Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	THERMOFLUIDS
COURSE CODE	:	BDU 10403
PROGRAMME CODE	:	BDC
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **TWO (2)** QUESTIONS ONLY IN **PART A** AND **TWO (2)** QUESTIONS ONLY IN **PART B**. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**. 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

(ii) The uniform swamp gate has a mass of 3 Mg and a width of 1.5 m. Determine the depth of the water d if the gate is held in equilibrium at an angle of $\theta = 60°$.

(8 marks)

(iii) Based on the results in **Q2(c)(i)** and **(ii),** which mass (kg) and angle (degree) are the best for your new gate. Explain your answer.

(2 marks)

Q3 (a) The air is flown through the test section of a small wind tunnel at speed V = 15.5 ft/s. The temperature of the air is 70°F, kinematic viscosity, $v = 1.643 \times 10^{-4}$ ft^2/s and length of the wind tunnel test section is 10.6 ft. Assume that the boundary layer thickness is negligible prior to the start of the test section.

(i) Determine whether boundary layer along the test section wall laminar or turbulent or transitional.

(2 marks)

(ii) Based on the answer in **Q3(a) (i),** estimate the boundary layer thickness.

(2 marks)

(b) At cruise conditions of Airbus A380, air flows into a Rolls-Royce Trent 900 turbofan engine (**Figure Q3(b)**) at a steady rate of 27.22 kg/s. Fuel enters the engine at a steady rate of 0.27 kg/s. The average velocity of the exhaust gases is 452.2 m/s relative to the engine. If the engine exhaust effective cross section area is 0.325 m^2, determine the density of the exhaust gases in kg/m^3.

(5 marks)

(c) A steady, incompressible, two-dimensional velocity fields is given by

$$\boldsymbol{V} = (u,v) = (1 + 1.25x + y)\,\boldsymbol{i} + (-0.5 - 3x - 2.5y)\,\boldsymbol{j}$$

where the x and y coodinates are in *m* and the magnitude of velocity is in m/s.

(i) Determine if there are any stagnation points in the flow field.

(2 marks)

(ii) Sketch velocity vectors at several locations in the upper-right quadrant for $x = 0$ m to 4 m and $y = 0$ m to 4 m.

(6 marks)

(iii) Calculate the material acceleration at the point, $x = 2$ m and $y = 3$ m.

(2 marks)

(iv) Sketch the material acceleration vectors at several locations in the upper-right quadrant for $x = 0$ m to 4 m and $y = 0$ m to 4 m.

(6 marks)

PART B: ANSWER **TWO (2)** QUESTIONS ONLY

Q4 (a) Provide a brief explanation on the following laws:

(i) Zeroth law of thermodynamics. (2 marks)

(ii) First law of thermodynamics. (2 marks)

(iii) Second law of thermodynamics. (2 marks)

(b) Steam at 30 bar and 330°C is being expend until it is saturated at 3.5 bar. Determine the specific enthalpy and entropy changes.

(6 marks)

(c) 0.5 kg of water is at initial condition of 10bar 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 the pressure is reduced to 5bar
Process 3-4: Isobaric heating until the temperature is raised to 230°C

Determine:

(i) The volume at state 2. (1 mark)

(ii) The dryness fraction at state 3. (2 marks)

(iii) The work and heat transfer of each process. (5 marks)

(iv) Sketch the T-v diagram of the processes mentioned above. (5 marks)

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

Q5 (a) Consider two closed systems A and B. System A contains 3000 kJ of thermal energy at 20°C, whereas system B contains 200 kJ of thermal energy at 50°C. Now the systems are brought into contact with each other. Determine the direction of any heat transfer between the two systems.

(2 marks)

(b) Air enters an adiabatic turbine at 950 kPa, 400°C with a velocity of 85 m/s. It leaves the turbine at 140 kPa with velocity 160 m/s. The cross-sectional area of the inlet is 70 cm^2. If power output of the turbine is 300 kW, determine the outlet temperature. State the assumption before the analysis is carried out.

(6 marks)

(c) A water tank located in a paint processing factory has two inlets and one outlet. Steam at 2 bar, 95°C enters the first inlet at 5kg/s with a velocity of 30m/s. At the same time, saturated vapour at 5 bars enters the second inlet at 2 kg/s with a velocity of 50m/s. The heights of the first, second inlet and outlet are 25m, 10m and 5m respectively. If the velocity and pressure of the mixture at the outlet are 75m/s and 10bar respectively, determine:

(i) Temperature of the mixture at the outlet.

(6 marks)

(ii) Cross sectional area of each inlet and outlet.

(11 marks)

Q6 (a) Explain the Carnot Principle and write the coefficient of performance of an ideal (carnot) heat pump.

(5 marks)

(b) A steam power plant works between 1000 K dan 300 K. The plant receives heat at a rate of 2500 kW and produces power at 1500 kW. Using the Carnot Principle, determine whether the plant operates using reversible, irreversible or imposible cycle.

(10 marks)

(c) During winter, it is estimated that a typical single storey house will loose heat to the surrounding at 100,000 kJ/hour. To maintain the temperature of the house to 26°C, a heat pump is used. If the lightings and electronic appliances disperse 5,000 kJ/hour and 20,000 kJ/hour of energy respectively, determine:

(i) the coefficient of performance of the heat pump if the power of the heat pump is 40,000 kJ/hour.

(3 marks)

(ii) the rate of the heat transfer from the surrounding.

(7 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2021/2022
COURSE NAME : THERMOFLUIDS
PROGRAMME CODE : BDC
COURSE CODE : BDU 10403

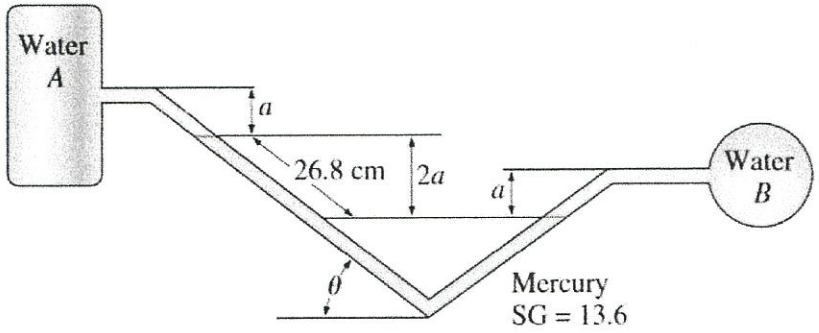

Figure Q1(b)

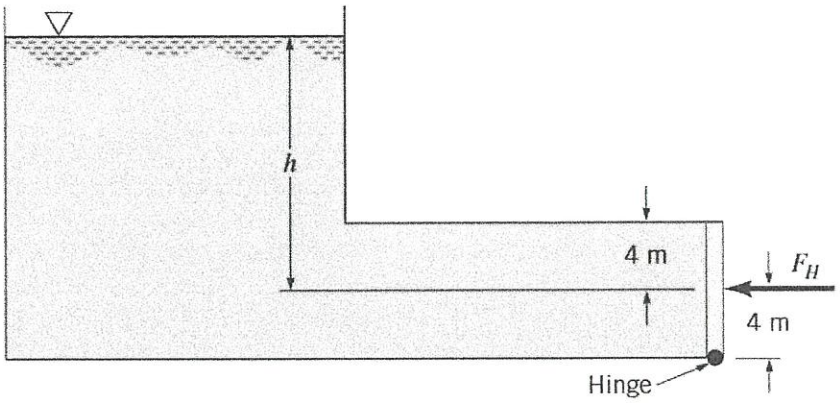

Figure Q1(c)

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2021/2022
COURSE NAME : THERMOFLUIDS
PROGRAMME CODE : BDC
COURSE CODE : BDU 10403

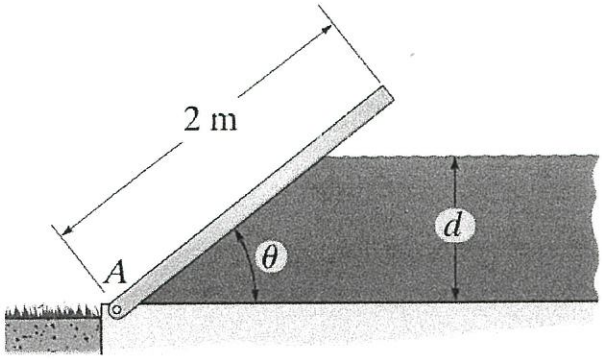

Figure Q2 (c)

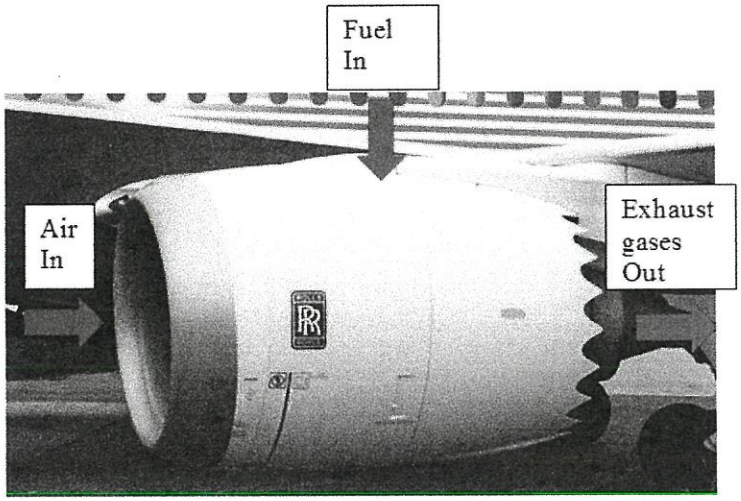

Figure Q3(b)