(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

MAIN UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 271

COURSE TITLE: THERMODYNAMICS I

DATE: 15TH DECEMBER 2023 **TIME:** 03:00 – 05:00 PM

Instructions to Candidates

1. Answer **Question ONE (compulsory)** and any other **TWO** Questions.
2. All symbols have their usual meaning.
3. Steam tables are provided.

TIME: 2 Hours

QUESTION ONE – Compulsory - (30 MARKS)

a) Define the following thermodynamic systems:

i) An isolated system.

(1 Mark)

ii) A closed system.

(1 Mark)

iii) An open system.

(1 Mark)

b) State the First Law of Thermodynamics.

(2 Marks)

c) Use sketches to show the difference between the following:
i) A Convergent nozzle

(2 Marks)

ii) A Convergent-Divergent nozzle.

(3 Marks)

d) Steam at 150 bar has an enthalpy of 3309 kJ/kg. Determine the following:
i) Temperature.

(5 Marks)

ii) Specific volume.

(2 Marks)

iii) Internal energy.

(5 Marks)

e) State the SFEE.

(4 Marks)

f) Give two conditions for reversibility of a thermodynamic process.

(4 Marks)

QUESTION TWO (20 MARKS)

Steam at a pressure of 12.8 bar enters a turbine with a velocity of 26 m/s and a specific volume of 0.14 m^3/kg. After a steady flow through the turbine the steam leaves at a pressure of 0.38 bar, a velocity of 80 m/s and a specific volume of 4.0 m^3/kg. The internal energy of steam leaving the turbine is 260 kJ/kg less than that of the steam entering the turbine. Heat is lost to the surroundings at a rate of 0.3 kJ/s. The steam flow is 0.4 kg/s. Calculate the:

a) Power developed by the turbine.

(14 Marks)

b) Inlet and outlet cross-sectional areas.

(6 Marks)

QUESTION THREE (20 MARKS)

a) Show from first principles that the heat flow in a polytropic process is given by:

$$Q = \left(\frac{\gamma - n}{\gamma - 1}\right) W$$

(10 Marks)

b) Carbon dioxide at 1 bar is compressed reversibly until the pressure is 6 bar according to the law $PV^{1.4}$ = constant. If the initial specific volume is 0.6 m^3/kg, calculate the:

(i) Final temperature.

(3 Marks)

(ii) Work done on the gas.

(2 Mark)

(iii)Heat flow to or from the cylinder walls.

(5 Marks)

QUESTION FOUR (20 MARKS)

Steam at 70 bar, 300^0C is contained in a rigid cylinder of volume 0.02m^3. The cylinder is cooled until the pressure is 40 bar.

a) Determine the state of steam after cooling.

(6 Marks)

b) Calculate the amount of heat rejected by steam.

(9 Marks)

c) Show the process on a T-S diagram indicating the area which represents heat flow.

(5 Marks)