THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 03
FINAL EXAMINATION– 2006/2007

MEX3235 – THERMO-FLUIDS
MEX3232/ MED1206 – THERMODYNAMICS AND FLUID MECHANICS

DATE : 08th MARCH 2007
TIME : 0930 HRS. – 1230 HRS.
DURATION : TWO AND QUARTER HOURS

ANSWER FOUR 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 Cp=1.005kJ/kg.K , Cv=0.718kJ/kg.K, R=0.287kJ/kg.K, γ=1.4.

1. *Part –B consists of eight questions..*
2. *All questions carry equal marks.*
3. *Time allocation for **Part B** is 2hrs and 15minutes.*
4. *Do not spend more than 20-25 minutes for each question.*
5. *Hand over **Part** B separately.*

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PART B
SECTION 1

1. In an I.C. engine operating on the Dual combustion cycle , the temperature of the working fluid (air) at the beginning of compression is 27°C. The ratio of the maximum and minimum pressures of the cycle is 70 and compression ratio is 15. The amounts of heat added at constant volume and constant pressure are equal. Compute the air standard thermal efficiency of the cycle.

2. The following three processes are proposed to compress air from an initial state of 100kPa and 27°C to a final state of 500kPa and 27°C.
   (i) Heating at constant volume and then cooling at constant pressure.
   (ii) Isothermal compression.
   (iii) Adiabatic compression and then by cooling at constant volume.

   Draw the p-v diagram and calculate the net work done for each process and identify the best process to perform above state change.

3. In a steam turbine steam at 20 bar and 360°C is expanded to 0.08bar. It then enters the condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming that this steam power plant operates in a Rankine cycle, determine;
   (i) thermal efficiency.
   (ii) work ratio.
   (iii) specific steam consumption.

4. State the steady flow energy equation for the open system flow process and briefly explain each term.

A compressor in a plant receives carbon dioxide (CO_2) at 100kPa and 280 K, with negligible velocity. At the compressor discharge, the carbon dioxide exits at 1100kPa and 500K, with a velocity of 25m/s and then flows into a constant-pressure heat exchanger where it is cooled down to 350K. The power input to the compressor is 50kW. Determine:

(i) Mass flow rate in the compressor.

(ii) Heat transfer rate in the heat exchanger. (Assume that there is no kinetic energy change in the heat exchanger).

Enthalpy of CO_2 at 100kPa and 280K is 401.5kJ/kg.
Enthalpy of CO_2 at 1100kPa and 500K is 198kJ/kg
Enthalpy of CO_2 at 1100kPa and 350K is 257.9kJ/kg.
Hint : For compressor Q=0 and for heat exchanger W=0

SECTION 2

5. The catchment reservoir and service of a town water supply system lie 65km apart and have a difference of 150m in their water levels. These reservoirs are connected by a single pipe that can carry 0.3m^3/s. Calculate the diameter of the pipe.

Subsequently it became necessary to increase the flow rate by another 0.15 m^3/s. This was achieved by laying a second pipe of the same diameter in parallel over a part length of the original pipe as shown in Figure Q 5. Find the necessary length of the second pipe. Consider only friction losses and for each pipe take friction factor f =0.008. Darcy's formula for head loss is given in usual notations as $h_f = \frac{4fV^2}{2gd}$.

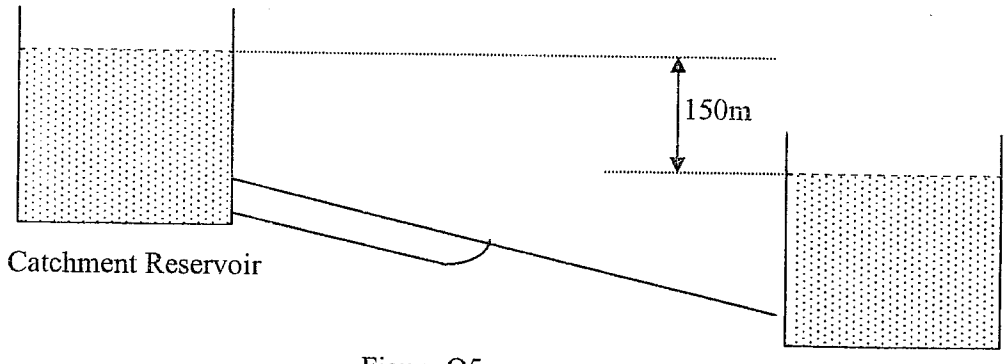


Figure Q5

6. A square door with side dimensions 300mm×300mm is provided in the sidewall of a tank, which is filled, with water of specific weight 9290N/m^3. What force must be applied at the lower end of the gate so as to hold the hinged door closed? The hinged end of the door lies at a depth of 3m from free water surface. How would this force be changed if the water surface is subjected to a pressure of 0.5×10^5N/m^3.

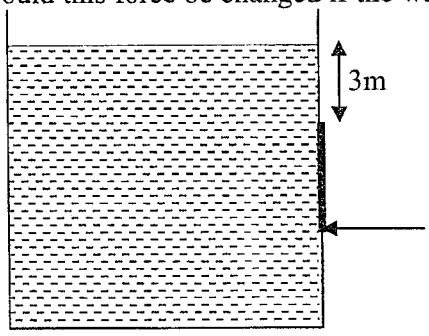


Figure Q6

7. A single acting reciprocating pump with a single cylinder of diameter of 500mm and a stroke of 750mm discharges 60litres/s. It is found that the suction head and the delivery head are 5m and 22m respectively. If the crank rotates at a speed of 25rev/min, find the theoretical discharge, slip of the pump and power required to drive the pump.

8. A pipe bend placed in a vertical plane tapers from 500mm diameter at inlet to 250mmdiameter at outlet. An oil of density 900kg/m^3 enters the reducing bend and gets turned through 45° in the clockwise direction as shown in Figure Q8. When the oil flows at the rate of 0.45m^3/s, the pressure at the inlet is 140kN/m^2 . Determine the magnitude and direction of the resultant force on the bend.

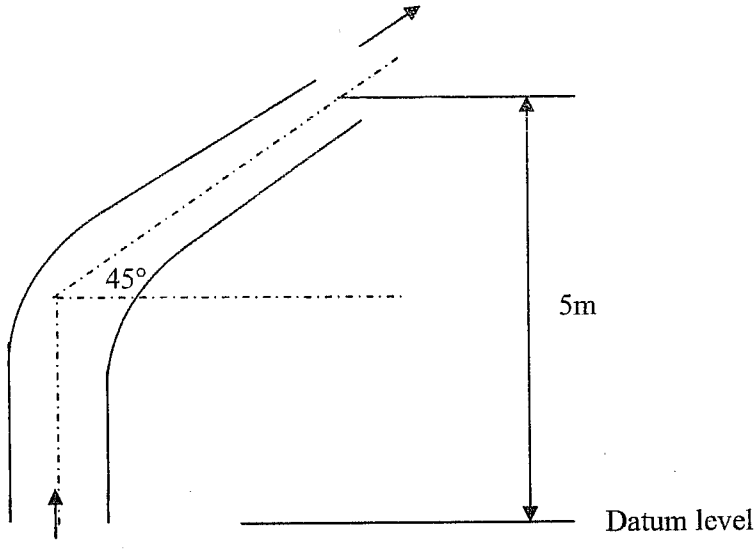


Figure Q8

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