(University of Choice)

MASINDE MULIRO UNIVERSITY OF

SCIENCE AND TECHNOLOGY

(MMUST)

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF
B.SC MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE:　　MIE 272

COURSE TITLE:　　THERMODYNAMICS II

DURATION: 2 HOURS

DATE: 20-4-2022　　　　　　　　**TIME: 12.00-14.00 HRS**

This paper consists of **3** printed pages. Please Turn Over ▶

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (Compulsory) – 30 Marks

a) Define the following terms:

   (i)   Stoichiometric combustion.

   (2 Marks)

   (ii) Ultimate analysis.

   (2 Marks)

b) Use a P-V diagram to explain the processes in an Atkinson cycle

   (5 Marks)

c) Define a heat engine

   (3 Marks)

d) Define Work ratio

   (2 Marks)

e) Briefly explain the following terms
   (i) Impulse turbines

   (3 Marks)

   (ii) Impulse-Reaction turbines

   (2 Marks)

f) Explain the purpose of the following design developments on an ICE:
   (i)   Eco-fan.

   (2 Marks)

   (ii) Replaceable wet sleeves and cylinders.

   (2 Marks)

   (iii) Cross-flow aspiration.

   (3 Marks)

   (iv) Piston spray cooling.

   (2 Marks)

   (v)   Turbo-chargers.

   (2 Marks)

QUESTION TWO – 20 MARKS

a) Show from first principles that the indicated work of an air compressor is expressed as:

$$W = \left(\frac{n}{n-1}\right) mR(T_2 - T_1)$$

   (8 Marks)

b) A single-acting single-cylinder air compressor running at 290 rpm takes $1m^3$ of air per minute at a pressure of 1 bar and 18^0C. The compression process which takes place in a single stage follows the law $pv^{1.32}$ = constant. Air is then delivered at a pressure of 8 bar.

Assuming negligible clearance volume, calculate:
   (i) Indicated power

(6 Marks)

   (ii) Isothermal efficiency

(6 Marks)

QUESTION THREE (20 Marks)

A sample of coal has elements with the following composition by mass: 88% C, 5% H_2, 2.5% O_2, 1% N_2, 0.5% S, and 3% Ash.

a) Determine the stoichiometric A/F ratio for its combustion.

(10 Marks)

b) Find the actual A/F ratio if 25% excess air is supplied.

(2 Marks)

c) Do a volumetric analysis of combustion products in (b) on a dry basis.

(8 Marks)

QUESTION FOUR – 20 MARKS

A steam power plant operates on a Rankine cycle with reheat between a boiler pressure of 42bar and a condenser pressure of 0.035bar. The steam entering the turbine is initially superheated at 500^0C. When the steam is expanded in the turbine to a pressure of 2.3bar, it is reheated to 500^0C and thereafter allowed to expand to a pressure of 0.035bar.

Neglecting feed-pump work, calculate the:

   a) Cycle efficiency

(15 Marks)

   b) Work ratio

(2 Marks)

   c) Specific steam consumption

(3 Marks)

3