MUEO

MOI UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR
(ACADEMICS, RESEARCH & EXTENSION)

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER EXAMINATION

FOR THE DEGREE OF

BACHELOR OF ENGINEERING
IN
MECHANICAL AND PRODUCTION ENGINEERING

COURSE CODE: MPE 371

COURSE TITLE: THERMODYNAMICS II

DATE: 28TH FEBRUARY, 2018 **TIME:** 9.00 A.M. – 12.00 NOON

INSTRUCTION TO CANDIDATES

- This paper contains seven (7) questions
- All questions carry equal marks
- Answer any Five questions

THIS PAPER CONSISTS OF (3) PRINTED PAGES

PLEASE TURN OVER

QUESTION ONE

Working from basic principles of an ideal constant pressure cycle, formulate the relationship between:

i) The work ratio, minimum and maximum temperatures, adiabatic index and pressure ratio.

ii) The cycle efficiency, adiabatic index and pressure ratio. **[14 marks]**

QUESTION TWO

An oil engine takes in air at 1.01 bar, 20 °C and the maximum cycle pressure is 69 bar. The compressor ratio is 18/1. Calculate the air standard thermal efficiency and the mean effective pressure based on the dual-combustion cycle. Assume that the heat added at constant volume is equal to the heat added at constant pressure. **[14 marks]**

QUESTION THREE

The gas in an engine cylinder has a volumetric analysis of 12% CO_2, 11.5% O_2 and 76.5% N_2. The temperature at the beginning of expansion is 1000 °C and the gas mixture expands reversibly through a volume of 7 to 1, according to a law $pv^{1.25}$ = constant. Calculate the work done, the heat flow and the change in entropy per unit mass of gas. The values of c_p for CO_2 = 1.271 kJ/kg.K, c_p for O_2 = 1.11 kJ/kg.K, and c_p for N_2 = ~~1.271~~ 1.196 kJ/kg.K. **[14 marks]**

QUESTION FOUR

Air and carbon monoxide are mixed in the proportion of 3 to 1 by mass. The CO is supplied at 4 bar and 15 °C, and the air is supplied at 7 bar and 32 °C. The two constituents are passed in steady flow through non-return valves to mix adiabatically at a pressure of 1 bar. Assume air is made of only N_2 and O_2 and take the c_p values of N_2, O_2 and CO as 1.04, 0.9182 and 1.041 kJ/kg.K respectively. Calculate;

i) The final temperature of the mixture,

ii) The partial pressure of each constituent of the mixture,

iii) The increase of entropy per kilogram of mixture,

iv) The volume flow of mixture for a flow of 1 kg/min of CO, and

v) The velocity of the mixture if the area of the pipe downstream of the mixing section is 0.1 m^2.

[14 marks]

QUESTION FIVE

Ethyl alcohol (C_2H_6O) is burned in a petrol engine. Calculate:

i) The stoichiometric A/F ratio,

ii) The volume of the mixture per kg of fuel at 65 °C and 1.013 bar,

iii) The volume of the products of combustion per kg of fuel after cooling to 120 °C and 1 bar, and

iv) The amount of water which will condense per kg of fuel, if the products are cooled further to 15 °C.

[14 marks]

QUESTION SIX

A quantity of coal used in a boiler had the following analysis: 82% C, 5% H, 6% O, 2% N, and 5% ash. The dry flue gas analysis showed 14% CO_2 and some oxygen. Calculate the oxygen content of the dry flue gas, the A/F ratio and the excess air supplied. **[14 marks]**

QUESTION SEVEN

In a regenerative steam cycle employing two close-feed heaters the steam is supplied to the turbine at 40 bar and 500 °C and is exhausted to the condenser at 0.035 bar. The intermediate bleed pressures are obtained such that the saturation temperature intervals are approximately equal, giving pressures of 10 and 1.1 bar. Calculate the amount of steam bled at each stage, the work output of the plant per kg of boiler steam and the cycle efficiency of the plant. Assume ideal process where required.

[14 marks]

GOODLUCK