**THE OPEN UNIVERSITY OF SRI LANKA**

FACULTY OF ENGINEERING TECHNOLOGY

DIPLOMA IN TECHNOLOGY – LEVEL 02

**FINAL EXAMINATION 2008/2009**

**MEX2331 HEAT AND FLUIDS**

**DATE : 04 – 04 - 2009**

**TIME : 1.30 p.m. – 4.30p.m.**

**DURATION : 3 hours**

---

**Read the following instructions carefully before answering the questions**

1. This question paper consists of **eight** questions. Answer **any five** questions **only**.
2. All questions carry equal marks.
3. Time allocation for the paper is **03hrs.**
4. Do not spend more than **30 – 35** minutes for a question.

---

**Q1.** (a) Define the terms "energy" and "power" with their SI units of measurement.

(b) What is meant by "Alternative sources of energy"? Describe three alternative sources of energy available in Sri Lanka with their practical applications.

**Q2.** (a) Radial heat flow through a tube is given by the following formula.

$$Q = \frac{2\pi kL(T_i - T_o)}{\ln \frac{r_o}{r_i}}$$

Identify each term of the above formula and state their SI units of measurement.

(b) A circular sheet metal duct carries cold air to a cold storage room. The outside diameter of the duct is 250mm and is covered with a 50mm layer of insulation. The inner surface temperature of the duct is 0°C and the outer surface temperature of insulation is 25°C. The thermal conductivity of the insulation is 0.04W/mK.

(i) Calculate the rate of heat flow through the insulation per meter length of the duct neglecting the resistance to heat flow through the sheet metal.

(ii) If heat flow is to be reduced by 50% what should be the conductivity of the insulation?

**Q3.** (a) What are the different types of heat exchangers?

(b) Heat transfer in a parallel flow heat exchanger is given by the following equation.

$$Q = UA\left(\frac{\Delta t_1 - \Delta t_2}{\ln \frac{\Delta t_1}{\Delta t_2}}\right)$$

(i) Identify each term of the above equation and state their SI units of measurement.

(ii) Sketch the variation of temperature of the cold and hot fluids along the heat exchanger and mark the $\Delta t_1$ and $\Delta t_2$.

(iii) If the temperatures of the two fluids are as given below, calculate the heat transfer per unit area taking overall heat transfer coefficient as 600W/m$^2$K.

Hot fluid: inlet temperature = 100°C, Outlet temperature = 60°C

Cold fluid: Inlet temperature = 25°C, Outlet temperature = 50°C

**Q4.** (a) State the Bernoulli's equation for fluid flow and name its different terms.

(b) Water is pumped from a reservoir to a location situated 10m above the reservoir as shown in figure Q4. The diameter of the pipe is 50mm. The head loss per meter length of the pipe is 0.02m.

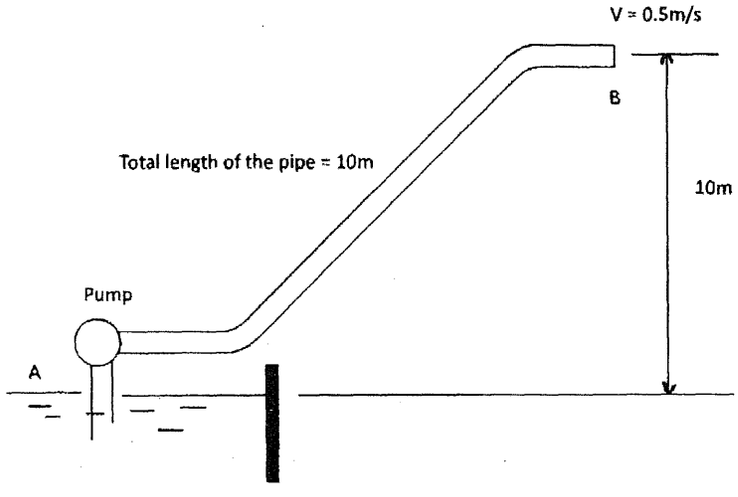



Figure Q4

(i) Write down the Bernoulli's equation between points A and B.

(ii) Determine the power of the pump.

(iii) What are the losses other than due to pipe friction that occur in this system?

(iv) Why is velocity at point A taken to be zero?

**Q5.** (a) State the Boyle's law and Charle's law. Show how these two laws can be combined to give $\frac{PV}{T} = \text{Constant}$

(b) A cylinder containing 20kg of compressed air at a pressure of 5 times that of the atmospheric pressure is stored at 5°C. When the temperature is increased to 30°C the safety valve released certain amount of air. If the safety valve allows air to escape when the pressure inside the cylinder exceeds 6 times atmospheric pressure, calculate the mass of air escaped.

**Q6.** (a) Show that the fluid pressure at a depth of h from the free surface of a reservoir is equal to hρg.

(b) (i) Explain with a diagram, how fluid pressure inside a tube is measured, using a U-tube manometer.

(ii) U-tube manometer is used to measure the pressure of a fluid flowing in a pipe. The density of the fluid is 1200kg/m$^3$. The liquid interface is 0.5m below the center of the pipe. The manometer liquid surface opened to the atmosphere is 1m above the liquid interface. If the density of the manometer liquid is 13,600kg/m$^3$, determine the pressure of the fluid in the pipe.

**Q7.** (a) A rectangular plate is immersed in a fluid, as shown in figure Q7(a). Show that the distance to the center of pressure from the free surface is given by the following formula.

$$h^* = \frac{2}{3}\left[\frac{h_1^3 - h_2^3}{h_1^2 - h_2^2}\right]$$

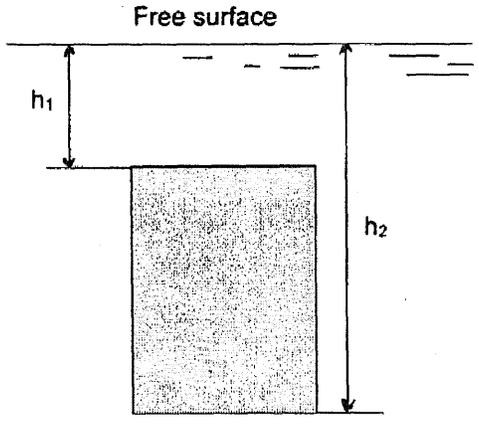



Figure Q7(a)

(b) A water tank has a rectangular gate of height 0.6m and width 0.8m as shown in figure Q7 (b).

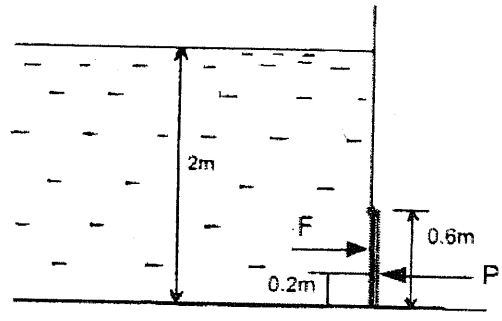



Figure Q7(b)

Determine the following

(i) The fluid thrust on the gate (F).
(ii) The distance (h) from the free surface to the point of action of F.
(iii) The value of force P required to keep the gate without opening.

**Q8.** (a) State Archimedes principle.

(b) A solid cylinder of diameter D and height h is floating in water. The immersed height of the cylinder is equal to D. When a solid sphere of diameter D is attached to the underside of the cylinder by means of a string, the cylinder just floats completely submerged in water and the string is tight.

Find the following

(i) Relative density of cylinder material in terms of D and h

(ii) Relative density of sphere material in terms of D and h

(iii) Tension of the string if D = 0.3m and h = 1m