INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2018**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**EGM2172 : Engineering Thermodynamics 1**
Date of Examination	:	July 26, 2018 (Thursday)
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** & Aaron Edward Teo Sheng Jye
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 2018 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) Briefly explain why a bicyclist picks up speed on a downhill road even when he is not pedalling. Briefly explain whether this condition violates the conservation of energy principle.

(4 marks)

(b) State what is the net force acting on a car cruising at a constant velocity of 70 km/h for the following cases;

(i) on a level road and

(ii) on an uphill road.

State the reason for your answer.

(4 marks)

(c) Briefly explain the process of quasi-equilibrium and its importance in engineering analysis.

(4 marks)

(d) Energy can be transformed from one type to another and transferred from one object to another. Many engineering devices have been created to optimize energy production and consumption and one of them is the heat engine.

(i) Briefly explain the mechanism of heat engine. Sketch a diagram to aid your answer.

(ii) Briefly explain the working process of a steam power plant.

(13 marks)

Question 2

(a) A piston-cylinder device containing 0.2 m^3 of liquid water and 1.2 m^3 of vapor at 600 kPa. Heat is transferred at constant pressure until the temperature reaches 400 °C.

(i) Sketch the T-v diagram that will represent this process.

(ii) What is the initial temperature of the mixture?

(iii) Determine the total mass of the mixture.

(iv) Determine the quality of mixture.

(v) Determine the enthalpy of mixture.

(vi) Calculate the final volume of water at 400 °C.

(19 marks)

(b) A mass of 20 grams of oxygen filled in a weighted piston cylinder device at 30 kPa and 90 °C. The device is now cooled until temperature reaches 10 °C. Assuming oxygen as an ideal gas and R = 0.2598 kJ/kg.K. Determine the following:

(i) The initial volume of oxygen.

(ii) The final volume of oxygen.

(iii) The change of volume. State the system is under expansion/compression.

(6 marks)

Question 3

(a) A 0.5 m^3 rigid tank contains refrigerant-134a at 160 kPa and 40 percent initial quality. Heat is now transferred to the refrigerant until the pressure reaches 700 kPa. Determine;

(i) the mass of the refrigerant in the tank and

(ii) the amount of heat transferred.

(15 marks)

(b) 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.

(10 marks)

Question 4

(a) Air enters an adiabatic nozzle steadily at 300 kPa, 200°C, and 30 m/s and leaves at 100 kPa and 180 m/s. The inlet area of the nozzle is 80 cm^2. Calculate;

(i) the mass flow rate through the nozzle,

(ii) the exit temperature of the air, and

(iii) the exit area of the nozzle.

(13 marks)

(b) Steam flows steadily through an adiabatic turbine. The inlet conditions of the steam are 10 MPa, 450 °C and 80 m/s, and the exit conditions are 10 kPa, 92 percent quality, and 50 m/s. The mass flow rate of the steam is 12 kg/s. Calculate;

(i) the change in kinetic energy,

(ii) the power output, and

(iii) the turbine inlet area.

(12 marks)

Question 5

(a) A rigid tank contains an ideal gas at 40 °C that is stirred by a paddle wheel, as shown in Figure Q5. The paddle wheel does 200 kJ of work on the ideal gas. It is observed that the temperature remains constant during this process as a result of heat transfer. State either there is any entropy changes in this system with a valid reason.

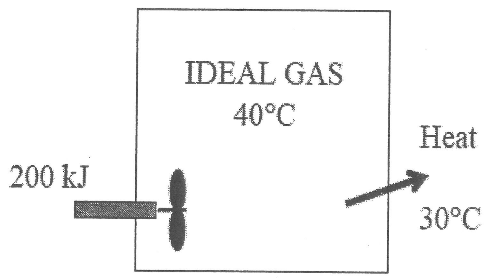

Figure Q5

(3 marks)

(b) Using the relation ds = (δQ/T) for the definition of entropy, calculate the change in the specific entropy of R-134a as it is heated at a constant pressure of 200 kPa from a saturated liquid to a saturated vapor. Use R-134a property tables to verify your answer and sketch the T-s diagram.

(7 marks)

(c) Steam is expanded in an isentropic turbine with a single inlet and outlet, respectively. At the inlet, the steam is at 2 MPa and 360°C. The steam pressure at the outlet is 100 kPa and in saturated liquid-vapor condition.

(i) Sketch the T-s diagram.

(ii) Calculated the work produce by turbine in kJ/kg.

(iii) Now consider the turbine has an efficiency of 87 percent; calculate the actual work produced by the turbine.

(15 marks)

Question 6

(a) A fan is running in a well-sealed and well insulated room, as shown in Figure Q6.

(i) Briefly explain if there is any heat transfer when the fan is running.

(ii) After operating for a few hours, state either the room temperature will be increasing, decreasing or constant. Explain your answer.

(iii) If the fan is running at 10 m/s in 10 s, would the energy transferred to the fan be different if it is running with same speed but in 5 s?

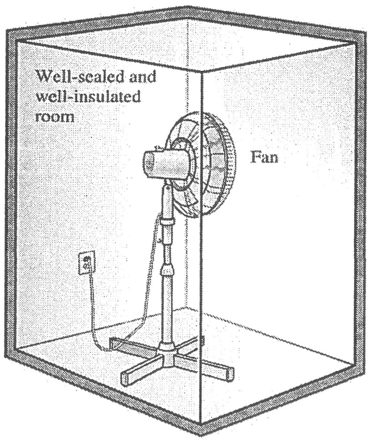

Figure Q6

(10 marks)

(b) A Carnot heat engine operates between two reservoirs at 800 °C and 20 °C, respectively. One-half of the work output of the heat engine is used to drive a Carnot heat pump that removes heat from the cold surroundings at 2 °C and transfers it to a house maintained at 22 °C. If the house is losing heat at a rate of 62,000 kJ/h, determine the minimum rate of heat supply to the heat engine required to keep the house at 22 °C.

(15 marks)

-THE END-