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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	DAM 20503
PROGRAMME	:	DAM
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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Q1 (a) Explain the following matters and give real world example each:

(i) control mass
(ii) control volume
(iii) second law of thermodynamics
(iv) adiabatic process
(v) isothermal process

(10 marks)

(b) **Figure Q1(b)** showed a river flowing steadily at a rate of 270 m^3/s is considered for hydroelectric power generation. It is determined that a dam can be built to collect water and release it from an elevation difference of 70 m to generate power. [Given: Gravitational acceleration, g =9.81ms^{-2}; Density of water, ρ = 1000 kg/m^{-3}]

(i) Calculate the potential energy of the river water per unit mass (kJ/kg);

(5 marks)

(ii) Determine the power generated ($\dot{W}$) from the river water after the dam is filled in MW unit.

(5 marks)

Q2 (a) Explain and give **two (2)** examples for each of the following terms:

(i) Macroscopic energy,

(2.5 marks)

(ii) Microscopic energy.

(2.5 marks)

(b) An oil pump is drawing 35 kW of electric power while pumping oil with a density, ρ = 860 kg/m^3 at a rate of 0.1 m^3/s. The inlet and outlet diameters of the pipe are 8 cm and 12 cm, respectively. If the pressure rise of oil in the pump is measured to be 400 kPa and the motor efficiency is 90 percent, determine the mechanical efficiency of the pump.

(15 marks)

Q3 (a) Explain the definition of saturated water and superheated vapor?

(2 marks)

(b) Determine the enthalpy (h) in kJ/kg of 1.5 kg of water contained in a volume of 1.2 m^3 at 200 kPa

(6 marks)

(c) Complete the following **Table 1** for **H_2O** (water) and write it into your answer papers.

Table 1: H_2O

Condition	**P, kPa**	**T, °C**	**x**	**v, m^3/kg**	**u, kJ/kg**	**h, kJ/kg**	**Phase Description**
1	750	125	A	B	C	D	E
2	6000	450	F	G	H	I	J

(10 marks)

(d) How does the boiling process at supercritical pressures differ from the boiling process at subcritical pressures?

(2 marks)

Q4 (a) Real gases behave as an ideal gas at low densities. Define condition of low densities.

(2 marks)

(b) A 1 kg mass of air have a complete thermodynamic cycle which consist of 3 states:

Process 1-2: Cooled at constant pressure
Process 2-3: Heated at constant volume until final temperature, T_3 equal to initial temperature, T_1
Process 3-1: Volume expand at constant temperature

At state 1, the initial temperature, T_1 is 600 K and the pressure, P_1 is 220 kPa. The volume for state 3 is 40% of state 1 volume. Assume gas constant, R = 0.287 kJ/kg.K. By using the ideal gas model, determine:

(i) Volume at state 1 and state 2,

(4 marks)

(ii) Temperature at state 2,

(4 marks)

(iii) Pressure at state 3.

(4 marks)

(c) A 20 L pressure vessel contains pressurize air at 28 ˚C. Pressure gauge showed 1.5 bar and weight of the empty pressure vessel is 129 kg. Determine the total weight of the pressure vessel if atmospheric pressure is 1.01 bar. Assume the air behave as an ideal gas. [Note: 1 m^3 = 1000 L]

(6 marks)

Q5 (a) List **three (3)** types of total energy for a non-flowing fluid.

(3 marks)

(b) The function of compressor in air conditioning unit is to compress and circulate refrigerant gas throughout the system. Refrigerant-134a (R-134a) enters an adiabatic compressor, as saturated vapor at 24°C and leaves at 0.8 MPa and 60°C. The mass flow rate ($\dot{m}$) of the refrigerant is 1.2 kg/s. Determine:

(i) the power input ($\dot{W}$) to the compressor in kJ/s

(5 marks)

(ii) the volume flow rate ($\dot{v}$) of the refrigerant at the compressor inlet in m^3/s.

(2 marks)

(c) Mixing chamber are devices that mix two streams of fluid with different temperature into one single stream with equilibrium temperature. Liquid water at 300 kPa and 20°C is heated in a chamber by mixing it with superheated steam at 300 kPa and 300°C. Cold water enters the chamber at a rate of 1.8 kg/s. If the mixture leaves the mixing chamber at 60°C, determine:

(i) The enthalpy (h) for cold water, superheated steam and mixture in kJ/kg.

(5 marks)

(ii) the mass flow rate ($\dot{m}$) of the superheated steam required in kg/s.

(5 marks)

Q6 (a) List **two (2)** example of thermal energy reservoir.

(2 marks)

(b) Prof H claims to have invented a newly concept of a heat engine that develops a thermal efficiency of 85 percent when operating between two heat reservoirs at 1000 K and 300 K. Proof and evaluate whether his claim is true or false.

(4 marks)

(c) A domestic food freezer maintains a temperature of - 15°C. The ambient air is at 30°C. If the heat leaks into the freezer at a continuous rate of 1.75 KJ/s, what is the least power necessary to pump the heat out continuously?

(4 marks)

(d) A heat pump with 7.07 kW of electric power was provided the heat energy to a house at a rate of 64,400 kJ / hour. Calculate the:

(i) Heat pump's coefficient of performance, COP_{HP},

(3 marks)

(ii) Rate of heat absorption from the outside air, Q_L.

(3 marks)

(e) Heat pump used to heat a house runs about one third of the time. The house is losing heat at an average rate of 22,000 kJ/h. If the COP of the heat pump is 2.8, determine the power the heat pump draws when running

(4 marks)

Q7 (a) State **three (3)** conclusions that can be made based on the Clausius inequality, $\oint \frac{\delta Q}{T} \leq 0$.

(4 marks)

(b) A steam power plant operates between 900K and 350K reservoirs. The power plant receives 2800 kJ from the heat reservoir then it produce 1550 kJ of work. Determine the operating status plant cycle whether reversible, irreversible or impossible to use:

(i) Carnot principle

(ii) Clausius Inequalities

(6 marks)

(c) An air compressor is used to supply compressed air at a rate of $0.3 kgs^{-1}$ at a pressure of 4 bar and a temperature of 60°C. Atmospheric air conditions are 1 bar and temperature is 27°C. If the required compressor power is 20 kW, determine:

(i) entropy change

(ii) heat transfer rate

(iii) the rate of entropy generation

For gas: take C_p = 1.005 kJ/kg.K and R = 0.287 kJ/kg.K

(10 markah)

- END OF QUESTION -

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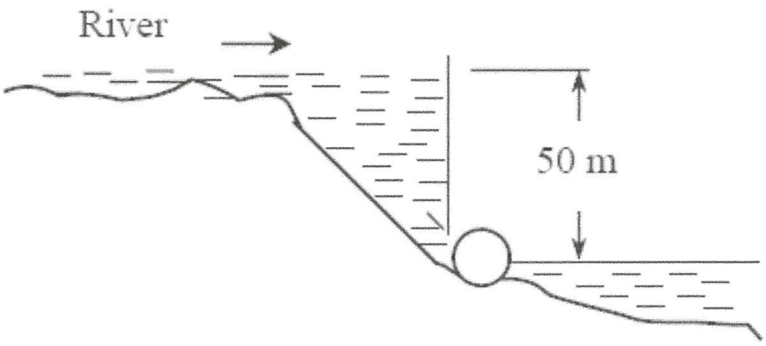

Figure Q1 (b)