity components if the velocity potential function follows the law $\phi = \log\frac{x}{y}$. [8+7]

2. (a) Explain briefly the following terms:
      i. Mass density
      ii. Weight density
      iii. Specific volume
      iv. Specific gravity.
   (b) A flat plate weighing 0.45 kN has a surface area of 0.1 m^2. It slides down an inclined plane at 30^0 to the horizontal, at a constant speed of 3 m/s. If the inclined plane is lubricated with an oil of viscosity 0.1 Ns/m^2, find the thickness of the oil film. [8+7]

3. (a) Give a detailed classification of heat exchangers.
   (b) Water enters a parallel flow double-pipe heat exchanger at 15^0C, flowing at the rate of 1200 kg/hr. It is heated by oil(C_p = 2000 J/kg.K), flowing at the rate of 500 kg/hr from an inlet temperature of 90^0C. For an area of 1 m^2 and an overall heat transfer coefficient of 1,200 W/m^2.K, determine the total heat transfer and the outlet temperatures of water and oil. [7+8]

4. Through the second pipe. Determine the discharge through a pipe system described below connecting two reservoirs with a difference in level of 6 m. A single pipe of 0.6 m dia. of 3000 m length takes off from the higher reservoir and feeds to a junction from which, two pipes of 0.3 m dia. and 3000 m length each feed the water in parallel to the lower reservoir. f = 0.04. [15]

5. (a) State and explain Newton's law of heat convection.
   (b) A refrigerator stands in room where the air temperature is 20^0C. The surface temperature on the outer side of the refrigerator is 16^0C, the sides are 30 mm thick having a thermal conductivity of 0.1 W/mK. The heat transfer coefficient on the outer side is 10 W/m^2 K. Assuming one dimensional conduction through the sides, calculate the net heat flow and the surface temperature inside the refrigerator. [4+11]

6. (a) Calculate the heat transfer from a 60 W incandescent bulb at 115^0C to ambient air 25^0C. Assume the bulb as a sphere of 50 mm diameter. Also find the percentage of power lost by free convection. Explain briefly the various regions in boiling heat transfer.

   (b) Explain the following Dimensionless number and their physical significance:

      i. Reynolds number
      ii. Prandtl number
      iii. Nusselt number. [9+6]

7. (a) Explain how hydraulic turbines are classified.

   (b) What are the types of turbines suitable under the following conditions :

      i. high head and low discharge
      ii. medium head and medium discharge
      iii. low head and large discharge.

   (c) What is the advantage gained by diverting the water jet on both sides by the splitter in the buckets of Pelton wheel. [15]

8. (a) What is radiation shield? Explain the functions and applications.

   (b) Two parallel rectangular surfaces 1 m $\times$ 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. 1**

II B.Tech II Semester Examinations,APRIL 2011
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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) What is an opaque body? Give examples of some surfaces which do not appear black, but have high values of absorptivities.
   (b) Calculate the rate at which radiant energy streams out from a conical cavity having a semi vertex angle of 45^0 and height 300mm, if the surface temperature is 600 K and the emissivity is 0.8. [6+9]

2. Define the term "Governing of a turbine". Describe with a neat sketch the working of an oil pressure governor. [15]

3. (a) What do you understand by the terms: Major energy loss and minor energy losses in pipes?
   (b) What do you understand by total energy line, hydraulic gradient line, pipes in series, pipes in parallel and equivalent pipe? [8+7]

4. (a) Derive an expression for the temperature profile in a thick walled cylinder during heat transfer by conduction under steady state.
   (b) A steel pipe (K = 50 W/m.K) of I.D. = 100 mm and O.D. = 110 mm is to be covered with two layers of insulation, each having a thickness of 50 mm. Thermal conductivity of the first insulation material is 0.06 W/m.K and that of the second is 0.12 W/m.K. Calculate the loss of heat per metre length of pipe and the interface temperature between the two layers of insulation when the temperature of the inside tube surface is 250^0C and that of the outside surface of the insulation is 50^0C. [7+8]

5. (a) Derive expression for total pressure and centre of pressure for a vertically immersed surface.
   (b) An inverted differential manometer containing an oil of sp. Gravity 0.9 is connected to find the difference of pressures at two points of a pipe containing water. If the manometer reading is 400 mm, find the difference of pressures. [7+8]

6. (a) Explain the development of hydrodynamic boundary layer for flow thorugh a tube.
   (b) A heavy lubricating oil(k = 0.072W/mk, μ = 0.3kg/ms) at room temperature flows in the clearance between the journal and its bearing. Calculate the maximum temperature rise in the lubricant for a velocity of shaft = 6.1m/s assuming both the bearing and the shaft are kept at same temperature. [7+8]

7. Assuming second degree velocity distribution in the boundary layer determine using the integral momentum equation, the thickness of boundary layer friction coefficient, displacement and momentum thicknesses. [15]

8. Explain the field of application, advantages and disadvantages of

   (a) double pipe heat exchanger
   (b) shell and tube heat exchanger
   (c) plate type heat exchanger
   (d) compact heat exchanger. [15]

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

II B.Tech II Semester Examinations,APRIL 2011
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) Define the term "Pressure". State and prove "Pascal's Law"
   (b) Define the following :
      i. Atmospheric pressure
      ii. Gauge pressure
      iii. Absolute pressure.
   (c) Convert a pressure head of 100 m of water to
      i. Kerosene of specific gravity 0.81
      ii. Carbon tetrachloride of specific gravity 1.6. [5+5+5]

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. How will you determine the loss of head due to friction in pipes by using
   (a) Darcy Formula
   (b) Chezys formula? [15]

4. (a) Sate and explain Kirchhoff's identity. What are the conditions under which it is applicable?
   (b) A diffuse reflector of area 0.2 m^2 is receiving radiation from a source with an intensity of 145 W/m^2. Calculate the absorpitivity of the reflector surface if it reflects 54.5 W.
   (c) Explain the concept of total emissive power of a surface. [6+5+4]

5. Velocity of oil at a point in a pipe is measured by Pitot tube connected to an inverted U-tube manometer with air at the top. If the difference in level in the manometer is 5 cm, find the velocity Assume K = 0.97. [15]

6. (a) Explain the mechanism of thermal conduction in gases, liquids and solids, Discuss the effect of temperature on thermal conductivity.
   (b) A thick concrete retaining wall is in contact with air on its exposed side. During a particular season, the daily variation in temperature of the air is sinusoidal over the range 10^0C to 25^0C, and the expected convection coefficient

is 11.35 W/m^{2}K, find the variation in temperature at the surface of the wall and at a point 50 mm inside the wall. Take $\alpha = 1.486 \times 10^{-3} m^2/hr$ and K = 1.73 W/ m K. [7+8]

7. (a) A horizontal steam pipe of diameter 20 cm runs through a large room and exposed to air at temperature of 20^{0}C. The pipe surface temperature is 280^{0}C. Find the flow of heat per meter length of the pipe by convection. Take properties of air as, $\rho = 0.946$ kg/m^3, $C_p = 1.009$ kJ/ kg K, K = 3.208×10^{-2} W/mK, v = 22.13×10^{-6} m^2/s

   (b) State and explain Buckingham π theorem. [9+6]

8. A refrigerator is designed to cool 300 kg/hr of hot fluid of specific heat, 3000 J/kg.K using a parallel flow arrangement. 1200 kg/hr of cooling water is available for cooling purposes at a temperature of 15^{0}C. If the overall heat transfer coefficient is 1,500 W/m^2.K, calculate the outlet temperatures of the cooled liquid and water and also the effectiveness of the heat exchanger. Take Surface area of the heat exchanger = 0.3 m^2 Heat capacity of water = 4186 J/kgK [15]

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