UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	THERMOFLUIDS
COURSE CODE	:	BDU 10403
PROGRAMME	:	BDC / BDM
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **TWO (2)** QUESTIONS IN **SECTION A** AND **THREE (3)** QUESTIONS IN **SECTION B**

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THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

SECTION A

Q1 (a) Define Boundary Layer for flate plate and piping by sketching the streamline.

(5 marks)

(b) A 50-cm x 30-cm x 20-cm block weighing 150 N as shown in **FIGURE Q1 (b)**, is to be moved at a constant velocity of 0.8 m/s on an inclined surface with a friction coefficient of 0.27.
Determine:

(i) the force *F* that needs to be applied in the horizontal direction;

(7 marks)

(ii) If a 0.4-mm-thick oil film with a dynamic viscosity of 0.012 Pa. s is applied between the block and inclined surface, determine the percent reduction in the required force.

(8 marks)

Q2

(a) What is buoyant force? What causes it? What is the magnitude of the buoyant force acting on a submerged body whose volume is *V*? What are the direction and the line of action of the buoyant force?

(5 marks)

(b) A fish tank that contains 40-cm-high water as shown in **FIGURE Q2 (b)** is moved in the cabin of an elevator. Determine the pressure at the bottom of the tank when the elevator is

(i) stationary;
(ii) moving up with an upward acceleration of 3 m/s2; and
(iii) moving down with a downward acceleration of 3 m/s2.

(10 marks)

Q3 (a) What is minor loss in pipe flow? How is the minor loss coefficient K_L defined?

(4 marks)

(b) Two water reservoirs A and B at **FIGURE Q3 (b)**, are connected to each other through a 40-m-long, 2-cm-diameter cast iron pipe with a sharp-edged entrance. The pipe also involves a swing check valve and a fully open gate valve. The water level in both reservoirs is the same, but reservoir *A* is pressurized by compressed air while reservoir *B* is open to the atmosphere at 88 kPa. Take the water temperature to be 10°C. If the initial flow rate through the pipe is 1.2 L/s, determine.

(i) the average flow velocity;

(3 marks)

(ii) Reynolds no. ;

(3 marks)

(iii) the absolute air pressure on top of reservoir *A* horizontal resistance force required by the fire fighters to hold

(10 marks)

SECTION B

Q4 (a) The power output of an adiabatic steam turbine is 6.5 MW. If the inlet and exit conditions of the steam are as indicated in **Figure Q4 (b)**, calculate:

(i) The magnitude of Δh, Δke, and Δpe.

(ii) The work done per unit mass of the steam flowing through the turbine.

(iii) The mass flow rate of the steam.

(15 marks)

(b) A well-insulated shell-and-tube heat exchanger is used to heat water in the tubes from 20°C to 80°C at a rate of 5 kg/s. Heat is supplied by hot oil that enters the shell side at 180°C at a rate of 10 kg/s. Determine the rate of heat transfer in the heat exchanger and the exit temperature of oil.
[Take $c_{p,H2O}$ = 4.18 kJ/kg.°C and $c_{p,oil}$ = 2.30 kJ/kg.°C]

(10 marks)

Q5 (a) A Carnot heat engine receives heat from a reservoir at 900°C at a rate of 700 kJ/min and rejects the waste heat to the ambient air at 27°C as shown in **Figure Q5 (a).** The entire work output of the heat engine is used to drive a Carnot refrigerator that removes heat from the refrigerated space at -5°C and transfers it to the same ambient air at 27°C. Determine

i. The maximum heat transfer from cooled space

ii. The total rate of heat rejection to the ambient air.

(15 marks)

(b) A house is estimated to lose heat at a rate of 8000 kJ/h per °C difference between the indoors and outdoors as shown in **Figure Q5(b).** A heat pump with a power input of 7 kW is required to maintain the temperature of the house at 25°C. Determine the lowest outdoor temperature in °C for which the heat pump can meet the heating requirements of the house.

(10 marks)

Q6 (a) Air is compressed from initial state at 2 bar and 330 K to a final state of 5bar and 550 K.Determine the entropy change during this compression process. Take $C_{p\,air}$ = 1.005 kJ/kg.K and R = 0.287 kJ/kg.K

(5 marks)

(b) What is the significance of isentropic performance analysis to an engineering devices? Explain.

(5 marks)

(c) Steam enters an adiabatic turbine steadily at 5 Mpa and 350°C and leaves at 50 kPa. The isentropic efficiency of the turbine is 80%.

(i) Determine the steam temperature at the exit of turbine.

(ii) Find the power output if the mass flow rate of the steam is 15 kg/s.

(iii) Show the process on Temperature Vs Entropy (T-s) diagram with respect to saturation line.

(15 marks)

Q7 (a) Provide a brief explanation on the following laws:

(i) Zeroth law of thermodynamics.
(ii) First law of thermodynamics.
(iii) Second law of thermodynamics.

(6 marks)

(b) 0.3 kg of air is at initial condition of 150 kPa and 70°C. It undergoes series of processes such as the following:

Process 1-2: Isometric heating until the pressure is three times the initial pressure.
Process 2-3: Isobaric heating until the volume is 2 times the initial volume.
Process 3-4: Polytropic expansion process with $n = 1.35$ until the pressure is reduced to 85 kPa.

Determine:

(i) The pressure, temperature and volume of each process.
(ii) The total work and heat transfer.

Sketch the *P-V* diagram of the processes mentioned above. Take $R = 0.287$ *kJ/kg.K*, $Cp = 1.005$ *kJ/kg*, $Cv = 0.718$ *kJ/kg* and $\gamma = 1.4$.

(10 marks)

(c) A piston cylinder system contains 2.4 kg of saturated water at 1.4 bar as shown in **Figure Q7(c)**. The water is heated until a portion of it evaporates and causes the piston to move upward. When the piston is at its constraint, the volume is 0.04 m^3. The heating is continued until its final pressure is twice its initial pressure. Determine:

(i) The fraction of saturated water at the end of the process.
(ii) The final temperature.
(iii) The total heat transfer.

(9 marks)

- END OF QUESTION -

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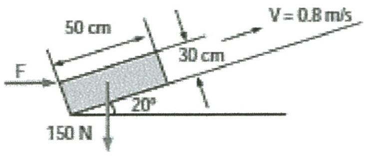

FIGURE Q1 (b)

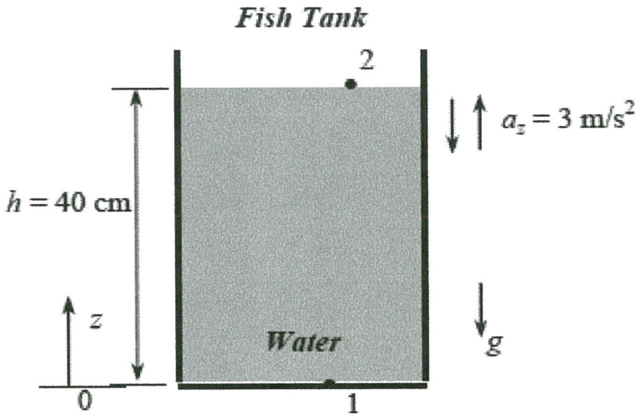

FIGURE Q2 (b)

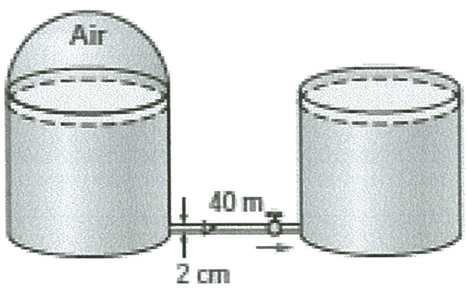

FIGURE Q3 (b)

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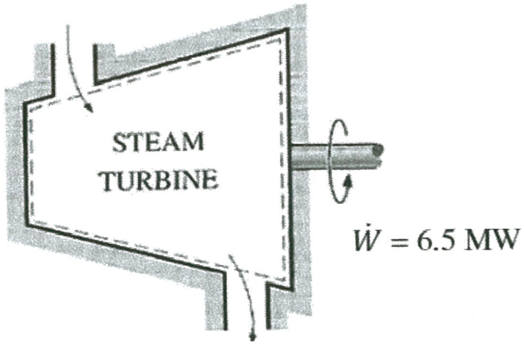
$P_1 = 2000$ kPa

$T_1 = 500°C$

$V_1 = 50$ m/s

$z_1 = 8$ m



$P_2 = 1750$ kPa

$x_2 = 88\%$

$V_2 = 180$ m/s

$z_2 = 5$ m

Figure Q4 (b)

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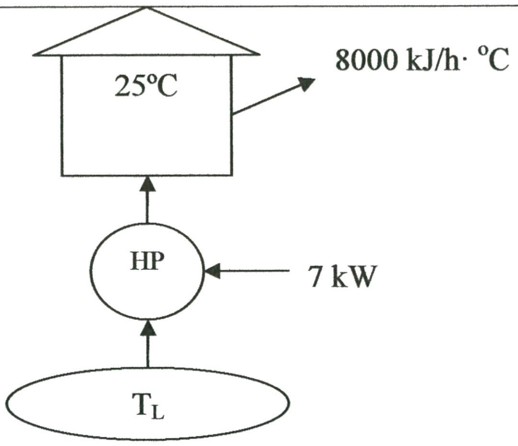

Figure Q5 (b)

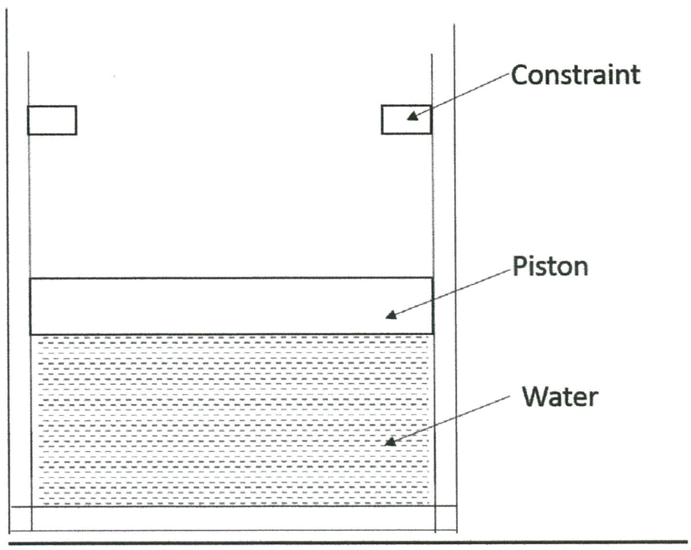

Figure Q7(c)