CODE NO: 07A40302 | R07 | SET No - 1

II B.TECH - II SEMESTER EXAMINATIONS, APRIL/MAY, 2011
FLUID MECHANICS AND HEAT TRANSFER
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All Questions Carry Equal Marks

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1.a) Define bulk modulus of fluids. What is its significance?

b) A cylindrical shaft of 90 mm diameter rotates about a vertical axis inside a fixed cylindrical tube of length 50 cm and 95 mm internal diameter. If the space between the tube and the shaft is filled by a lubricant of dynamic viscosity 2 poise, determine the power required to overcome viscous resistance when the shaft is rotated at a speed of 240 rpm. [8+8]

2.a) In a two dimensional flow, the fluid velocity components are given by u = x-4y and v = -y-4x. Show that the velocity potential exists and determine its form as well as stream function.

b) What does the smoke emitting from a lighted cigarette represent, stream line or path line or streak line? Why? [8+8]

3.a) State and prove Euler's equation of motion. Obtain the Bernoulli's equation from Euler's equation.

b) At a certain section A of pipe line carrying water, the diameter is 1 m, the pressure is 98.1 kN/m^2 and the velocity is 3 m/sec. At another section B which is 2 higher than A, the diameter is 0.7 and the pressure is 59.2 kN/m^2. What is the direction of flow? [8+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 10 cm diameter pipe is covered by two layers of insulation. The inside layer is 4 cm thick and has a thermal conductivity of 0.07 W/mK. The outside layer is 25 mm thick and has a thermal conductivity of 0.1 W/mK. The pipe conveys steam at a pressure of 1.7 MPa with 30^0 C degree of superheat. The outside temperature of the insulation is 24^0C. If the steam pipe is 20 m long determine:
a) The heat lost per hour and b) The interface temperature of the insulation
Neglect the resistance of the steam pipe. [16]

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 temperature 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
ρ = 988 kg/m^3, $\mu = 544 \times 10^{-6}$ kg/ms. [6+10]

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

b) Determine the heat lost by radiation per meter length of 8 cm diameter pipe at 300^0C if it is

i) Located in a large room with red brick walls at a temperature of 27^0C and

ii) Enclosed in a 16 cm diameter red brick conduit at a temperature of 27^0C.

Given emissivity of steel pipe as 0.79 and emissivity of brick conduit as 0.93. [6+10]

8. A multi pass heat exchanger (two passes on shell side and four passes on the tube side) is designed for the cooling of oil. The oil is passed through the tubes and cooled from 134^0C to 53^0C. The cooling water passing through the shell enters at 14^0C and leaves at 32^0C. Find the heat transfer rate for the following data.

h_1 (oil) = 268 W/m^2-K ; h_0 (water) = 962 W/m^2K;

h (scale on water side) = 2832 W/m^2K; Number of tubes per pass =118;

Length and outer diameter of each tube are 2 m and 2.5 cm;

Thickness of tube = 1.6 mm; LMTD correction factor = 0.97.

Neglect the tube wall resistance. [16]

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FLUID MECHANICS AND HEAT TRANSFER
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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Answer any FIVE questions
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1.a) State and prove Euler's equation of motion. Obtain the Bernoulli's equation from Euler's equation.

b) At a certain section A of pipe line carrying water, the diameter is 1 m, the pressure is 98.1 kN/m^2 and the velocity is 3 m/sec. At another section B which is 2 higher than A, the diameter is 0.7 and the pressure is 59.2 kN/m^2. What is the direction of flow? [8+8]

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3. A 10 cm diameter pipe is covered by two layers of insulation. The inside layer is 4 cm thick and has a thermal conductivity of 0.07 W/mK. The outside layer is 25 mm thick and has a thermal conductivity of 0.1 W/mK. The pipe conveys steam at a pressure of 1.7 MPa with 30^0 C degree of superheat. The outside temperature of the insulation is 24^0C. If the steam pipe is 20 m long determine:
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Neglect the resistance of the steam pipe. [16]

4. 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 temperature 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:
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Neglect the tube wall resistance. [16]

7.a) Define bulk modulus of fluids. What is its significance?
b) A cylindrical shaft of 90 mm diameter rotates about a vertical axis inside a fixed cylindrical tube of length 50 cm and 95 mm internal diameter. If the space between the tube and the shaft is filled by a lubricant of dynamic viscosity 2 poise, determine the power required to overcome viscous resistance when the shaft is rotated at a speed of 240 rpm. [8+8]

8.a) In a two dimensional flow, the fluid velocity components are given by u = x-4y and v = -y-4x. Show that the velocity potential exists and determine its form as well as stream function.
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   a) The heat lost per hour and b) The interface temperature of the insulation
   Neglect the resistance of the steam pipe. [16]

2. 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 temperature 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:
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   Length and outer diameter of each tube are 2 m and 2.5 cm;
   Thickness of tube = 1.6 mm; LMTD correction factor = 0.97.
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