UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	TERMOFLUIDS
COURSE CODE	:	BDU 10403
PROGRAM	:	1 BDC
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS. **TWO (2)** QUESTIONS FROM **SECTION A** AND **THREE (3)** QUESTIONS FROM **SECTION B.**

THIS EXAMINATION PAPER CONSISTS OF SIX (6) PAGES OF PRINTED MATERIAL

SECTION A

INSTRUCTION : ANSWER TWO (2) QUESTIONS ONLY

Q1 a) Explain briefly the following;

i). the Newton's law of viscosity

ii) total pressure

iii) centre of pressure

[6 marks]

b) If a mercury barometer reads 700 mm and a Bourdon gauge at a point in a flow system reads 500 kN/m^2, what is the absolute pressure at the point?

[5 marks]

c) A circular plate of diameter 1.5 metre is placed vertically in water in such a way that the centre of the plate is 3 metre below the free surface of water.
Determine:

i) total pressure on the plate

ii) position of the centre of pressure

[9 marks]

Q2 a) Differentiate between the Eulerian and Lagrangian methods of representing fluid flow.

(6 marks)

b) Consider the flow field given by $V = xy^2\,i - (1/3)y^3\,j$.

i) Show that the velocity field represents a possible incompressible flow.

ii) Determine the acceleration at point (x,y) = (1,2).

iii) Determine the expression for the stream function, ψ.

(14 marks)

Q3 a) Explain briefly the formation of boundary layer and give two (2) examples in everyday life where formation of boundary layer is important.

(9 marks)

b) Air flows on a smooth flat plate, with a velocity (free stream) of 10 m/s. The velocity profile is in the form (laminar boundary layer e.g. parabolic profile);

$$u / U_s = 2 (y / \delta) - (y / \delta)^2$$

where; u = local velocity, U_s = free stream velocity, δ = boundary layer thickness

The length of the plate is 1.2 metre and width 0.90 metre. If laminar boundary layer exists up to a value of Reynolds number, Re = 2 x 10^5 (critical Reynolds number), find:

i) the maximum distance from the leading edge upto which laminar boundary layer exists (length of transition) , x_T

ii) the maximum thickness of laminar boundary layer, δ (x)

Assume for air, density, ρ = 1.204 kg/m^3 and dynamic viscosity, μ = 0.0000181 Pa.s

[11 marks]

SECTION B

INSTRUCTION : ANSWER THREE (3) QUESTIONS ONLY

Q4 A fluid at 0.7 bar occupying 0.09 m^3 is compressed reversibly following the law $pv^n = C$ (constant), to a pressure 3.5 bar. The fluid is then heated reversibly at constant volume until the pressure is 4 bars and specific volume is then 0.5 m^3/kg. The fluid undergoes a reversible expansion process according to a law $pv^2 = C$ (constant), to restore its initial state. Sketch the cycle on a p-v diagram and calculate:

(i) the mass of fluid present

(ii) the value of the index of compression, n in the first process

(iii) the net work of the cycle

(20 marks)

Q5 (a) An air compressor delivers 1000 kg of air per hour. The enthalpy of air at inlet and exit of the compressor are 350 kJ/kg and 550 kJ/kg respectively. The air enters at velocity of 10 m/s and leaves at 15 m/s. A quantity of 2500 W of heat is lost from the compressor. Sketch the system showing clearly the energy, work, heat and mass interaction at the system boundary. What is the required work to drive the compressor.

(10 marks)

(b) 0.25 kg of air behind a piston cylinder assembly is compressed until its internal energy increased from 30 kJ/kg to 70 kJ/kg. During the compression process, 2000 J of heat is lost to the surrounding. Sketch the system showing the interaction of heat and work at the system boundary and calculate the work input needed for the compression.

(10 marks)

Q6 (a) Dry saturated steam at 6 bars expands reversibly in a cylinder behind a piston to a pressure of 0.65 bars. If the cylinder is perfectly thermally insulted, calculate the work done during the expansion process per kilogram of steam. Show the process on a T – s diagram.

(10 marks)

(b) 1 kg of air at 1.013 bar, 17 ^{0}C, is compressed according to a law $pv^{1.3} = C$ (constant), until the pressure is 5 bar. Calculate the change of entropy and sketch the process on a T – s diagram, indicating the area which represents the heat flow.

Given that c_v and R for air as 1.005 kJ/kg and 0.287 kJ/kg K respectively

(10 marks)

Q7 (a) Consider a closed system consisting of a perfect gas with unit mass changing state by means of a reversible non-flow process, from State 1 (p_1,v_1 andT_1) to a new state, State 2 (p_2, v_2 and T_2). During the process, a quantity of heat, dQ, is supplied to the system and a quantity of work dW is delivered. Appling energy balance on the system, show that:

$$dQ/T = c_v\, dT/T + p\, dv/T$$

and thus

$$s_2 - s_1 = c_v \ln (T_2/T_1) + R \ln (v_2/v_1)$$

(8 marks)

(b) Five kilograms of air at a pressure of 10 bar expands isothermally to a pressure of 2 bar and returned to its original state i.e. 10 bar by following the law $pv^{1.3}$ = constant. Show the complete process on a p – s diagram and determine the change of entropy during the complete process.

Given that c_v and R for air as 1.005 kJ/kg and 0.287 kJ/kg K respectively.

(12 marks)

Q8 An engine working on the Carnot cycle receives heat from a source at 1200 ^{0}C and rejects heat to a sink at 180 ^{0}C. If the power output of the engine is 15 kW, determine:

i) The efficiency of the engine

ii) The heat rate at which is supplied and rejected

iii) The percentage increase in power output if the sink temperature is reduced to 40 ^{0}C, while the same amount of heat is supplied to the engine.

iv) Applying the concept of entropy balance, shows that the above heat engine cycle is possible or otherwise.

(20 marks)