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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 03
FINAL EXAMINATION– 2011/2012

MEX3235 - THERMO-FLUIDS

DATE : 14th MARCH 2012
TIME : 1400 HRS. – 1700 HRS.
DURATION : THREE HOURS

ANSWER FIVE QUESTIONS SELECTING AT LEAST ONE QUESTION FROM EACH SECTION. ALL QUESTIONS CARRY EQUAL MARKS. YOU MAY OBTAIN TABLES OF THERMODYNAMICS AND TRANSPORT PROPERTIES OF FLUIDS ON REQUEST.

Density of water = 1000kg/m^3. Acceleration due to gravity = 9.81m/s^2.
For air C_p= 1.005kJ/kg.K, C_v= 0.718kJ/kg.K, R = 0.287kJ/kg.K, γ = 1.4.

SECTION 1

1 An Air flows through an open system at the steady mass flow rate of 5 kg/s. At inlet the air velocity is negligible, the pressure is 1 bar and the temperature is 15°C. The air flow is compressed isentropically and leaves the system at a pressure of 5 bar through a pipe with an internal diameter of 80 mm. Calculate:

a The temperature of the air as it leaves the system. 5 marks

b The velocity in the exit pipe. 5 marks

c The power input to the air. 5 marks

d Explain why the power(P) input is not given by $P = \dot{m}\int_{v_1}^{v_2} p\,dv$ 5 marks

2 a State the second law of thermodynamics. 5 marks

b One kilogram of water at 0°C is brought into contact with heat reservoir at 90°C. When the water has reached 90 °C, Determine:

i Entropy change of water. 3 marks

ii Entropy change of the heat reservoir. 3 marks

iii Entropy change of the universe. 3 marks

c If water is heated from 0°C to 90°C by first bringing it in contact with a reservoir at 40°C and then with a reservoir at 90°C, what will the entropy change of the universe be? 6 marks

3 a Describe the major differences between Carnot cycle and Rankine cycle. 5 marks

b In a steam turbine steam at 20bar and 360°C is expanded to 0.08bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feed back the water into the boiler. Determine:

i Work done. 5 marks

ii Thermal Efficiency 10 marks

4 A cold storage room has wall made of 220mm of brick on the outside, 90mm of plastic foam, and finally 16mm of wood on the inside. The outside and inside temperatures are 25°C and -3°C respectively. If the inside and outside heat transfer co-efficients are respectively 30 W/m² K and 11 W/m² K, and the thermal conductivities of brick, foam and wood are 0.99 W/m K , 0.022W/m K and 0.17W/mK respectively, Determine:

i The rate of heat removal by refrigeration if the total wall area is 85m². 10 marks

ii The temperature of the inside surface of the brick. 10 marks

SECTION 2

5 i Explain the terms absolute, gauge and vacuum pressures. 6 marks

ii Water flows in a pipe shown in figure Q 5 from A to C at the rate of 222*l*/s and the friction loss between A and B is negligible. The friction loss between B and C is $0.1\frac{V_B^2}{2g}$. where V_B is the velocity of flow at B. Find the pressure heads at A and C. 14marks

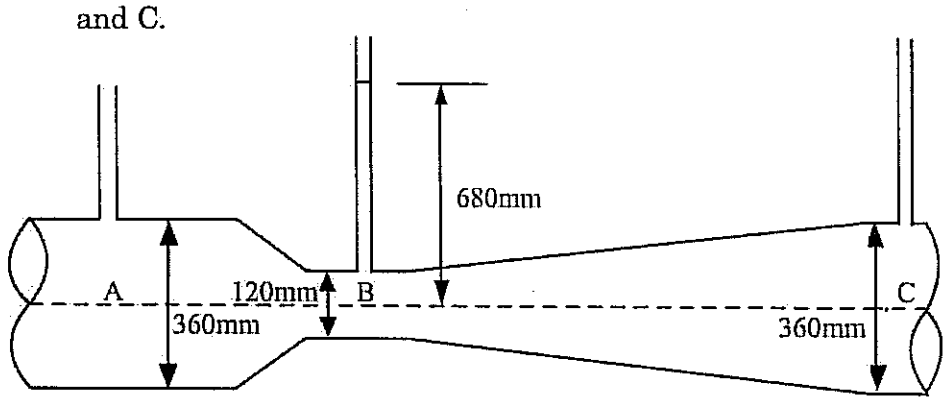


Figure Q 5

6 a A trapezoidal shaped water dam measures a meters at the bottom edge and (a+b) meters at the top edge. If the water depth measured from the top to bottom edge stands h meters as shown in Figure Q 6, show the followings.

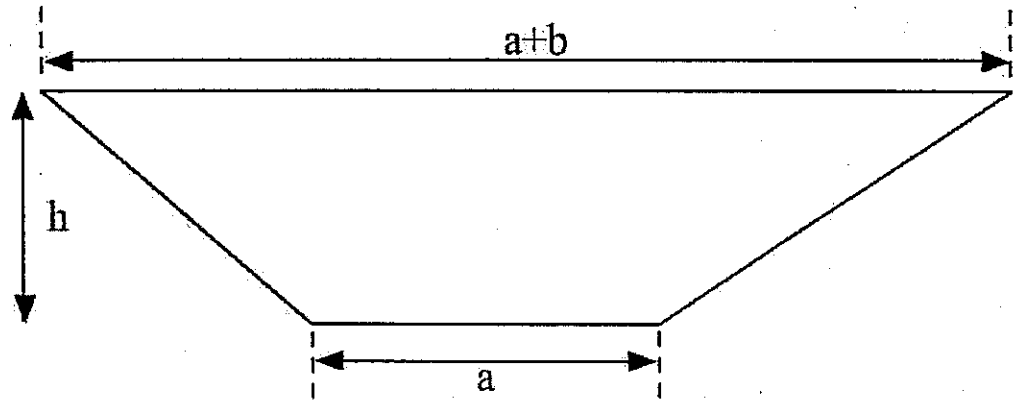


Figure Q 6

i Depth of centroid $(y_c) = \left(\frac{3a+b}{2a+b}\right) \times \frac{h}{3}$ 5 marks

ii The resultant pressure force on the dam face (F) is given by

$F = \frac{1}{6}\rho g h^2(3a + b)$ 5 marks

iii Depth of pressure $(y_p) = \left(\frac{4a+b}{6a+2b}\right) \times h$ 10 marks

Second moment of area for trapezoid is given by $\frac{h^3}{36}(3a + b)$

7 a A square plate weighing 115N and of uniform thickness and 300mm edge is hung so that horizontal jet 20mm diameter and having a velocity of 15m/s impinges on the plate as shown in Figure Q 7(a). The centre line of the jet is 150mm below the upper edge of the plate, and when the plate is vertical the jet strikes the plate normally and at its centre. Find the force (P) that should be applied at the lower edge of the plate in order to keep the plate vertical. 10 marks

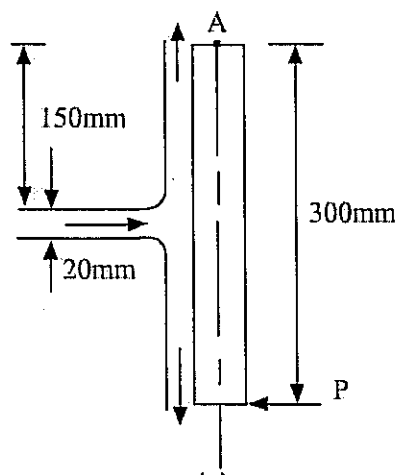


Figure Q 7 (a)

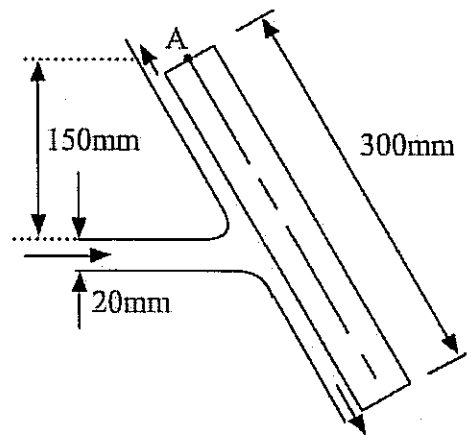


Figure Q 7 (b)

b If the plate is allowed to swing freely, find the inclination to the vertical which the plate will hang under the action of the jet as shown in figure Q 7 (b). 10 marks

8 a State the Darcy formula for head loss due to friction in the pipe. 5 marks

b Two pipes each 250m long are available for connecting to a reservoir from which a flow of 0.08m³/s is required. The pipe diameters are 100mm and 200mm respectively. Compare the head loss through the system if the pipes are in ; 15 marks

i series arrangement

ii parallel arrangement

Neglect minor losses due to pipe transition and fittings.
Assume $f=0.01$ in for both pipes.