Code: 9A14403

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

FLUID MECHANICS & HEAT TRANSFER

(Mechatronics)

Time: 3 hours Max. Marks: 70

All questions carry equal marks

A total of five questions are to be answered with at least two questions from each part

Use separate booklets for Part A and Part B

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PART – A

1. (a) What are the different properties of liquid? Explain briefly.
   (b) Derive an expression of pressure difference across a spherical droplet. Using the result, find the surface tension in a soap bubble of 50 mm diameter when the inside pressure is 1.96 N/m^2 above the atmosphere.

2. (a) State and prove Bernoulli's theorem for flow liquids.
   (b) What are the practical applications of Bernoulli's theorem?

3. Derive an expression for the loss of head due to:
   (a) Sudden enlargement and
   (b) Sudden contraction of a pipe.

4. (a) State and explain the advantage of making flow over a curved vane over that on plane plate.
   (b) On what factors does the cavitation in water turbines depend? Enumerate some methods to avoid cavitaion in turbines.

PART – B

5. (a) What are the boundary and initial conditions?
   (b) A large window glass 0.5 m thick of (K=0.78 W/mK) is exposed to warm air at 25℃, over the its inner surface, with convection coefficient of 15 W/m^2K. The outside air is -15℃ with convection coefficient of 50 W/m^2K. Determine the heat transfer rate and temperature at the inner and outer surface of the glass.

6. (a) Define Laminar and Turbulent flows. What is Reynolds number?
   (b) Air at a temperature of 20℃ flows through a rectangular duct with a velocity of 10 m/s. The duct is 30 cm x 20 cm is size and air leaves at 30℃. Find the heat gain by air, when it is passed through 10 m long heat.

7. (a) State and explain Stefan Boltzmann law. Derive an expression for total emissive power of a block body.
   (b) State and explain Kirchhoff's identity. What are the conditions under which it is applicable?

8. (a) What are the limits of LMTD method? How is effectiveness-NTU method superior to LMTD method?
   (b) Consider a concentric tube heat exchanger with hot and cold water inlet temperature of 200℃ and 35℃ respectively the flow rates of hot and cold water are 42 kg/h and 84 kg/h respectively. Assume the overall heat transfer coefficient is 180 W/m^2K. (i) What is the maximum heat transfer rate that could be achieved for the prescribed inlet conditions? (ii) If the exchange is operates is counter flow arrangement with a heat transfer area of 0.33m^2, determine the outlet fluid temperatures.

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PART – A

1. (a) Distinguish between: (i) Newtonian and non-Newtonian fluids (ii) Gauge pressure and absolute pressure.
   (b) A liquid has a viscosity of 0.005 Ns/m^2 and density of 850 kg/m^3. Calculate the kinematic viscosity.

2. (a) Derive an equation to measure the quantity of water flowing through a venturimeter.
   (b) Determine the kinetic energy correction factor for laminar flow in a circular pipe.

3. Explain with the help of sketch.
   (a) Hydraulic gradient.
   (b) Total gradient line.
   (c) Pipes in series.
   (d) Pipes in parallel.
   (e) Equivalent pipe.

4. (a) Draw a schematic diagram of a Francis turbine and explain briefly its construction and working.
   (b) A reaction turbine consumes 120 m^3/sec while working under a head of 64 m. What is the unit discharge?

PART –B

5. (a) What does conduction refer to? State Fourier's law of heat conduction.
   (b) A long hollow cylinder (K=50 W/mK) has an inner radius of 10 cm and outer radius of 20 cm. The inner surface is heated uniformly at constant rate of 1.16 x10^4 W/m^2 and outer surface is maintained at 30 °C. Calculate the temperature of inner surface.

6. (a) Explain the mechanism of convection heat transfer.
   (b) Show by the dimensional analysis, that the Nusselt number is function of Reynolds number and Prandth number.

7. (a) What is a block body? What are its properties? Why does a cavity with a small hole behave as block body?
   (b) A block body is kept at a temperature of 727 °C. Estimate the fraction of the thermal radiation emitted by the surface is the wavelength band 1.0 and 5 μ.

8. (a) Compare the parallel flow and counter flow heat exchangers.
   (b) Derive an expression for Logmean temperature difference (LMTD) of a parallel flow heat exchanger.

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Use separate booklets for Part A and Part B

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PART – A

1. (a) Define surface tension and derive expressions for the pressure.
   (i) Within a droplet of water and (ii) Inside a soap bubble.
   (b) On what factors does the viscosity depend and define the term viscosity and give the units in which it is expressed.

2. (a) Define the following and give one practical example for each of the following:
   (i) Laminar flow (ii) Turbulent flow (iii) Steady flow and (iv) Uniform flow.
   (b) What do you understand by the term boundary layer? Describe with reference to flow over a flat plate.

3. (a) A pipe 0.15 m diameter taking off from a reservoir suddenly expands to 0.3 m at the end of 15 m and continues for another 15 m. Determine the actual velocity at the exit taking into account all the losses. Assume f = 0.01 for both the pipe sections.
   (b) Determine the relation for the estimation of f in terms of Reynolds number. For laminar flow in a horizontal circular pipe.

4. (a) How are the hydraulic turbines classified? Draw comparison between impulse and reaction turbine.
   (b) A pelton wheel is to be designed for a head of 60 m, when running at 200 rpm. The pelton wheel develops 95.65 kW shaft power. The velocity of the bucket is 0.45 times the velocity of the jet. Assume overall efficiency 0.85 and co-efficient of velocity as 0.98.

PART –B

5. (a) What are the three modes of heat transfer? Explain their differences.
   (b) For the case of a cylinder, discuss the conditions for one-dimensional heat conduction is a radial direction.

6. (a) Explain Buckingham –π theorem. What are the merits and demerits?
   (b) Write the physical significance of:
   (i) Nusselt number. (ii) Reynolds number (iii) Grashof number (iv) Prandtl number

7. (a) What is Wien's displacement law? Derive an expression for its relation.
   (b) Emissivities of two large parallel plates maintained at 800℃ and 300 ℃ are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter for these plates.

8. (a) What do you mean by fouling factor? State the causes of fouling.
   (b) A thin walled concentric tube counter flow heat exchanger is used to cool engine oil from 160℃ to 60℃ and water. Which is available at 25℃ acts as coolant. The oil and water flow rates are each 2 kg/sec and the diameter of the inner tube is 0.5 m and corresponding value of overall heat transfer coefficient is 250 W/m^2K. Find the length of the heat exchanger to get the desired cooling.

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Use separate booklets for Part A and Part B

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PART – A

1. (a) Why is the specific weight of sea water more than that of pure water? Give their numerical values.
   (b) State and prove the Pascal's law and give some examples where this principle is applied.

2. (a) Define and distinguish between streamline, path line and streakline.
   (b) For a laminar steady flow, prove that pressure gradient in the direction of motion is equal to the shear gradient normal to the direction of motion.

3. (a) Show that the loss of head due to sudden expansion in a pipeline is a function of velocity head.
   (b) A pipe carrying 0.08 cumecs of water suddenly contracts from 30 cm to 15 cm diameter. Calculate the coefficient of contraction if the loss of head is 0.5 m.
   (c) What do you understand by minor losses in pipes? When can these losses be neglected?

4. (a) Define and state the advantages of draft tube and justify why draft tube is not used in pelton wheel.
   (b) Define and explain
   (i) Hydraulic efficiency (ii) Mechanical efficiency (iii) Specific speed of turbine (iv) Overall efficiency of a turbine.

PART –B

5. (a) Differentiate between steady and transient heat conduction.
   (b) Derive the general heat conduction equation in the Cartesian coordinates system.

6. (a) What are the differences between the natural and forced convection?
   (b) Air at 27°C and 1 atm pressure flows over a heated plate with a velocity of 2 m/sec. The plate is at uniform temperature of 60°C. Calculate the heat transfer rate for 1 m width from (i) first 0.2 m of the plate (ii) first 0.4 m of the plate.

7. (a) Explain the concept of shape factor.
   (b) It is observed that intensity of the radiation emitted by the sun is maximum at wave length of 0.5µ . Assuming the sun to be a block body, estimate its surface temperature and emissive power.

8. (a) What is a heat exchanger? Classify the heat exchanger is three broad classes.
   (b) A heat exchanger is required to cool 55,000 kg/hr of alchohal from 66°C to 40°C using 40,000 kg /hr of water entering at 5°C. Calculate exit temperature of water, heat transfer rate and surface area required for.
   (i) Parallel flow type and.
   (ii) Counter flow type.

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