THE OPEN UNIVERSITY OF SRI LANKA

FACULTY OF ENGINEERING TECHNOLOGY

DIPLOMA IN TECHNOLOGY

FINAL EXAMINATION 2010/11

MEX3212 Basic Thermo fluids/MEX2331 Heat and Fluids

Date: 14 – 03 – 2011

Time: 9.30am – 12.30pm

Duration: 3 hours

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Read the following instructions carefully before answering the questions.

1. This question paper consists of 8 questions. All questions carry equal marks
2. Answer any 5 questions only.

Q1. (a) State the modes of heat transfer. (3 marks)

Explain the mechanism of energy flow in each mode. (6 marks)

(b) A wall of a cold storage room has been built with 120mm thick brick wall, having an inner insulation layer of 20mm thick mineral wool. Outside the brick wall is paved with 10mm thick gypsum plaster. The inner surface of the cold storage wall is at 15°C and the outer surface is at 28°C.

(i) Calculate the heat loss through one square meter of the wall (7 marks)

(ii) If the temperature at the inner surface is to be maintained at 10°C with a heat loss of 25 W through the wall, what should be the thickness of the gypsum plaster? (4 marks)

Coefficients of thermal conductivity in W/mK are as follows.

Bricks – 0.72, Mineral wool – 0.04, Gypsum plaster – 0.45

Q2. (a) Explain what is meant by Renewable Energy Sources? (5marks)

(b) State three major Renewable Energy Sources available in Sri Lanka? (3 marks)

Briefly describe how these energy sources are tapped for useful applications by giving examples. (12 marks)

Q3. (a) Write down Bernoulli's equation for incompressible fluid flow and name the variables with their SI Units of measurement. (4 marks)

(b) A pump is used to lift water from a reservoir to a location, 20m above it. The diameter and the total length of the pipe are 5cm and 150m respectively. The head loss due to pipe friction can be accounted as 0.01m for one meter length.

Density of water and acceleration of gravity are 10^3 kg/m^3 and 10ms^{-2}respectively.

Find,

(i) Minimum head required to lift water by the pump. (4 marks)

(ii) Head of the pump if the outlet velocity of the flow is to be 5m/s. (6 marks)

(iii) The power of the pump when the outlet velocity is 5m/s. (6 marks)

Q4. (a) What is meant by the centre of pressure referred to in submerged surfaces? (4 marks)

(b) Show that the distance to centre of pressure from the free surface (H*) is (8 marks)

$$H^* = \frac{2}{3}D$$

when a rectangular plate is immersed in a fluid as shown in figure Q4-a.

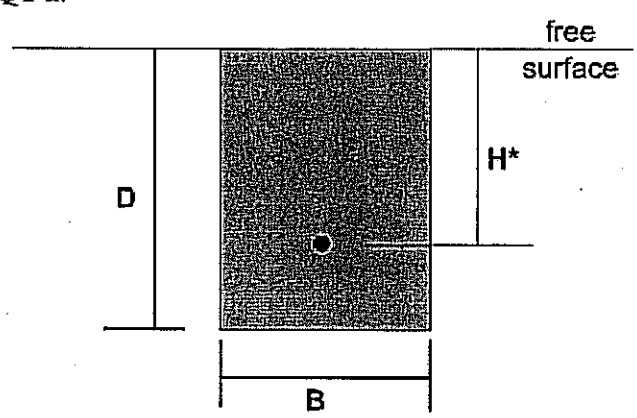


Figure Q4-a

(c) In the water level control mechanism shown in Figure Q4-b, the gate should automatically open when the water rises above a certain level. Determine this level, h.
Assume that the weight of the gate is negligible. (8 marks)

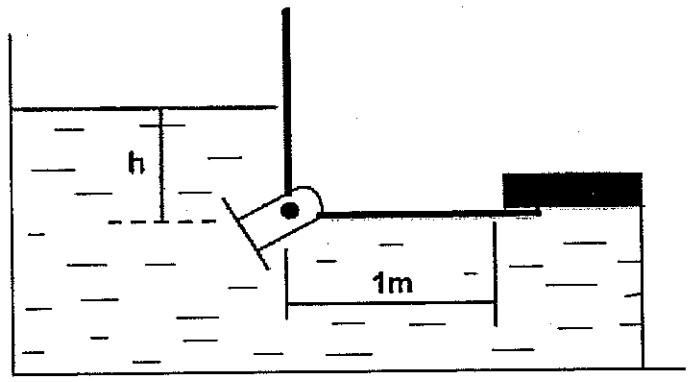


Figure Q4-b

Q5. (a) Methane (CH4) is burnt with 50% excess air.

(i) Write down the balanced chemical equation for the burning of methane assuming that air has 20% oxygen and 80% nitrogen by volume. (4 marks)

(ii) Calculate the percentage mass of nitrogen and water present in the combustion products. (6 marks)

(b) A certain fuel was found to contain the following elements in mass parentage.

carbon – 66.8 , hydrogen– 11.24, oxygen – 21.96

Determine the empirical formula of the fuel. (10 marks)

[*Atomic weights: C – 12.01, H – 1.008, O – 16, N - 14*]

Q6. (a) Sketch the air standard cycle used to analyse the four stroke petrol engines (Otto cycle) on P – V axes and explain each process. (4 marks)

(b) Define thermal efficiency for Otto cycle and derive an expression for it in terms of temperatures. (6 marks)

(c) Illustrate a steam power plant using a schematic layout diagram showing main components. (5 marks)

State the processes taking place in each component indicating the state of the working fluid. (5 marks)

Q7. (a) Define the dynamic viscosity of fluids in terms of shear stress and velocity gradient. (4 marks)
State common units of measurement of viscosity. (2 marks)

(b) Figure Q7 shows a shaft and bearing of 5cm length flooded with a lubricating oil of viscosity 0.1Ns/m^2. The shaft and bearing radii are 2cm and 2.1cm respectively. Determine the torque and the power required to rotate the shaft at a speed of 1000rpm. (14 marks)
[Hint: consider the circumferential velocity at shaft outer surface and hence find the velocity gradient]

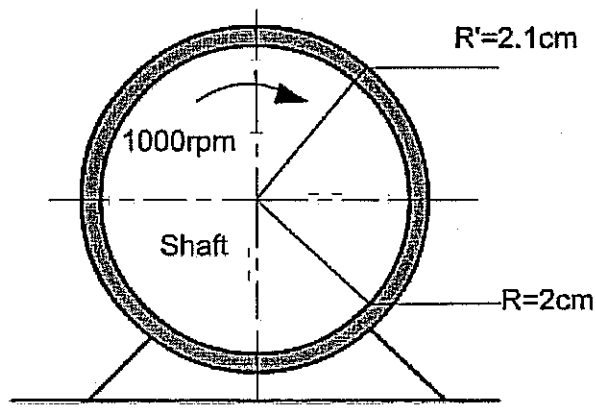


Figure Q7

Q8. (a) State the first law of Thermodynamics. (4 marks)

(b) Derive an expression relating specific heat capacities of a gas at constant volume and constant pressure to the specific gas constant R. (8 marks)
What is the relationship between specific gas constant R and universal gas constant R_o?

(c) A gas in a cylinder expands according to the relationship, PV = Constant. Initial pressure and volume are 10bar and 0.2m^3 respectively. The final pressure is 1.2bar.
Determine,

(i) Final volume. (4 marks)

(ii) Work done by the gas. (4 marks)

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