UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	THERMOFLUIDS
COURSE CODE	:	BDU 10403
PROGRAMME	:	BACHELOR OF AERONAUTICAL ENGINEERING TECHNOLOGY WITH HONOURS
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS. **TWO (2)** QUESTIONS FROM **SECTION A** AND **THREE (3)** QUESTIONS FROM **SECTION B.**

THIS PAPER CONSISTS OF EIGHT (8) PRINTED PAGES

SECTION A

INSTRUCTION : ANSWER TWO (2) QUESTIONS ONLY

Q1 (a) Explain briefly the following terms;

(i) Absolute and gauge pressures
(ii) Incompressible and compressible flows

(8 marks)

(b) A rectangular plate 2 m x 4 m plate is vertically immersed in water in such a way that 2 meters side is parallel to the water surface and 2.5 meters below it.

(i) Derive expressions for total pressure and centre of pressure for a vertically immersed surface.
(ii) Determine the total pressure on the rectangular plate.

(12 marks)

Q2 (a) Differentiate between the path and stream lines of representing fluid flow lines.

(6 marks)

(b) Consider the expression for stream function is given by $\psi = x^3 - 3\,xy^2$.

(i) Show that whether the flow is rotational or irrotational
(ii) Determine the velocity potential, Φ and velocity field, V.
(iii) Determine the stagnation point.

(14 marks)

Q3 (a) Explain briefly the formation of laminar and turbulent boundary layers. Give one (1) example in everyday life the relationship between boundary layer and force drag.

(6 marks)

(b) A smooth, flat plate of length $L = 6$ m and width $b = 4$ m is placed in water with an upstream velocity of $U = 0.5$ m/s. (Take for water, $\rho = 998.2$ kg/m^3 and $\mu = 1.002 \times 10^{-3}$ N.s/m$^{2)}$. Determine:

(i) The boundary layer thickness at the center of the plate; and
(ii) The shear stress at the center of the plate.

(14 marks)

SECTION B

INSTRUCTION : ANSWER THREE (3) QUESTIONS ONLY

Q4 (a) Choose three (3) of the available choices and provide a brief description for each of them.

Choice 1: Close system and open system
Choice 2: System, surrounding and boundary
Choice 3: Flow work and boundary work
Choice 4: Intensive and extensive properties
Choice 5: Static and dynamic energy
Choice 6: Isobaric and isometric processes

(6 marks)

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

Process 1-2: Compression process following the law of $PV^{1.25} = C$ until it reaches 500kPa and 50% in its initial volume.
Process 2-3: Isobaric process until its velocity reduces to 50% from the beginning of the process 2.
Process 3-4: Isometric process until the initial pressure of 100kPa is reached.

Determine:

(i) The work per unit mass of each process
(ii) The total work per unit mass
(iii) The heat transfer per unit mass of each process
(iv) The total heat transfer per unit mass

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* $\gamma = 1.4$.

(14 marks)

Q5 (a) A piston-cylinder device contains water at 20°C and 1 atm. It is then heated with a constant pressure until its temperature reaches 300°C. Discuss the phase-change processes from its initial state until it reaches 300°C. The discussion should include the changes of its volume and temperature. Sketch the T-*v* diagram with its important values.

(5 marks)

(b) Steam at 30 bar and 330°C is being expand until it is saturated at 3.5 bar. Determine:

(i) The specific enthalpy change
(ii) The specific entropy change

(5 marks)

(c) Steam at 10 bar with quality x= 0.9 is heated at constant pressure until its temperature reaches 250°C. Determine:

(i) The specific enthalpy change
(ii) The specific entropy change

Sketch the T-v diagram to show its process.

(10 marks)

Q6 (a) List the main function of below engineering components:

(i) Compressor
(ii) Diffuser
(iii) Heat exchanger
(iv) Expansion valve

(4 marks)

(b) Using suitable assumption(s), show how the first law energy balance, $q - w = \Delta h + \Delta ke + \Delta pe$ changes as the assumptions are applied for compressor, diffuser and heat exchanger listed in Q6(a).

(6 marks)

(c) Choose <u>one (1)</u> of the <u>two (2)</u> options given in this section. For the chosen option, provide the solution:

<u>Option A</u>
A heat exchanger as in Figure Q6(c) uses exhausts gas to heat up the air. The air enters the heat exchanger at 500K with the rate of 800kg/min. Exhaust gas enters the heat exchanger at 140kPa and 800K; and exits at 130kPa and 600K. The rate of heat transfer between the exhaust gas and the air is 3200kJ/s. Determine:

(i) The exit temperature of the air; and
(ii) The mass flow rate of the exhaust gas.

Take for air and exhaust gas, $Cv = 0.718\ kJ/kg.K$ and $R = 0.287\ kJ/kg.K$.

(10 marks)

OR

Option B

Steam at velocity 60 m/s, having a mass flow rate of 6.49 kg/s enters a steam turbine at 20 bar and 350°C. It exits the turbine at 5 bar with dryness fraction 0.8. During expansion, 30kJ/kg of heat is transferred to the surrounding. If the velocity of steam at the exit of the turbine is 13.90 m/s, determine the power output of the turbine

(10 marks)

Q7 (a) Using the thermodynamics temperature scale, $Q_C/Q_H = T_C/T_H$, explain how the scale is being used to determine whether a reverse heat engine cycle is a reversible, irreversible or an impossible cycle.

(4 marks)

(b) Several refrigerators are going to designed to operate between 250K and 305K respectively. Determine for each design, whether the cycle is a reversible, irreversible or an impossible cycle:

(i) Design 1: Q_C= 1200 kJ dan W= 500 kJ
(ii) Design 2: Q_C=1700 kJ dan Q_H= 2200 kJ
(iii) Design 3: Q_H= 2500kJ dan COP_R = 4.5
(iv) Design 4: Q_H= 3000 kJ dan W =500kJ

(10 marks)

(c) A steam power plant operates between 1100K and 310K. The thermal efficiency of the plant is 68%. If the plant is able to produce 2500kW of power, determine the heat rate transferred into the plant. Using the thermodynamics temperature scale, determine whether the plant has a reversible or irreversible cycle.

(6 marks)

Q8 (a) Explain Claussius inequality and how it is used to determine the nature of a given process.

(5 marks)

(b) A steam power plant will be designed to operate between 700°C and 24°C. The plant will have four (4) major components which are a feed water pam, a boiler,

a steam turbine and a condenser. Work of a feed water pump and turbine are estimated to be 2 kJ and 350 kJ respectively. In addition heat transferred in the boiler is calculated to be 450 kJ. Using the Claussius inequality, give comment in terms of the practicality of the plant.

(5 marks)

(c) 0.8 kg of air in a piston cylinder system is at an initial condition 250 kPa and 27°C. The air undergoes series of processes as follows:

Process 1-2: Heat addition at constant pressure until the air expands three times its initial volume.

Process 2-3: Cooling at constant temperature until the pressure is two time the pressure at state 2.

Determine for each process:

(i) The volume of air

(ii) The change of in entropy

Sketch both the *T-s* and *P-V* diagrams.

(10 marks)

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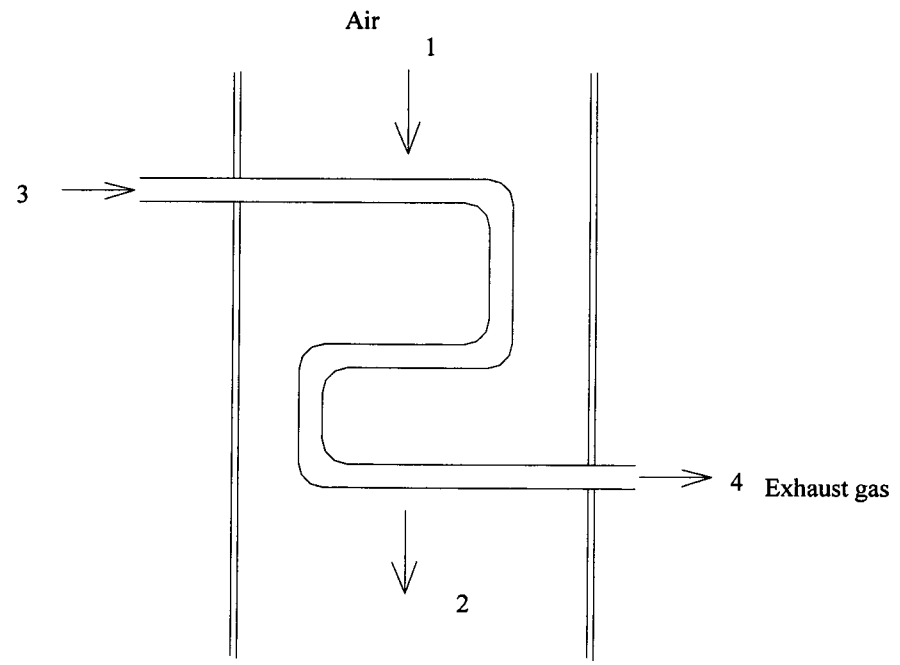

FIGURE Q6(C)