Code.No: 07A40302 | R07 | SET-1

II B.TECH – II SEM EXAMINATIONS, DECEMBER - 2010
FLUID MECHANICS AND HEAT TRANSFER
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

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

2.a) What is velocity potential function? What is its use in the fluid flow analysis.
b) For the given three dimensional flow field described by $V = (x + y)i + (y + z)j + (x^2 + y^2 + z^2)w$ find the components of rotation at (1, 1, 1). [8+8]

3.a) Represent schematically the Bernoulli's equation for through a tapering pipe and show the position of total energy line and the datum line. Explain how Euler's equation is integrated to get Bernoulli's equation along a stream line.
b) An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter give readings of 14.715 N/cm^2 and 9.81 N/cm^2 respectively. Find the rate of flow of water through the pipe in lit/sec. Take $C_d = 0.6$. [8+8]

4. A pipeline 16 km long supplies 40 million liters of water per day to city. The first 5 km length of the pipe is of 1 m diameter and the remaining part is 0.8 m diameter pipe. If the water to the city is to be supplied at a residual head of 15 m of water calculate the supply head at the inlet end. Neglect minor losses and take f = 0.03 for the entire Pipe line. Sketch the hydraulic gradient for the pipe line. [16]

5.a) Derive an expression for the overall coefficient of heat transfer based on the inside area for the composite cylinder having two layers with fluid boundaries.
b) A brick wall 25 cm thick is faced with concrete of 5 cm thick. The thermal conductivity of the brick is 0.7 W/mK while that of the concrete is 0.9 W/mK. If the temperature of the exposed brick face is 30^0C and that of the concrete is 5^0C, find the heat loss per hour through a wall of 10 × 5 m. [8+8]

6.a) Define Nusselt and Prandtl numbers. Explain their importance in convection heat transfer.
b) A vertical pipe 5 cm diameter carrying hot water is exposed to ambient air at 15^0C. If the outer surface of the pipe is 65^0C, find the heat loss from one metre height of the pipe per hour. [8+8]

7.a) What do you mean by 'Gray surface'? Explain.
b) D meters outer diameter is located eccentrically in a D meters inner diameter sphere. Determine
i) The shape factor between outer sphere to inner sphere

ii) If the inner sphere diameter is 1 m and outer sphere diameter is 2 m then find the shape factor F_{2-1}
iii) If the temperature of the outer sphere is 300^0C and emissivity is 0.8 and the temperature of the inner sphere is 100^0C and emissivity is 0.6, for the same dimensions given in.
iv) Determine the heat transfer rate. [6+10]

8.a) Derive an expression for logarithmic mean temperature difference for the case of counter flow exchanger.

b) A liquid chemical flows through a thin walled copper tube of 12 mm diameter at the rate of 0.5 kg/sec water flows in opposite direction at the rate 0.37 kg/sec through the annular space formed by this tube and a tube diameter of 20 mm. The liquid chemical enters and leaves at 100^0C and 60^0C, while water enters at 10^0C. Find the length of tube required. Also find the length of tube required if the water flows in the same direction as chemical. The properties of water and liquid chemical are [8+8]

PRPERTIES 27^0C	LIQUID CHEMICAL AT 80^0C	WATER AT
ρ, Kg/m^3	1078	995
μ, Kg/m-Sec^2	3200×10^{-6}	853×10^{-6}
Cp, J/Kg-K	2050	4180
K, W/mK	0.261	0.614

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SET-2

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FLUID MECHANICS AND HEAT TRANSFER
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(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) What is kinematic viscosity? What are its units?

b) Two coaxial cylinders 10 cm and 9.75 cm in diameter and 2.5 cm high have both their ends open and have a viscous liquid filled in between. A torque of 1.2 N – m is produced on the inner cylinder when the outer one rotates at 90 rpm. Determine the coefficient of viscosity of the liquid. [6+10]

2.a) What do you mean by one, two and three dimensional flows? Give examples for each type?

b) The flow of the fluid has the velocity components u = 3x + y and v = 2x – 3y. Determine whether or not the flow is irrotational. [8+8]

3.a) Differentiate between
i) Stream lines body and bulk body
ii) Friction drag and pressure drag.

b) The air is flowing over a cylinder of diameter 10 cm and of infinite length with a velocity of 15 cm/sec. Find the total drag, shear drag, pressure drag on 1 m 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+8]

4. What is meant by hydraulic gradient line and what is meant by total energy line? Also draw both these lines for a horizontal pipe as well as an inclined pipe. Describe the Reynolds experiment. [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 7 m 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) Explain the boundary layer concept and define clearly hydrodynamic and thermal boundary layer thickness.

b) A rectangle duct 30 cm × 20 cm in cross section carries cold air. The temperature of the outer surface of the duct is 5^0C and surrounding air temperature is 25^0C. Find the heat gain by the duct assuming one duct is exposed to the air in vertical position.[8+8]

7. A thin polished copper plate having an emisivity of 0.06 is introduced as a radiation shield between two dull steel plates having an emisivity of 0.8.

a) Determine the fractional reduction in radiant energy transfer due to the presence of the shield.

b) What is the fractional reduction if the copper shield becomes oxidized having an emisivity of 0.6. [16]

8. A drying needs hot air at 135^0C. This is obtained by passing 2.45 Kg/Sec of atmospheric air at 1 bar pressure and 27^0C over tubes through which hot glycerin is circulated. The tubes have 20 mm diameter, 1.5 mm thickness, with a thermal conductivity of the material of the tube 50 W/m-K. The hot glycerin enters at 210^0C and leaves at 305^0C. Assuming counter flow, find

a) Overall heat transfer coefficient

b) Total heating surface and

c) Number of tubes and number of passes for heater length of 3.22 m, at average temperature, the properties for air; C_p = 1005 J/kg-K; R = 287 J/kg-K and connective heat transfer coefficient from air to metal h = 170 W/m^2-K for hot glycerin, C_p = 1885 J/kg-K; k = 0.13 W/m-K; m = 2.0×10^{-3} Kg/m-s and flow rate = 496 kg/sec-m^2 and the heat transfer coefficient for glycerin to metal is governed by the relation $hd/K = 0.023(Re)^{0.8}\ Pr^{0.4}$. [16]

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(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) Define fluid surface tension property. What are its examples?
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. [6+10]

2.a) What do you understand by stream tube? Explain in detail.
b) The stream function and velocity potential for a flow are given by $\psi = 2xy$ and $\phi = x^2 - y^2$. Show that the conditions of continuity and irrotational flow are satisfied. [8+8]

3.a) Define laminar boundary layer, turbulent boundary layer, laminar sub-layer and boundary layer thickness.
b) A 1.8m wide, 5m long plate moves through stationary air of density 1.22×10^{-3} gm/cc and viscosity 1.8×10^{-4} poise at a velocity of 1.75 m/sec parallel to its length. Determine the drag force on one side of the plate assuming
i) laminar flow condition
ii) turbulent flow condition. [8+8]

4. A pipe line 0.225 m in diameter and 1580 m long has a slope of 1 in 200 for the first 790 m and 1 in 100 for the next 790 m. The pressure at the upper end of the pipeline is 107.91 kpa and at the lower end is 53.955 kpa. Taking f = 0.032 determine the discharge through the pipe. [16]

5.a) What is the basic difference between conduction and radiation heat transfer processes?
b) Identify the modes of heat transfer in the following examples.
i) A car disc brake during braking
ii) A domestic boiler
iii) Heating a room using an electric fan heater
iv) Soldering an electric circuit board
v) Gas welding two sheets of steel plate. [6+10]

6.a) Explain the difference between laminar and turbulent flow.
b) Derive an equation for the film heat transfer coefficient in forced convection using dimensional analysis. What are its limitations? [6+10]

7.a) Is the absorptivity of a substance always equals to its emissivity? It so does this mean that energy absorbed is always equal to its emissivity? Does it also mean that the net gain of radiation energy is always equal to zero?

b) Two equal parallel black discs, 0.5 m diameter are located 0.25 m apart and directly opposite to each other. If the temperature of the discs are 200^0C and 50^0C, calculate the net radiant heat transfer per square meter of surface area. [8+8]

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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SET-4

II B.TECH – II SEM EXAMINATIONS, DECEMBER - 2010
FLUID MECHANICS AND HEAT TRANSFER
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) How do you find the force acting on a plane surface immersed in a static fluid medium?

b) A 90 mm diameter shaft rotates at 1200 rpm in a 100 mm long journal bearing of 90.5 mm internal diameter. The annular space in the bearing is filled with oil having a dynamic viscosity of 0.12 Pa.sec. Estimate the power required to keep the shaft in rotation. [8+8]

2.a) Define stream function. What is its significance in the analysis of fluid flow?

b) A certain flow pattern has a velocity potential $\phi = 12x^2 (3y-4)$. Determine the stream function and the velocity at (4,5). [8+8]

3.a) Define displacement thickness. Derive an expression for the displacement thickness.

b) A thin plate is moving in still atmospheric air at a velocity 4 m/sec. The length of the plate is 0.5 m and width is 0.4 m. Calculate the thickness of the boundary layer at the end of the plate and drag force on one side of the plate. Take density of air as 1.25 kg/m^3 and kinematic viscosity of 0.15 stokes. [8+8]

4. A pipe 50 mm dia is 6 m long and the velocity of flow of water in the pipe is 2.4 m/s. What loss of head and the corresponding power would be saved if the central 2 m length of pipe was replaced by 75 mm dia pipe, the change of section being sudden? Take f = 0.04 for the pipes of both diameter. Consider the minor losses also. [16]

5. Calculate

a) The rate of heat flow through 1 m^2 area of a clean heating surface of a steam boiler and surface temperature if the flue gas temperature is 1000^{0}C and boiling water temperature is 200^{0}C. The heat transfer coefficient from gas to wall and from wall to water are 100 W/m^2 ^{0}C and 5000 W/m^2 ^{0}C respectively. The thermal conductivity of the boiler wall material is 50 W/m ^{0}C and its thickness is 12 cm.

b) If the heating surface exposed to gas side is covered without layer of 1 mm (k = 0.08 W/m ^{0}C) and water side surface is covered with scale of 2 mm thickness (k = 0.8 W/m ^{0}C). Calculate the rate of heat flow through 1 m^2 area of boiler heating surface temperatures of the corresponding layers. [16]

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

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. [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. 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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