INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2019**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**EGM2172 : Engineering Thermodynamics 1**
Date of Examination	:	August 2, 2019 (Friday)
Time	:	11:00 am – 1:00 pm Reading Time: Nil
Duration	:	2 Hours
Special Instructions	:	

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :

Non-Programmable Calculator

Materials provided :

Thermodynamics and Transport Properties of Fluids,Property Tables and Charts (SI Units)

Examiner (s)	:	**Iylia Elena Abdul Jamil** and Nur Hafizah Habideen
Moderator	:	Dr Idris Saad

*This paper consists of **6** printed pages, including the cover page.*

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2172: ENGINEERING THERMODYNAMICS 1
FINAL EXAMINATION: APRIL 2019 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provide. All questions carry equal marks.

Question 1

(a) Saturated liquid-vapor mixture of water exist in equilibrium at 800 kPa in a piston–cylinder device as shown in Figure Q1 (a). The volumes of the liquid and vapor are 0.1 m^3 and 0.9 m^3, respectively. Heat is transferred to the system at constant pressure until the temperature reaches 350°C.

(i) Determine the initial temperature of the water.
(2 marks)

(ii) Determine the total mass of the water.
(5 marks)

(iii) Calculate the final volume of the piston-cylinder device.
(2 marks)

(iv) Show the process on a *P-v* diagram with respect to saturation lines
(3 marks)

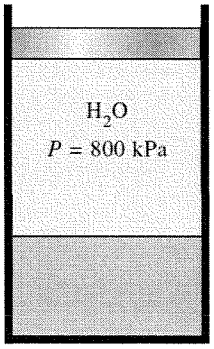

Figure Q1 (a)

(b) A rigid tank contains hydrogen at 20°C and 600 kPa. The tank connects to another tank that holds hydrogen at 30°C and 150 kPa, as shown in Figure Q1 (b). The volume of each tank is 0.5 m^3. When the valve is opened, the system reaches thermal equilibrium with the surroundings, which are at 15°C. Determine the final pressure in the tank.
(7 marks)

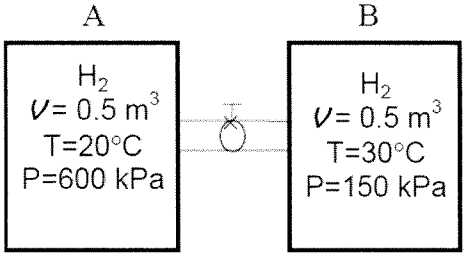

Figure Q1 (b)

(c) After cooking, a pot and its perfectly fitted lid often stick, making it difficult to lift the lid up when the pot cools down.

(i) Explain this phenomenon.

(3 marks)

(ii) What is the easiest way to open the lid?

(3 marks)

Question 2

(a) A can of soft drink at room temperature is put into the refrigerator so that it will cool.

(i) Define the system, boundary, and surrounding to analyze the heat leaving the soft drink.

(3 marks)

(ii) Would you model the system in (i) as a closed system or as an open system? Explain.

(2 marks)

(b) Explain why some people experience nose bleeding and some others experience shortness of breath at high elevations.

(4 marks)

(c) Saturated liquid–vapor mixture of water is contained in a well–insulated rigid tank as shown in Figure Q2 (b). Mass of the mixture is 5 kg and pressure inside the tank is 100 kPa. Initially, three–quarters of the mass is in the liquid phase. An electric resistor placed in the tank is connected to a 110 V source and a current of 8 A flows through the resistor when the switch is turned on.

(i) Write the energy balance equation for this problem.

(3 marks)

(ii) Determine the time taken to vaporize all the liquid in the tank.

(10 marks)

(iii) Show the process on a T-v diagram with respect to saturation lines.

(3 marks)

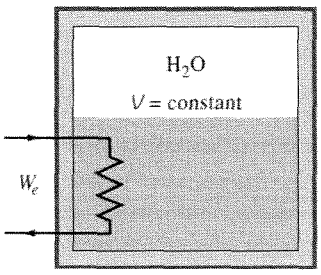

Figure Q2 (b)

Question 3

(a) Define the quasi–equilibrium process. Provide **ONE (1)** example.

(4 marks)

(b) A mass of 5 kg of saturated water vapor at 300 kPa is heated at constant pressure until the temperature reaches 200°C.

(i) Calculate the work done by the steam during this process.

(5 marks)

(ii) Show the process on a *P-v* diagram.

(3 marks)

(c) Steam at 5 MPa and 400°C enters a nozzle steadily with a velocity of 80 m/s, and it leaves at 2 MPa and 300°C. The inlet area of the nozzle is 50 cm^2, and heat lost at a rate of 120 kJ/s occurs in the nozzle.

(i) Determine the mass flow rate of the steam.

(3 marks)

(ii) Calculate the exit velocity of the steam.

(7 marks)

(iii) Calculate the exit area of the nozzle.

(3 marks)

Question 4

(a) A mass of 15 kg of air in a piston–cylinder device is heated from 25°C to 77°C by passing current through a resistance heater inside the cylinder. The pressure inside the cylinder is held constant at 300 kPa during the process, with the occurrence of 60 kJ of heat loss. Calculate the electric energy supplied, in kWh.

(6 marks)

(b) Argon gas enters an adiabatic turbine steadily at 900 kPa and 450°C with a velocity of 80 m/s and leaves at 150 kPa with a velocity of 150 m/s. The inlet area of the turbine is 60 cm^2.

(i) Write the energy balance equation for this turbine.

(3 marks)

(ii) Calculate the mass flow rate of the gas.

(4 marks)

(iii) If the power output of the turbine is 250 kW, determine the exit temperature of the argon.

(2 marks)

(c) The laws of thermodynamics govern our daily lives.

(i) State the first law of thermodynamics. Describe the law using an example process.

(4 marks)

(ii) State the second law of thermodynamics. Describe a process that violates the second law.

(4 marks)

(iii) Explain the second law of thermodynamics relation to entropy generation.

(2 marks)

Question 5

(a) In Figure Q5 (a), a Carnot heat engine receives heat at 750 K and rejects the waste heat to the environment at 300 K. The entire work output of the heat engine is used to drive a Carnot refrigerator. The refrigerator removes heat from the cooled space at –15°C at a rate of 400 kJ/min and rejects it to the same environment at 300 K.

(i) Determine the rate of heat supplied to the heat engine.

(8 marks)

(ii) Determine the total rate of heat rejection to the environment.

(7 marks)

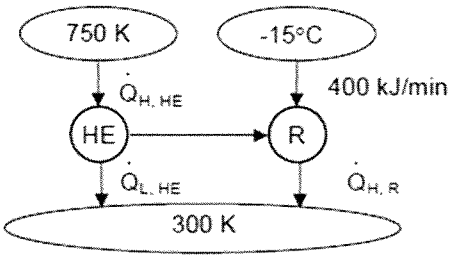

Figure Q5 (a)

(b) The radiator of a steam heating system has a volume of 20 L and is filled with superheated water vapor at 200 kPa and 150°C. At this moment, both the inlet and the exit valves to the radiator are closed. After a while, the temperature of the steam drops to 40°C because of heat transfer to the room air. Determine the entropy change of the steam during this process.

(10 marks)

Question 6

(a) Refrigerant–134a enters the condenser of a residential heat pump at 800 kPa and 35°C at a rate of 0.018 kg/s and leaves at 800 kPa as a saturated liquid, as shown in Figure Q6 (a). The compressor consumes 1.2 kW of power.

(iii) Determine the COP of the heat pump.

(6 marks)

(iv) Determine the rate of heat absorption from the outside air.

(3 marks)

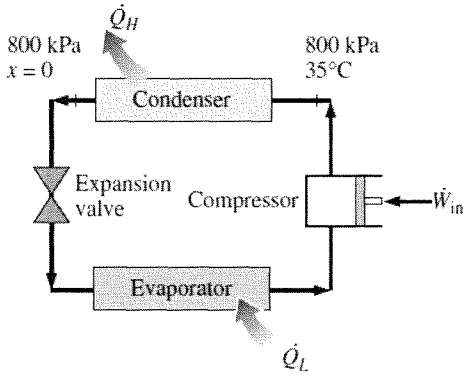

Figure Q6 (a)

(b) The first and second laws of thermodynamics govern all processes.

(i) Describe an imaginary process that satisfies the first law but violates the second law of thermodynamics.

(2 marks)

(ii) Describe an imaginary process that satisfies the second law but violates the first law of thermodynamics.

(2 marks)

(iii) Describe an imaginary process that violates both the laws.

(2 marks)

(c) A heavily insulated piston–cylinder device contains 0.05 m^3 of steam at 300 kPa and 150°C. Steam is now compressed in a reversible manner to a pressure of 1 MPa. Determine the work done on the steam during this process.

(10 marks)

-THE END-