KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2019/2020 ACADEMIC YEAR

SECOND YEAR SECONDSEMESTER
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: 4/2/2021 **TIME: 2:00-4:00PM**

INSTRUCTIONS TO CANDIDATES

(i) Answer Q**uestion 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

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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)

Steam at a pressure of 1.28MN/m^2 enters a turbine with a velocity of 26m/s and a specificvolume of 0.14m^3/kg. After a steady flow through the turbine the steam leaves at a pressure of38kN/m^2, a velocity of 80m/s and a specific volume of 4m^3/kg. The internal energy of steamleaving the turbine is 260kJ/kg less than that of the steam entering the turbine. Heat is lost tothe surroundings at a rate of 0.3kJ/s. The steam flow is 0.4kg/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 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 in the cycle.

(7 Marks)

QUESTION FOUR (20 Marks)

A fluid whose mass is 1kg is contained in a cylinder. The fluid is expanded reversibly behind a piston according to a law pv^2 = constant until its initial volume is doubled. The fluid is then cooled reversibly under constant pressure until the piston is at its original position; heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to its initial value.

a) Show the process on a P-V diagram.**(4 Marks)**
b) If the initial pressure and volume are 18bar and $0.04m^3$ respectively, calculate the net work done on or by the fluid.**(16 Marks)**

QUESTION FIVE (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. If the initial specific volume is 0.6 m^3/kg, calculate the:
   (i) Final temperature.**(3 Marks)**
   (ii) Work done on the gas.**(2 Marks)**
   (iii)Heat flow to or from the cylinder walls.**(5 Marks)**