THE OPEN UNIVERSITY OF SRI LANKA

FACULTY OF ENGINEERING TECHNOLOGY

DIPLOMA IN TECHNOLOGY

FINAL EXAMINATION 2011/12

MEX3212 Basic Thermo fluids/MEX2331 Heat and Fluids

Date: 05 – 03 – 2012

Time: 9.30am – 12.30pm

Duration: 3 hours

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) (i) On what factors heat flow by thermal conduction depends? (3 marks)

(ii) Write down the equation for thermal conduction and name its different terms with their SI Units of measurements. (6 marks)

(b) A 150mm thick wall is made of two layers A and B of different materials. Layer A is 125mm thick and the layer B is 25mm thick. The thermal conductivities of materials A and B are 0.7W/mK and 0.35W/mK respectively. A temperature difference of 10 °C exists between the outer surfaces and heat flow takes place from A to B.

(i) Calculate the rate of heat loss through one square meter of the wall. (4 marks)

(ii) If the temperature of the outer surface of A is 40°C, what is the temperature in the common interface? (4 marks)

(iii) If heat flow rate is to be reduced by 25%, what should be the thermal conductivity of the material A (assume same overall temperature difference). (3 marks)

Q2. (a) State three major Renewable Energy Sources available in Sri Lanka with one application for each of them. (6marks)

(b) What is meant by gasification? State the processes taking place in gasification. (6 marks)

(c) Explain how biogas is produced, indicating its constituent gas compositions approximately. (8 marks)

Q3. (a) What are the two types of fluid flow normally occur? Explain the nature of flow in each case. (4marks)

(b) What is the dimensionless number used to determine the flow type? Write down the number and name its variables. (5marks)

(c) Write down the Bernoulli's equation and name its variables. (5marks)

(d) A liquid having a specific gravity of 1.2 flows through a pipe of 25mm diameter. At a location, 2m above the datum level, the pressure is 200kPa. The rate of flow is $0.01m^3/s$. (6marks)

Determine,

a. The velocity of flow
b. Total Energy available per unit weight of the liquid

Q4. (a) Define the terms, (6marks)

(i) Centre of Buoyancy and
(ii) Meta Centre

(b) A Solid circular cylinder of radius R and height H is made out of a material of density $600kgm^{-3}$. This cylinder floats in water of density $1000kgm^{-3}$ as shown in Fig. Q4.

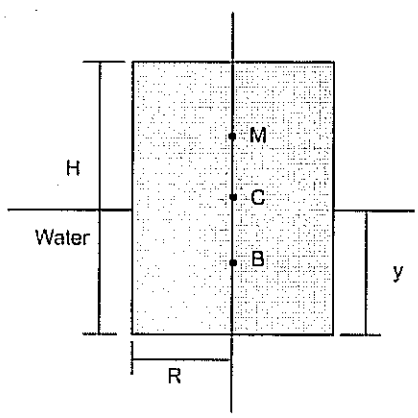


Fig. Q 4

Where,

M – Meta centre

C – Centre of gravity

B – Centre of buoyancy

Find,

(i) The height of the submerged portion of the cylinder (y) in terms of H. (6 marks)

(ii) Meta centric height CM in terms of R and H. (8 marks)

The distance from the centre of buoyancy to meta-centre, BM is given by the following formula:

$$BM = \frac{I}{V}$$

Where I = second moment of area $= \left(\frac{\pi}{4}R^4\right)$

V = Volume of submerged portion of the cylinder

Q5. (a) (i) What is meant by centre of pressure? (2 marks)

(ii) When a rectangular plate is submerged in a fluid, show that magnitude of fluid thrust (F) acting on the plate is given by: (6 marks)

$$F = \text{Area of the plate} \times \text{Fluid pressure at the centre of gravity of the plate}$$

(b) A rectangular shape gate AB of 2m height and 1m wide is used to close the opening of a water tank as shown in Fig.Q5. The gate is hinged at A.

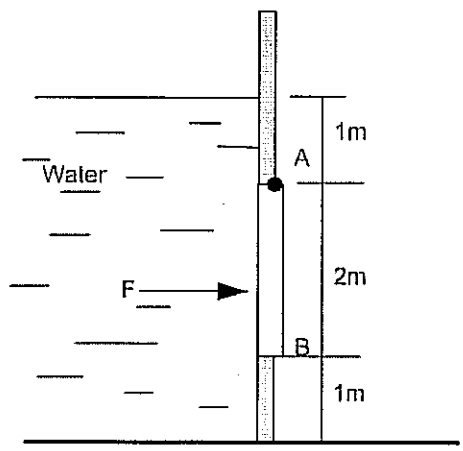


Fig Q.5

(i) Find the fluid thrust (F) acting on the gate. (6 marks)

(ii) If the force F is acting 2.35m below the free surface, determine the force that should be applied at the lower edge of the gate to prevent it opening. (6 marks)

Q6. (a) Sketch the air standard cycle used to analyse the four stroke petrol engines (Otto cycle) on P – V axes and explain all processes. (6 marks)

(b) Define thermal efficiency for Otto cycle and derive an expression in terms of temperatures. (7 marks)

(c) Illustrate a closed loop gas turbine power plant layout using a schematic diagram showing main components. Also show the processes on a P-V diagram. (7 marks)

Q7. (a) What is meant by stoichiometric air-fuel ratio in combustion? (4 marks)

(b) Propane, one of the constituents of LP gas has the formula C_3H_8. Complete combustion of propane yields carbon dioxide and water.

(i) Write the balanced chemical equation for the combustion of propane. (5 marks)

(ii) How many grams of water would be produced from 10g of propane? (5 marks)

(iii) If propane is combusted with atmospheric air having 20% oxygen and 80% nitrogen, determine the mass of combustion products per 1 mole of propane. (6 marks)

[*Atomic weights: C – 12, H – 1, O – 16, N - 14*]

Q8 (a) Define the dynamic viscosity of fluids in terms of shear stress and velocity gradient. (4 marks)

(b) A flat plate of $0.1m^2$ is pulled at a uniform velocity of $30cms^{-1}$ relative to another plate. The gap between the two plates is 0.01cm and is filled with a fluid having viscosity $0.001Nsm^{-2}$. Find the

(i) Force and (5 marks)

(ii) Power required , to maintain the uniform velocity (5marks)

(c) Write down the stokes equation that relates viscous drag force to viscosity naming its terms. (6 marks)

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