(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

SPECIAL/SUPPLEMENTARY EXAMINATION

2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY EDUCATION (MECHANICAL ENGINEERING)

COURSE CODE: TEM 471

COURSE TITLE: THERMODYNAMICS II

DATE: 5/10/2022   **TIME: 12:00 PM – 2:00 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

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (COMPULSORY) – 30 MARKS

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

(5 Marks)

b) Define:
   (i) Proximate analysis

(2 Marks)

   (ii) Work ratio

(3 Marks)

c) Give the firing order for the following engines
   (i)   V4

(2 Marks)

   (ii)   V6

(2 Marks)

   (iii) V8

(3 Marks)

d) Describe any 4 design developments done to improve on the efficiency of an ICE

(8 Marks)

e) A steam power plant operates between a boiler pressure of 4.2MN/m^2 and a condenser pressure of 6kN/m^2. For a Carnot cycle using wet steam for these limits, calculate the cycle efficiency

(5 Marks)

QUESTION TWO – 20 MARKS

During an adiabatic compression of air in an engine, the volume is reduced to 0.0625 of its initial value. Heat is then added at constant pressure until the temperature is 1400^{0}C. The stroke is followed by an adiabatic expansion until the initial volume is attained again. The cycle is completed by a constant volume process. At the beginning of adiabatic compression, the pressure is 0.9bar and the temperature is 40^{0}C.

a) Sketch the p-v diagram for the engine

(6 Marks)

b) Calculate the thermal efficiency of the cycle

(14 Marks)

QUESTION THREE

A sample of coal has elements with the 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 wet basis   **(8 Marks)**

QUESTION FOUR – 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)