BOWEN UNIVERSITY, IWO, OSUN STATE
DEPARTMENT OF MECHATRONICS ENGINEERING
B.Eng. Degree Examination
Second Semester 2022/2023 Session
COURSE CODE: MCE204
COURSE TITLE: Fundamentals of Thermodynamics I
Units: 2   *Time:* 2 hours
Instructions: Attempt question one and any other three questions

QUESTION ONE

(a) State the five (5) assumptions made in an air standard cycle engine.   **5 marks**

(b) Sketch the *Pv* diagram of an Otto cycle, describing the processes involved.   **6 marks**

(c) Show that the thermal efficiency (η_{th}) of an engine operating on Otto cycle is:

$$\eta_{th} = 1 - \frac{1}{\gamma_v^{\gamma-1}}$$

Where,

γ_v and γ are compression and specific heat ratios respectively.   **8 marks**

QUESTION TWO

(a) Define and mathematically express the first law of thermodynamics.   **5 marks**

(b) The working fluid in an air engine continuously executes a cyclic process. During one cycle the fluid engages in two work interactions: 20KJ to the working fluid and 57KJ from the working fluid. Also during the cycle there are three heat transfers, two of which are known: 80KJ to the working fluid and 45KJ from the working fluid. Determine the magnitude and direction of the third heat transfer.   **6 marks**

(c) State the three (3) corollaries of the first law of thermodynamics.   **6 marks**

QUESTION THREE

(a) Write briefly on these thermodynamic processes:-

    (i)   Adiabatic Process

    (ii)   Isothermal Process

    (iii)   Isobaric Process

    (iv)   Isochoric Process   **8 marks**

(b) Write briefly on thermodynamics and thermodynamic systems.   **4 marks**

(c) Write briefly on extensive and intensive properties with an example of each. **5 marks**

QUESTION FOUR

(a) State the third law of thermodynamics **2 marks**

(b) Define the following: (i) Condensation (ii) Vaporization (iii) Freezing **6 marks**

(c) Steam at 15 bar with enthalpy of 3148 kJ/kg exits a boiler and enters a turbine. Determine:

(i) the degree of superheat. **2 marks**

(ii) the dryness fraction and specific volume if the enthalpy of the steam is 2650 kJ/kg at 10bar, at the exit of the turbine. **7 marks**

Note: At 15bar, the saturation temperature = 198.3 °C and the temperature of the superheated steam with enthalpy (h_g) of 3148 kJ/kg is 350 °C.

At 10 bar, h_f = 763 kJ/kg, h_{fg} =2015 kJ/kg and v_g = 0.1944 m³/Kg.

QUESTION FIVE

(a) (i) Write briefly on the "Steam Dome". **2 marks**

(ii) Sketch and discuss various labelled regions in the P-v diagram of the saturated liquid and vapour lines. **6 marks**

(b) The work done on a reversed heat engine is 150KJ while the heat transfer to the engine from the low temperature reservoir is 450KJ. Determine the heat transfer to the high temperature reservoir and the COP as a refrigerator and as a heat pump. **7 marks**

(c) Define the thermal efficiency of an engine **2 marks**

QUESTION SIX

(a) Define the following terms with reference to thermodynamics.

(i) Thermal Equilibrium (ii) State (iii) Property (iv) Phase **8 marks**

(b) Write briefly on thermodynamic temperature scale. **3 marks**

(c) Obtain the equivalent values of 80°C in (i) Kelvin (ii) Rankine and (iii) Fahrenheit

6 marks