Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BNJ 10703
PROGRAMME CODE	:	BNG / BNL
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) A 3-kg plastic tank that has a volume of 0.2 m3 is filled with liquid water. Assuming the density of water is 1000 kg/m3, determine the weight of the combined system.

(6 marks)

(b) The constant-pressure specific heat of air at 25°C is 1.005 kJ/kg·°C. Express this value in kJ/kg·K, J/g·°C, kcal/ kg·°C, and Btu/lbm·°F.

(4 marks)

(c) A large fraction of the thermal energy generated in the engine of a car is rejected to the air by the radiator through the circulating water. Determine the system for the radiator should be analyzed and explain your answer.

(2 marks)

(d) Define the isothermal, isobaric, and isochoric processes.

(6 marks)

(e) The water in a tank is pressurized by air, and the pressure is measured by a multifluid manometer as shown in **Figure Q1**. Determine the gage pressure of air in the tank if h1 5 0.2 m, h2 5 0.3 m, and h3 5 0.4 m. Take the densities of water, oil, and mercury to be 1000 kg/m3, 50 kg/m3, and 13,600 kg/m3, respectively.

(4 marks)

Q2 (a) At a certain location, wind is blowing steadily at 10 m/s. Determine the mechanical energy of air per unit mass and the power generation potential of a wind turbine with 60-m-diameter blades at that location. Take the air density to be 1.25 kg/m3.

(6 marks)

(b) A water jet that leaves a nozzle at 60 m/s at a flow rate of 120 kg/s is to be used to generate power by striking the buckets located on the perimeter of a wheel. Determine the power generation potential of this water jet.

(4 marks)

(c) A ski lift has a one-way length of 1 km and a vertical rise of 200 m. The chairs are spaced 20 m apart, and each chair can seat three people. The lift is operating at a steady speed of 10 km/h. Neglecting friction and air drag and assuming that the average mass of each loaded chair is 250 kg, formulate the power required to operate this ski lift. Also estimate the power required to accelerate this ski lift in 5 s to its operating speed when it is first turned on.

(10 marks)

Q3 (a) Using the given property table, complete **Table Q3** for H_2O.

(4 marks)

(b) A 1.8-m^3 rigid tank contains steam at 220°C. One-third of the volume is in the liquid phase and the rest is in the vapor form. Analyze

(i) the pressure of the steam

(ii) the quality of the saturated mixture, and

(iii) the density of the mixture.

(10 marks)

(c) 10-kg of R-134a fill a 1.348-m^3 rigid container at an initial temperature of -40°C. The container is then heated until the pressure is 200 kPa. Calculate the final temperature and the initial pressure.

(6 marks)

Q4 (a) Explain specific heat, Cv and Cp.

(6 marks)

(b) Air is compressed from 20 psia and 70°F to 150 psia in a compressor. The compressor is operated such that the air temperature remains constant. Calculate the change in the specific volume of air as it passes through this compressor.

(4 marks)

(c) A 3-m^3 rigid tank contains hydrogen at 250 kPa and 550 K. The gas is now cooled until its temperature drops to 350 K. Determine

(i) the final pressure in the tank and

(ii) the amount of heat transfer.

(10 marks)

Q5 (a) (i) Explain thermal energy reservoir and give **three (3)** examples.

(4 marks)

(ii) Describe the characteristics of all heat engines.

(2 marks)

(b) (i) Steam power plant with a power output of 150 MW consumes coal at a rate of 60 tons/h. If the heating value of the coal is 30,000 kJ/kg, calculate the overall efficiency of this plant.

(4 marks)

(ii) An automobile engine consumes fuel at a rate of 22 L/h and delivers 55 kW of power to the wheels. If the fuel has a heating value of 44,000 kJ/kg and a density of 0.8 g/cm3, calculate the efficiency of this engine.

(4 marks)

(c) A household refrigerator that has a power input of 450 W and a COP of 1.5 is to cool 5 large watermelons, 10 kg each, to 88C. If the watermelons are initially at 28°C, determine how long it will take for the refrigerator to cool them. The watermelons can be treated as water whose specific heat is 4.2 kJ/kg·°C.

(6 marks)

-END OF QUESTIONS –

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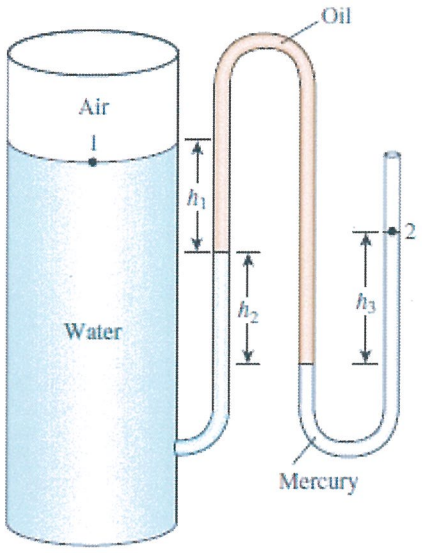

Figure Q1

Table Q3

T, °C	*P*, kPa	*u*, kJ/kg	Phase description
	400	1450	
220			Saturated vapor
190	2500		
	4000	3040	