KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
SPECIAL/SUPPLIMENTARY EXAMINATIONS

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

COURSE CODE: PRD 272

COURSE TITLE: THERMODYNAMICS I

DURATION: 2 HOURS

DATE: 15/10/2018 **TIME:** 11:30-1:30PM

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

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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 1.28 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 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)**

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 Mark)**
   (iii)Heat flow to or from the cylinder walls. **(5 Marks)**