Code No: R05221402

Set No. 1

II B.Tech II Semester Supplimentary Examinations, Aug/Sep 2008
FLUID MECHANICS AND HEAT TRANSFER
(Common to Mechatronics and Production Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Why should a mercury column in a thin glass tube be depressed while a water column be lifted up ? [8]
   (b) The barometric pressure at sea level is 760 mm of mercury while on a mountain top it is found to be 735 mm. If the specific weight of air is 11.8 N/ m^3 calculate the height of the mountain. [8]
2. (a) What is a streak line ? What are the practical examples? [8]
   (b) If the stream function is given by $\psi = x^3 - 3xy^2$, determine whether the flow is rotational or irrotational. Find the velocity components at (4,7). [8]
3. (a) Name the different forces present in a fluid flow. What is Euler's equation of motion for this equation which forces are taken into consideration? [8]
   (b) Water is flowing through a pipe having diameters 30cm and 15 cm at the bottom and upper end respectively. The intensity if pressure at the bottom end is 29.43 N/cm^2 and the pressure at the upper end is 14.715 N/cm^2. Determine the difference in datum head if the rate of flow through pipe is 50 lit/sec. [8]
4. Derive the equation for head loss in pipes due to friction. Explain the variation of friction factor with Reynolds number. [16]
5. A cold room has the initial dimensions of 6 m $\times$ 6 m $\times$ 3m high. Each wall, including the ceiling and floor, consists of an inner layer of 25 mm thick wood, backed up, with a 75 mm thick layer of fibre glass and as the outside, 110mm layer of brick. The thermal conductivities are: Wood = 1.7 W/mK, Fibre-glass = 0.04 W/mK, Brick =1.15 W/mK surface heat transfer coefficients are: Wood to still air = 2.5 W/m^2 K, Turbulent air to brick = 4 W/m^2 K.
   Average external ambient temperature can be taken as 15^0C. It is required to maintain the interior temperature of the cold room at -15^0C. The enthalpy of evaporation of refrigerant in the evaporator is 150 kJ/Kg. Determine
   (a) The overall heat transfer coefficient
   (b) the mass flow of refrigerant through the refrigerant plant. [16]
6. (a) Explain the mechanism of heat flow by natural convection.
   (b) Calculate the rate of free convection heat loss from 30 cm diameter sphere maintained at 100^0C and exposed to atmospheric air at 20^0C. [8+8]
7. (a) State and explain Wien's law or radiation?

(b) Prove that the emissivity factor F_{1-2} for two concentric spheres is $\frac{1}{\frac{1}{E_1}+\left(\frac{r_1}{r_2}\right)^2\left(\frac{1}{E_2}-1\right)}$. It is given that total emissivities of the two spheres are E_1 and E_2 the outer radius of the inner sphere is r_1 and the inside radius of the outer sphere is r_2. [10+6]

8. (a) Obtain an expression for the overall heat transfer coefficient of a shell and tube exchanger taking into Consideration scale formation on the inside surface and film coefficients on the inside and outside Surface of the tube.

(b) A steam condenser works at a temperature of 60^0C transferring 250 kW of energy.The cooling water enters the condenser at 20^0C with a flow rate of 2kg/sec.find the logarithmic mean temperature difference. [8+8]

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1. (a) What do understand by vapour pressure of fluid ? What is its practical significance? [6]
   (b) The velocity distribution near the solid wall at a section is given by u=5 Sin (5xy). Compute the shear stress at points y = 0 and y=0.1m away from the boundary. The dynamic viscosity of the fluid is 5 poise. [10]

2. (a) What is a flow net? What are its uses ? Give examples. [8]
   (b) The flow field is described by V = (-Y^2)i - (6x)j . What is the equation of the stream line to pass through a point (12,15). [8]

3. (a) State and prove Bernoulli's theorem. Mention its limitations. [8]
   (b) An oil of specific gravity 0.84 flows through a uniform diameter pipe at the rate of 375 lit/sec. The energy head losses are 25 N-m/N per km length of the pipe. Find the slope of the hydraulic grade and total energy lines and the power lost per km of pipe. [8]

4. The population of a city is $8X10^5$ and it is to be supplied with water from a reservoir 6.4 km away. Water is to be supplied at the rate of $0.14m^3$ per head per day and half the supply is to be delivered in 8 hours. The full supply level of the reservoir is R.L 180.00. and its lowest water level is R.L.105.00. The delivery end of the main is at R.L 22.50 and the head required there is 12m. Find the diameter of the pipe. Take f= 0.04. [16]

5. (a) Identify the mode of heat transfer in the following examples.
      i. Coffee in a vacuum flask
      ii. A domestic boiler
      iii. Disc brake of a car during braking
   (b) The wall of a house 7m wide and 6 m high is made from 0.3 m thick brick with a thermal conductivity of 0.6 W/mk. The surface temperature on the inside of the wall is 16^0C and that as the outside is 6^0C. Find the heat flux through the wall and the total heat loss through it. [8+8]

6. (a) A gas flow (Pr = 0.71, $\mu = 4.63 \times 10^{-5}$ kg/ms and C_p = 1175 J/kg k) over a turbine blade of chord length 20 mm where the average heat transfer coefficient is 1000 W/m^2k. Calculate the Nusselt number.

(b) Calculate the heat transfer coefficient for water flowing through a 2 cm diameter tube with a velocity of 2.5 m/s. The average temperture of the water is 50^0C and surface temperature of the tube is slightly below this temperature. Assume the flow to be turbulent. The properties at 50^0C are given below:
$C_p = 4182$ J/kg k, K = 0.643 W/mK
$\rho = 988$ kg/m^3, $\mu = 544 \times 10^{-6}$ kg/ms. [6+10]

7. (a) When a body is said to be black? What is the range of wave lengths it absorbs?
   (b) Compute the radiant energy loss from 1 cm diameter opening in a thin walled furnace located in a large enclosure, if the temperature with in the furnace is 900^0C and the surroundings are at 20^0C. [6+10]

8. In a heat exchanger hot fluid enters at 180^0C and leaves at 118^0C. The cold fluid enters at 99^0C and leaves at 119^0C. Find the LMTD and effectiveness in the following cases .
   (a) counter flow
   (b) one shell passes and multiple tube passes
   (c) two shell passes and multiple tube passes
   (d) cross flow both fluid unmixed
   (e) cross flow , the cold fluid unmixed Also find NTU values. [16]

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Code No: R05221402 **Set No. 3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Define fluid surface tension property . What are its examples? [6]
   (b) The velocity distribution in a viscous flow over a plate is given by u = 4y - y^2 where u is velocity at distance y from the plate. If the coefficient of dynamic viscosity is 1.5 Pa.sec, determine the shear stress at y=0 and at y=2. [10]
2. (a) What is a streak line ? What are the practical examples? [8]
   (b) If the stream function is given by ψ= x^3 - $3xy^2$, determine whether the flow is rotational or irrotational. Find the velocity components at (4,7). [8]
3. (a) Differentiate between [8]
      i. Stream lines body and bulb body
      ii. Friction drag and pressure drag.
   (b) The air is flowing over a cylinder of diameter 10cm and of infinite length with a velocity of 15 cm/sec. Find the total drag, shear drag, pressure drag on 1m length of the cylinder if the total drag coefficient is 1.5 and shear drag coefficient is 0.25. The density of air is given as 1.25 kg/m^3. [8]
4. The population of a city is $8X10^5$ and it is to be supplied with water from a reservoir 6.4 km away. Water is to be supplied at the rate of $0.14m^3$ per head per day and half the supply is to be delivered in 8 hours. The full supply level of the reservoir is R.L 180.00. and its lowest water level is R.L.105.00. The delivery end of the main is at R.L 22.50 and the head required there is 12m. Find the diameter of the pipe. Take f= 0.04. [16]
5. (a) Identify the mode of heat transfer in the following examples.
      i. Coffee in a vacuum flask
      ii. A domestic boiler
      iii. Disc brake of a car during braking
   (b) The wall of a house 7m wide and 6 m high is made from 0.3 m thick brick with a thermal conductivity of 0.6 W/mk. The surface temperature on the inside of the wall is 16^0C and that as the outside is 6^0C. Find the heat flux through the wall and the total heat loss through it. [8+8]
6. (a) Calculate the appropriate Grashot numbers. State whether the flow is laminar of turbulent for the following case.
   A central heating radiator, 0.6m high with a surface temperture of 75^0C in a room at 18^0C (ρ = 1.2 kg/m^3, Pr = 0.72 and $\mu = 1.8 \times 10^{-5}$ kg/ms).

(b) An airplane wing in 1.2m wide and its surface is at 24^0C. The aeroplane is flying at 240 km/hr is air at 0^0C and 67 cm Hg pressure. Calculate the heat loss per metre length of the wing. [8+8]

7. (a) When a body is said to be black? What is the range of wave lengths it absorbs?

   (b) Compute the radiant energy loss from 1 cm diameter opening in a thin walled furnace located in a large enclosure, if the temperature with in the furnace is 900^0C and the surroundings are at 20^0C. [6+10]

8. A chemical (Sp.heat = 3.55 kj/kg-K) flowing at the rate of 3.8 kg /Sec enters a parallel flow heat exchanger at 94^0C. Cooling water enters the exchanger at 10^0C , the flow rate being 6.30 Kg/Sec . The heat transfer area is 15 m^2 and overall heat transfer coefficient is 1.132 kW/m^2-K. Find the outlet temperature of chemical and water and the thermal ratio of heat exchanger . If the quantities remain unchanged , Find the area required for a counter flow heat exchanger . [16]

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Set No. 4

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1. (a) Distinguish between gauge pressure and absolute pressure. [6]

   (b) A square flat plate of 1500 sq cm slides on oil of viscosity 0.75 Pa-sec. What force is required to drag the plate at a uniform velocity of 1.8 m /sec if the separating film is 2mm thick. [10]

2. (a) The velocity components in a flow field are given by u = 2xy and v = a^2 + x^2- y^2 , show that the flow is possible. Obtain the relevant stream function. [8]

   (b) Verify whether the following functions are valid potential functions

      i. ϕ = A xy ,
      ii. ϕ = m log x ,
      iii. ϕ = A(x^3- y^3) and
      iv. ϕ = A cos x [8]

3. (a) What do you understand by the total drag and resultant force on a body and coefficient of drag and coefficient of lift. [8]

   (b) A flat plate 1.5m ×1.5m moves at 50 km/hr in a stationary air of specific weight 1.15 kg /m^3. If the coefficient of drag and lift are 1.15 and 0.75 respectively determine

      i. The lift force
      ii. Drag force
      iii. The resultant force
      iv. The power required to keep the plate in motion

   [8]

4. The population of a city is 8X10^5 and it is to be supplied with water from a reservoir 6.4 km away. Water is to be supplied at the rate of $0.14m^3$ per head per day and half the supply is to be delivered in 8 hours. The full supply level of the reservoir is R.L 180.00. and its lowest water level is R.L.105.00. The delivery end of the main is at R.L 22.50 and the head required there is 12m. Find the diameter of the pipe. Take f= 0.04. [16]

5. Derive the heat conduction equation for a hollow spherical shell, taking the heat flux at the inner surface and temperature at the outer surface to have constant values. [16]

6. The parallel outer and inner walls of a building are 4m high and 5m long. The walls are 10 cm apart. The inner surface of the inner wall is at 25^0C and the inner surface of the outer wall is at 5^0C.

   (a) Calculate the total heat loss per hour.

   (b) If the air space is divided in half by a sheet of aluminium foil 0.025 mm thick parallel to the walls, what would be the heat loss per hour. [16]

7. (a) Explain the difference between the monochromatic emissive power and total emissive power of a black body.

   (b) A small oven measures 0.4m $\times$ 0.5m $\times$ 0.3 m. The floor of the oven receives radiation from all the walls and roof which are at 300^0C having an emissivity of 0.8. The floor is maintained at 150^0C and has an emissivity of 0.6. Calculate the radiation exchange. [6+10]

8. Steam is condensed in a single pass condenser at a pressure of 0.5 bar. The condenser consists of 100 thin walled tubes of 2.5 cm nominal diameter and 2m length .The cooling water enters and leaves at a temperature of 10^0C and 50^0C with a mean velocity of 2 m/Sec. The condensing heat transfer coefficient is 5 KW/m^2-K . Find

   (a) Overall heat transfer coefficient for heat exchanger

   (b) Condensation rate of steam

   (c) Mean temperature of metal at the center of condenser length. [16]

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