KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF
B.SC RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: REN 221

COURSE TITLE: THERMODYNAMICS I

DURATION: 2 HOURS

DATE: 9/05/2022 **TIME: 2:00PM-4:00PM**

INSTRUCTIONS TO CANDIDATES

(i) Answer Question 1 (Compulsory) and any other TWO questions
(ii) All symbols have their usual meaning
(iii) Use steam tables provided

This paper consists of 3 printed pages. Please Turn Over

QUESTION ONE (Compulsory) – 30 Marks

a) Derive the Steady Flow Energy Equation from first principles.

(5 Marks)

b) Determine the following properties of steam at a pressure of 90 bar and a temperature of 400^0C:

i) Specific volume.

(3 Marks)

ii) Enthalpy

(2 Marks)

iii) Entropy

(2 Marks)

iv) Internal energy.

(4 Marks)

c) Given steam at 0.7MPa with an enthalpy of 2.6MJ/kg, determine the:

(i) Dryness fraction.

(6 Marks)

(ii) Specific volume.

(2 Marks)

(iii) Internal energy.

(2 Marks)

d) Give any two implications of the Second Law of Thermodynamics.

(4 Marks)

QUESTION TWO - 20 MARKS

Steam at a pressure of 1.28 MN/m^2 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 38 kN/m^2, a velocity of 80 m/s, and a specific volume of 4 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. The initial specific volume is 0.6 m^3/kg.

Calculate the:

(i) Final temperature

(4 Marks)

(ii) Work done on the gas

(1 Mark)

(iii)Heat flow to or from the cylinder walls

(5 Marks)

QUESTION FOUR (20 Marks)

A fluid at $6\times10^4 N/m^2$, occupying a volume of $0.3m^3$ is compressed reversibly to a pressure of $0.24\times10^6 N/m^2$ according to a law pv^n = constant. The fluid is then heated reversibly at a constant volume until the pressure is $38\times10^4 N/m^2$ and a specific volume of $0.3m^3/kg$. The fluid is expanded reversibly according to the law pv^2 = constant to the initial state.

a) Show the process on a p-v diagram.

(3 Marks)

b) Calculate the mass of the fluid.

(5 Marks)

c) Determine the value of n in the first process.

(5 Marks)

d) Calculate the net work done on or by fluid cycle.

(7 Marks)