KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
SPECIAL/SUPPLIMENTARY EXAMINATIONS

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

COURSE CODE: REN 221

COURSE TITLE: THERMODYNAMICS I

DURATION: 2 HOURS

DATE: 25/07/2022 **TIME: 8:00AM-10:00AM**

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) State the Non-Flow Energy Equation.

(4 Marks)

b) Steam at 110 bar has a specific volume of 0.0196 m^3/kg. Find the following properties:

i) Temperature.

(3 Marks)

ii) Internal energy.

(3 Marks)

c) Given steam at 0.5MPa with an enthalpy of 2.4MJ/kg, determine the:

(i) Dryness fraction.

(5 Marks)

(ii) Specific volume.

(2 Marks)

(iii) Internal energy.

(2 Marks)

d) Show that for a perfect gas the following specific heats can be expressed as shown below:

(i) $C_v = \frac{R}{\gamma - 1}$

(4 Marks)

(ii) $C_p = \frac{\gamma R}{\gamma - 1}$

(3 Marks)

(e) Give two conditions for a thermodynamic equilibrium.

(4 Marks)

QUESTION TWO (20 Marks)

A turbine operating under steady flow conditions receives steam at the following state: pressure 13.8 bar, specific volume 0.143 m^3/kg, internal energy 2590 kJ/kg, velocity 30 m/s. The state of steam leaving the turbine is: pressure 0.35 bar, specific volume 4.37 m^3/kg, internal energy 2360 kJ/kg, velocity 90 m/s. Heat is lost to the surroundings at the rate of 0.25kJ/s.

If the rate of steam flow is 0.38 kg/s, what is the power developed by the turbine?

(20 Marks)

QUESTION THREE (20 Marks)

A fluid of mass 0.15kg undergoes the following processes in succession: reversible heating at constant pressure of $11.2\times10^4 N/m^2$ until it has a specific volume of $0.1m^3/kg$; reversible compression according to the law pv = constant to a pressure of $40.8\times10^4 N/m^2$; reversible expansion according to the law $pv^{1.3}$ = constant; and constant volume heating back to the initial conditions.

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

(4 Marks)

b) If the work done during the constant pressure process is 0.41kJ, determine the net work done on or by the fluid.

(16 Marks)

QUESTION FOUR (20 Marks)

a) Show that for a working fluid undergoing an adiabatic process, the work done can be expressed as:

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$$

(7 Marks)

b) Air at 1bar and 20^0C initially occupying a cylinder volume of $0.016m^3$ is compressed reversibly and adiabatically by a piston to a pressure of 7 bar.

Calculate the:

i) Mass of air.

(2 Marks)

ii) Final temperature.

(3 Marks)

iii) Final specific volume.

(6 Marks)

iv) Net work done.

(2 Marks)