Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	DAM 20503
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) Explain the following term of thermodynamics:

(i) Zeroth law of thermodynamics
(ii) First law of thermodynamics
(iii) Second law of thermodynamics
(iv) Adiabatic process
(v) Isothermal process

(10 marks)

(b) The absolute pressure in water at a depth of 5 m is 145 kPa. Determine:

(i) Local atmospheric pressure.
(ii) Absolute pressure at a depth of 5 m in a liquid whose specific gravity is 0.85 at the same location.

(4 marks)

(c) Consider a U-tube as shown in **Figure Q1(c)** whose arms are open to the atmosphere. Now water is poured into the U-tube from one arm, and light oil (ρ = 790kgm^{-3}) from the other. One arm contains 70-cm-high water, while the other arm contains both fluids with an oil-to-water height ratio of 4. Determine the height of each fluid in that arm.

(6 marks)

Q2 (a) Explain the definition of compressed liquid and superheated vapor.

(2 marks)

(b) Find the missing properties and the phase descriptions in the following **Table 1** for water. Each answer must be supported by related calculation.

Table 1: Properties of H_20

No.	T, °C	P, kPa	u, kJ/kg	x	Phase Description
a)	**A**	850	**B**	0.0	**C**
b)	**D**	200	**E**	0.6	**F**
c)	125	**G**	1600	**H**	**I**
d)	**J**	1000	2950	**K**	**L**

(12 marks)

(c) A rigid tank as shown in **Figure 2(c)** initially contains 1.4kg saturated liquid water at 200 °C. At this state, 25% of the volume is occupied by water and the rest by air. Now heat is supplied to the water until the tank contains saturated vapor only. Determine:

(i) Volume of the tank,
(ii) Final temperature and pressure,
(iii) Internal energy change of the water.

(6 marks)

Q3 (a) Under what conditions is the ideal-gas assumption suitable for real gases?
(4 marks)

(b) A 1 m^3 tank containing air at 25 °C and 500 kPa is connected through a valve to another tank containing 5 kg of air at 35 °C and 200 kPa. Now the valve is opened, and the entire system is allowed to reach thermal equilibrium with the surroundings, which are at 20 °C. Determine:

(i) The volume of the second tank
(ii) Final equilibrium pressure of air.

(10 marks)

(c) The pressure in an automobile tire as shown on **Figure Q3(c)** depends on the temperature of the air in the tire. When the air temperature is 25°C, the pressure gage reads 210kPa. If the volume of the tire is 0.025 m^3, determine the pressure rise in the tire when the air temperature in the tire rises to 50 °C. Also, determine the amount of air that remove from the tire to restore pressure to its original value at this temperature. Assume the atmospheric pressure is 100 kPa.

(6 marks)

Q4 (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
(ii) The volume flow rate ($\dot{v}$) of the refrigerant at the compressor inlet in m^3/s.

(7 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) Enthalpy for cold water, superheated steam and mixture in kJ/kg.
(ii) Mass flow rate ($\dot{m}$) of the superheated steam required in kg/s.

(10 marks)

Q5 (a) Prof N 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)

(b) 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)

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

(4 marks)

(d) Refrigerant-134a enters the condenser of a residential heat pump as shown in **Figure 5(d)** at 800 kPa and 35 °C at a rate of 0.018 kg/s and leaves at 800 kPa as a saturated liquid. If the compressor consumes 1.2 kW of power, determine

(i) The COP of the heat pump
(ii) The rate of heat absorption from the outside air.

(8 marks)

Q6 (a) State **three (3)** conclusions that can be made based on the Clausius inequality, $\oint \frac{\delta Q}{T} \leq 0$.

(3 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

(4 marks)

(c) Steam enters an adiabatic turbine steadily as illustrated at **Figure 6(c)** at 7MPa, 500°C, and 45 m/s, and leaves at 100 kPa and 75 m/s. If the power output of the turbine is 5 MW and the isentropic efficiency is 77 percent, determine:

(i) The mass flow rate of steam through the turbine
(ii) The temperature at the turbine exit
(iii) The rate of entropy generation during this process.

(9 marks)

(d) Refrigerant-134a is throttled in a throttling valve as shown in **Figure 6(d)** from 900 kPa and 35°C to 200 kPa. Heat is lost from the refrigerant in the amount of 0.8 kJ/kg to the surroundings at 25°C. Determine:

(i) Exit temperature of the refrigerant
(ii) Entropy generation during this process.

(4 marks)

- END OF QUESTION -

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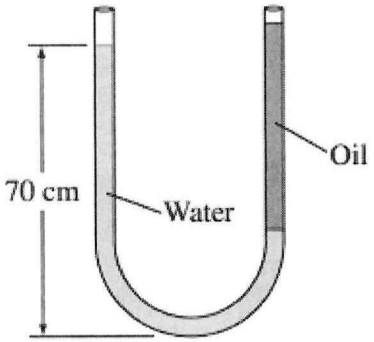

Figure Q1(c) : U-Tube

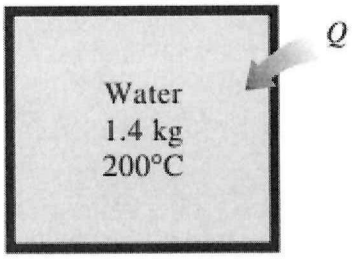

Figure 2(c): Rigid Tank

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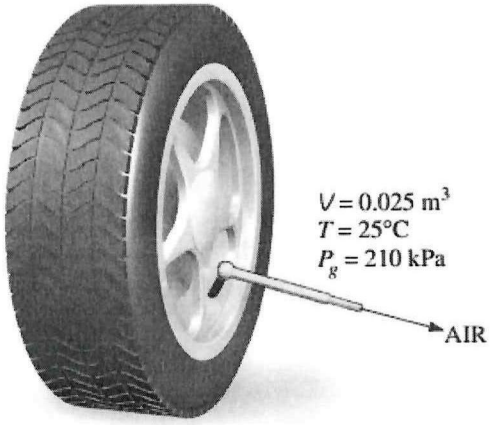

Figure Q3(c): Automobile Tire

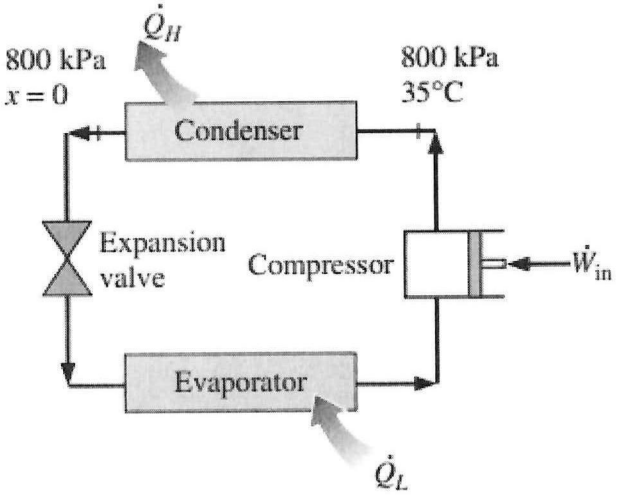

Figure 5(d): Illustrative of Residential Heat Pump

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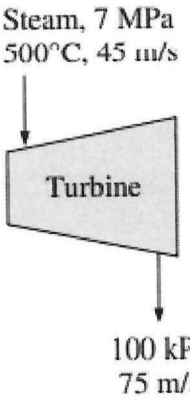

Figure 6(c)

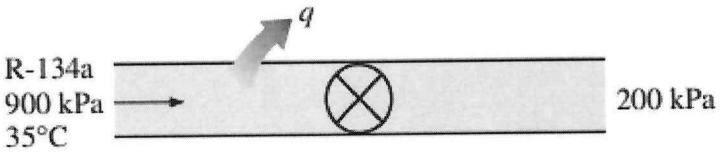

Figure 6(d): Throttling Valve