The Open University of Sri Lanka
Faculty of Engineering Technology

00223

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX3235 Thermo- Fluids**
Academic Year	:	2014/15
Date	:	9th September 2015
Time	:	1330 -1630hrs
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. Answer **five questions** selecting at least **two questions from each of section 1 and section 2.** All questions carry equal marks.
3. You may obtain tables of Thermodynamic and transport properties of fluids on request.
4. Density of water 1000 kg/m^3. Acceleration due to gravity = 9.81 m/s^2.
   For air C_p = 1.005 kJ/kgK, C_v = 0.718 kJ/kgK R = 0.287 kJ/kgK γ = 1.4

SECTION 1

1 a State the first Law of Thermodynamics and write down the non-flow energy equation which represents a corollary First Law. (03 marks)

b Define following terms. (03 marks)
- i work done
- ii enthalpy
- iii entropy

c A system exists with 0.3 m^3 of gas at 5 bar and 450 K. It is expanded adiabatically to 1 bar. The gas is then heated at constant pressure till its enthalpy increases by 100 kJ. Take C_p and C_v for gas as 1 kJ/kgK and 0.712 kJ/kgK respectively.

- i Draw the processes on P-V or T-S diagrams. (01 marks)
- ii Calculate characteristic gas constant (R) in J/kgK and ratio of specific heat capacities (γ) (02 marks)
- iii Determine mass of the gas (01 marks)
- iv Calculate final temperature and volume of the gas (04 marks)
- v Find work done during adiabatic expansion process (02 marks)
- vi Find work done and entropy change during constant pressure heating process. (04 marks)

2 a State the processes of Otto cycle and sketch them on T-S and P-V diagrams. Derive the expression for efficiency. (08 marks)

b A petrol engine of a vehicle work on Otto cycle with a compression ratio 7.5. Pressure and temperature of air at the entry to cycle are 1 bar and 300 K respectively. If the temperature of air after expansion is 600 K, Calculate the

i	thermal efficiency of the cycle.	(02 marks)
ii	maximum pressure.	(02 marks)
iii	maximum temperature.	(02 marks)
iv	net work done per kg of air.	(02 marks)
v	stroke volume.	(02 marks)
vi	mean effective pressure.	(02 marks)

3 a Steam is the working fluid in an ideal Rankine cycle. Saturated vapor enters the turbine at 80 bar and saturated liquid exits the condenser at a pressure of 0.08 bar. The net power output of the cycle is 100 MW.

Determine for the cycle

i	dryness fraction of steam after expansion process.	(04 marks)
ii	pump work.	(04 marks)
iii	thermal efficiency.	(04 marks)
iv	mass flow rate of the steam.	(04 marks)

b if the expansion stage has an isentropic efficiency "y" and neglecting the pump work, show that the thermal efficiency (η) is given by (04 marks)

$$\eta = 0.373\ y$$

4 **Answer either (a) or (b)**

a In oil cooler for a diesel engine 0.2 kg/s of oil is to be cooled from 130°C to 70°C in a double pipe heat exchanger with 0.2 kg/s of water available at 30°C. The overall heat transfer coefficient is 400 W/m^2 K.

The specific heat capacities of oil and water are 2131 J/kgK and 4176 J/kgK respectively. Determine the effective surface area for heat transfer,

i	if the flow is parallel in the same direction.	(12 marks)
ii	If the heat exchanger were of counter flow type.	(08 marks)

b Hot water flows in a steel tube of which inner and outer radii are 25 mm and 40 mm. The temperature of the water at a particular location is 300°C. The pipe is surrounded by air at 30°C. The convective heat transfer coefficients at the inner and outer surfaces are 1500 W/m^{2}K and 6 W/m^{2}K The thermal conductivity of steel is 40 W/mK.

i	Determine the heat transfer rate per meter length.	(15 marks)
ii	Find the temperature at the outer surface of the tube.	(05 marks)

SECTION 2

5 a Benzene at 200°C has a viscosity 0.00651 Pa.s. What shear stress is required to deform this fluid at a strain rate of 4900 s^{-1}? (05 marks)

b Multi compartment vessel is filled with water and oil (specific gravity of 0.9) as shown in Fig. Q5(b). Calculate the gauge pressure in kPa, at A, B, C and D? (07 marks)

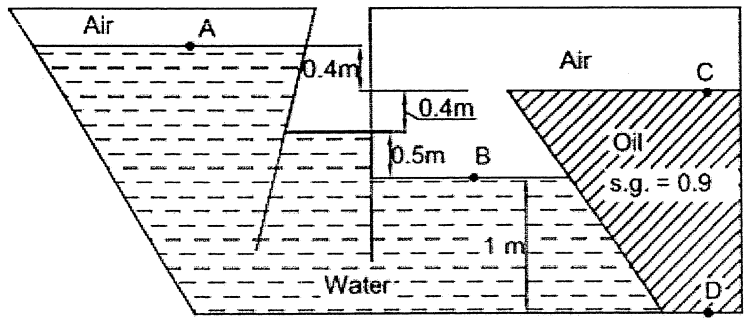

Fig. Q5(b)

c Cross sectional view of Dam ABC in Fig. Q5(c) is 38 m wide and made out of concrete. Find the hydrostatic force on surface BC. (08 marks)

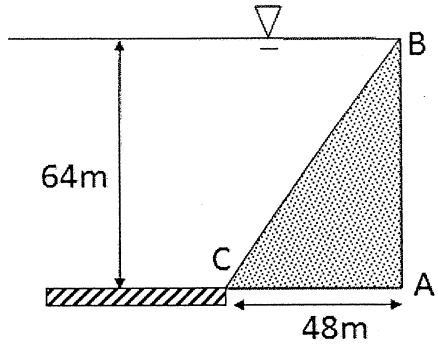

Fig. Q5(c)

6 a State Bernoulli's equation and identify each parameter with their SI units. (05 marks)

b Water flows at 0.36 m^3/s in a pipe as shown in Fig. Q6(b). The pipe diameters are 360 mm and 240 mm as shown in the figure. The control volume of ABCD bend is 0.14 m^3. The pressure at the entrance is 73 KN/m^2 and the exit is 2.4 m above the entrance section. Find the force exerted on the bend. (15 marks)

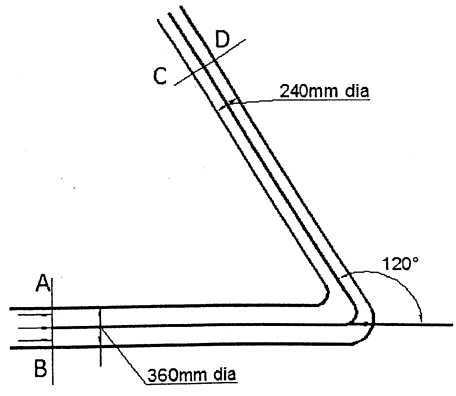

Fig. Q6(b)

7 For the flow situation shown in Fig.Q7 determine the ratio $\frac{h_1}{h_2}$ if the area ratio (20 marks)

$\frac{A_1}{A_2}$ = 1.8

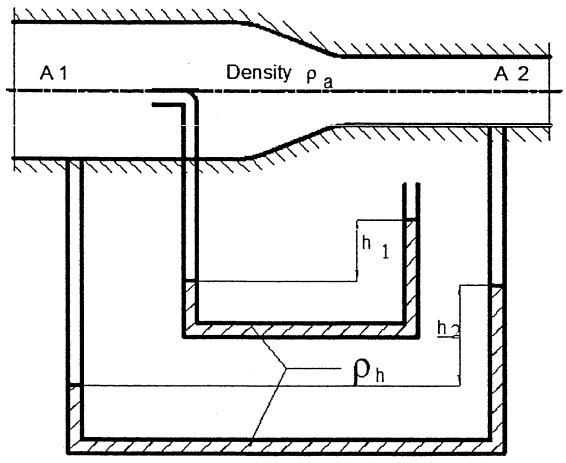

Fig. Q7

8 A pump is 2.2 m above the water level in the sump and has a pressure of - 200 mm of mercury at the suction side as shown in Fig.Q8. The suction pipe is of 200 mm diameter and the delivery pipe is a 250 mm diameter pipe ending in a nozzle of 80 mm diameter. If the nozzle is directed vertically upwards at an elevation of 4.2 m above the water sump level, Determine:

i Discharge. (05 marks)
ii Power of the pump (10 marks)
iii Elevation above the water sump level, to which the jet would reach (05 marks)

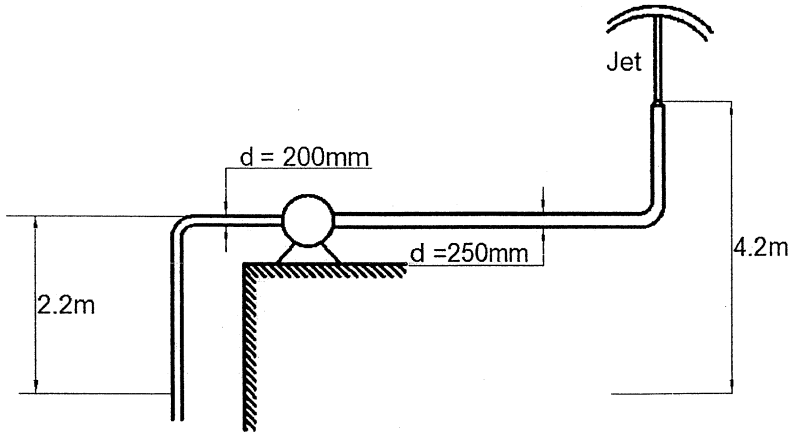

Fig. Q8