



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 2 Examination in Engineering: July 2022

Module Number: ME2201

Module Name: Fundamentals of Engineering
Thermodynamics

[Three Hours]

[Answer all questions, each question carries 12 marks]

Note: Provide neat sketches and state any reasonable assumptions made; Symbols have their usual meaning; Steam table is provided.

- Q1 a) Briefly explain **three** practical applications of Engineering Thermodynamics. [3.0 Marks]
- b) Define the following terms. [2.0 Marks]
- i) Thermodynamic system
 - ii) System boundary
- c) Briefly explain the following terms with suitable sketches. [3.0 Marks]
- i) Closed system
 - ii) Open system
 - iii) Isolated system
- d) Briefly explain the behaviour of the entropy of a working substance with its temperature with the aid of sketches. [2.0 Marks]
- e) Draw p - v diagrams for the following processes. [2.0 Marks]
- i) Isochoric process
 - ii) Isobaric process
 - iii) Isothermal process
 - iv) Adiabatic process
- Q2 a) State the first law of thermodynamics. [1.5 Marks]
- b) Draw a poster that indicates the practical applications of the first law of thermodynamics. [3.5 Marks]
- c) Oxygen gas at the pressure of 12 atm and temperature of 150 °C is adiabatically expanded in a frictionless piston-cylinder device to double its initial volume. Then the gas is compressed at constant pressure to its initial volume and then compressed again at constant volume to its initial state. If the weight of the oxygen gas inside the cylinder is 5 g, calculate the net work done on the gas during above mentioned process. Take the gas constant and polytropic index of the oxygen gas as 297 J/kg K and 1.3, respectively. [5.0 Marks]
- d) Write down **four** examples for intensive properties of a substance.

[2.0 Marks]

- Q3 a) Briefly explain the difference between "Mechanical work" and "Thermodynamic work".
[2.0 Marks]
- b) Saturated water vapour in a piston-cylinder device is maintained at the pressure of 200 kPa. Saturated water vapour is heated by a resistance heater installed within the cylinder by passing a current of 0.70 A from a 110 V source. The heat loss from the system during the heating process is 2.2 kJ. If the saturated water vapour 300 g is heated for 10 min, determine the followings.
i) The work done during the process.
ii) The final temperature of the steam.
[8.0 Marks]
- c) Draw the p - v diagram of the Carnot power cycle.
[2.0 Marks]
- Q4 a) The second law of thermodynamics can be stated in three alternative ways. Write down those three statements.
[6.0 Marks]
- b) Briefly explain the terms "Reversible Process" and "Irreversible Process".
[2.0 Marks]
- c) By steadily circulating a refrigerant at low temperature through passages in the walls of the freezer compartment, a refrigerator maintains the freezer compartment at $-5\text{ }^{\circ}\text{C}$ when the air surrounding the refrigerator is at $22\text{ }^{\circ}\text{C}$. The rate of heat transfer from the freezer compartment to the refrigerant is 8000 kJ/h and the power input required to operate the refrigerator is 3200 kJ/h. Determine the coefficient of performance of the refrigerator and compare with the coefficient of performance of a reversible refrigeration cycle operating between reservoirs at the same two temperatures.
[4.0 Marks]
- Q5 a) What is a power cycle? Give **two** examples for real world systems with power cycle.
[3.0 Marks]
- b) Explain the house hold refrigerator working principle with the aid of sketch.
[4.0 Marks]
- c) A large container ship is propelled by a heat engine that uses fuel oil as a heat source and sea water as a heat sink. The engine produces 75000 kW while consuming 13600 litres per hour of fuel oil. The fuel oil releases 43000 kJ per litre fuel oil burned. Calculate the rate of heat transfer to the ocean and the thermal efficiency of the ship heat engine.
[5.0 Marks]