UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	THERMOFLUIDS
COURSE CODE	:	BDU 10403
PROGRAMME	:	1 BDC/1 BDM/3 BDC
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSISTS OF **SIX (6)** PRINTED PAGES

Q1 (a) A plastic tank is filled with water. Its weight is 5 kg and it has a volume of 0.4 m^3. Determine the weight of the combined system by assuming that the density of water is 1000 kg/m^3.

(6 marks)

(b) Consider a room with dimensions 7 m x 7 m x 9 m. Determine the mass and the weight of the air contained in this room if the air density is 1.16 kg/m^3.

(6 marks)

(c) The temperature of the air in an automobile tire affects the pressure in the tire. The pressure gage reads 210 kPa when the air temperature is 25°C. Determine the pressure rise in the tire when the air temperature in the tire rises to 50°C. Also, determine the amount of air that must be bled off to restore pressure to its original value at this temperature. Assume that the volume of the tire is 0.025 m^3, and the atmospheric pressure to be 100 kPa.

(13 marks)

Q2 (a) If the surface tension of water is 0.065 N/m, obtain the maximum diameter of an aluminium ball and a steel ball that would float on water. Take the densities of aluminium and steel balls to be 2700 kg/m^3 and 7800 kg/m^3, respectively.

(6 marks)

(b) Consider steady air flow through the diffuser portion of a wind tunnel as shown in Fig. Q2(b). Along the centerline of the diffuser, the air speed decreases from $u_{entrance}$ to u_{exit} as sketched. Measurements shows that the centerline air speed $u(x)$ parabolically decreases through the diffuser, such that

$$u(x) = u_{entrance} + c(x - d)^2$$

Write a mathematical expression for centerline speed $u(x)$, based on the parameters given here, from $x = 0$ to $x = L$.

(13 marks)

(c) Water is being heated in a closed pan while being stirred by a paddle wheel. During the process, 40 kJ of heat is transferred to the water and 8 kJ of heat lost to surrounding air. The paddle wheel work amounts are 550Nm.
(i) State your assumption.
(ii) Determine the initial energy of the system if its final energy is 45 kJ.

(6 marks)

Q3 (a) Discuss the difference between a favorable and an adverse pressure gradient.

(8 marks)

(b) There are several laws of thermodynamics used to solve engineering problems that are related to thermal and energy. State and define **two (2)** of these laws.

(8 marks)

(c) What forms of energy which are able to cross the boundary of a closed system? State the difference between these forms and explain it by using a suitable example.

(9 marks)

Q4 (a) Compare in terms of the molecule bonding, arrangement, movement and energy level of substance when the substance is at solid, liquid and gas.

(6 marks)

(b) A piston cylinder devise contains water at 115.2°C and 1 bar. It is then cooled at constant temperature until the pressure reaches 3 bar. Discuss the phase change from the initial to final state. Sketch the p-v diagram with its important values.

(6 marks)

(c) 0.5 kg of water is at initial condition of 10 bar and 90°C. It undergoes series of processes such as the following:

Process 1-2: Isobaric heating until 100% of the water evaporates.
Process 2-3: Isometric cooling until the pressure is reduced to 5 bar
Process 3-4: Isobaric heating until the temperature is raised to 230°C

Determine:

(i) The volume at state 2
(ii) The dryness fraction at state 3
(iii) The work and heat transfer of each process.

Sketch the T-v diagram of the processes mentioned above.

(13 marks)

Q5 (a) From the basic First Law Energy Equation of close system, provide the equations used to calculate the boundary work and heat transfer of ideal gas for isobaric, isometric and isothermal processes respectively. The derivation of the equations should be shown when necessary.

(6 marks)

(b) 0.3 kg of air is at initial condition of 100 kPa and 50°C. It undergoes series of processes such as the following:

Process 1-2: Isometric heating until the pressure is two times the initial pressure
Process 2-3: Isobaric heating until the volume is 3 times the initial volume.
Process 3-4: Polytropic expansion process with $n = 1.3$ until the pressure is reduced to 90 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) Air at 100 kPa, 15°C enters a compressor and is compressed isentropically until the pressure at the exit is 10 times the initial pressure. Determine the temperature at the exit. Calculate also the specific work and heat transfer. If the isentropic efficiency of the compressor is 86%, recalculate the temperature at the exit.

Take $R = 0.287$ *kJ/kg.K,* $Cp = 1.005$ *kJ/kg,* $Cv = 0.718$ *kJ/kg and* $\gamma = 1.4$.

(9 marks)

Q6 (a) Describe the differences between:

(i) Reverse and reversible heat engine
(ii) Source and sink

(4 marks)

(b) Explain Claussius inequality and how it is used to determine the nature of a given process.

(3 marks)

(c) Steam power plant produces 25 MW of power while rejecting 28MW of heat to its surrounding. Determine the heat in MW generated by the burner and calculate plant thermal efficiency. If the temperatures of heat and sink are 2000K and 700K respectively, determine the practicality of the plant.

(8 marks)

(d) Several refrigerators are going to be designed to operate at 200K and 250K. Determine for each design whether the refrigeration cycle is a reversible, irreversible or an impossible cycle:

(i) Design 1: Q_H= 3200kJ and W =500kJ
(ii) Design 2: Q_C= 1200kJ and W= 450 kJ
(iii) Design 3: Q_H= 3000kJ and COP_R = 4.5
(iv) Design 2: Q_C=1500kJ and Q_H= 2300kJ

(10 marks)

- END OF QUESTION -

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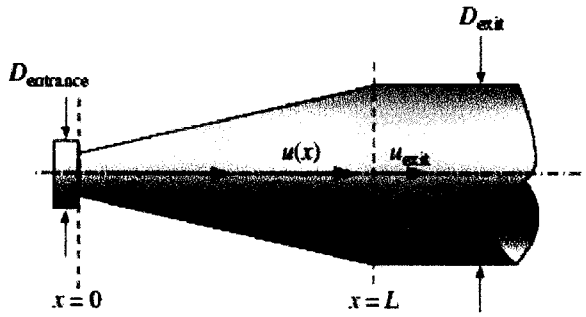

FIGURE Q2(b)