Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BNJ 20703
PROGRAMME CODE	:	BNH / BNG / BNL / BNM
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Give definition to the Zeroth Law of Thermodynamics.

(3 marks)

(b) A worker carries his 30-kg bag and uses an elevator from the hotel lobby to ascend the 10th floor of the hotel, 35-meter height. Given that the gravitational acceleration is 9.81 m/s^2, Determine the amount of energy (kWh) stored in the bag, as a result of the journey.

(8 marks)

(c) A 90-hp (shaft output) electric car is powered by an electric motor mounted in the engine compartment. If the motor has an average efficiency of 91 percent, Determine the rate of heat supply (kW) by the motor to the engine compartment at full load.

(9 marks)

Q2 (a) Explain the conservation of mass principle for a control volume.

(2 marks)

(b) Air at 110 kPa and -7°C enters an adiabatic diffuser steadily with inlet velocity of 189 m/s and leaves at 190 kPa with lower velocity. The diffuser exit area is 5.5 times the inlet area. Calculate:

(i) the temperature at the exit (K)

(10 marks)

(ii) the velocity of the air leaving the diffuser (m/s).

(8 marks)

Q3 (a) (i) Complete this table for refrigerant-134a:

	T, °C	*P, kPa*	*U, kJ/kg*	*Phase Description*
1	22		90	
2	-30			Saturated Liquid
3		500	280	
4	10	500		

(4 marks)

(ii) A 0.5 m^3 vessel contains 10 kg of refrigerant-134a at -20°C. Determine:

(a) the pressure

(2 marks)

(b) the total internal energy

(2 marks)

(c) the volume occupied by the liquid phase.

(2 marks)

(b) (i) What is the difference between R and R_u? How are these two related?

(3 marks)

(ii) A 1 m^3 tank ***A*** containing air at 25°C and 500 kPa is connected through a valve to another tank ***B*** 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 the volume of the tank ***B*** and the final equilibrium pressure of air.

(7 marks)

Q4 (a) Write the Kelvin – Planck Statement of the Second Law of Thermodynamics.

(3 marks)

(b) An Engineer claims to developed a new reversible heat-engine cycle that has the same theoretical efficiency as the Carnot cycle operating between the same temperature limits. Is this a reasonable claim?

(4 marks)

(c) Refrigerant-134a enters the evaporator coils placed at the back of the freezer section of a household refrigerator at 120 kPa with a quality of 20 percent and leaves at 120 kPa and 20°C. If the compressor consumes 450 W of power and the COP the refrigerator is 1.2, determine;

(i) the mass flow rate of the refrigerant

(5 marks)

(ii) the rate of heat rejected to the kitchen air.

(3 marks)

(d) A Carnot heat engine operates between a source at 1000 K and a sink at 300 K. If the heat engine is supplied with heat at a rate of 800 kJ/min, determine

(i) the thermal efficiency

(3 marks)

(ii) the power output of this heat engine.

(2 marks)

Q5 (a) Describe the ideal process for an adiabatic turbine, adiabatic compressor and adiabatic nozzle, and define the isentropic efficiency for each device.

(2 marks)

(b) A 50-kg block of iron casting at 500 K is thrown into a large lake that is at a temperature of 285 K. The iron block eventually reaches thermal equilibrium with the lake water. Assuming an average specific heat of 0.45 kJ/kg · K for the iron, determine

(i) the entropy change of the iron block

(4 marks)

(ii) the entropy change of the lake water

(4 marks)

(c) Steam enters an adiabatic turbine steadily at 7 MPa and 600°C and leaves at 50 kPa and 150°C. If the power output of the turbine is 6 MW, determine

(i) the isentropic efficiency of the turbine

(6 marks)

(ii) the mass flow rate of the steam flowing through the turbine.

(4 marks)

END OF QUESTIONS