KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2016/2017 ACADEMIC YEAR
SPECIAL/SUPPLEMENTARY EXAMINATIONS
THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: **PRD 372**

COURSE TITLE: **THERMODYNAMICS III**

DURATION: **2 HOURS**

DATE:22ND SEPTEMBER 2017 **TIME: 8 – 10 Am**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **3** printed pages. Please Turn Over

1. (a) Explain the following terms as applied to air conditioning engineering:

   (i) Specific humidity **(2 Marks)**

   (ii) Relative humidity **(2 Marks)**

   (iii) Dew point temperature **(2 Marks)**

   (iv) Dehumidification **(2 Marks)**

   b) (i) What is an internal combustion engine (ICE)? **(2 Marks)**

   (ii) Explain four design developments done to improve on the efficiency of an ICE **(6 Marks)**

   c) State the following:

   (i) Fourier's law of heat conduction**(4 Marks)**

   (ii) Newton's law of cooling**(4 Marks)**

   d) Explain the principle of working of a cooling tower**(6 Marks)**

2. A sample of coal has elements with the composition by mass: 88% C, 5% H_2, 2.5% O_2, 1% N_2, 0.5% S, and 3% Ash.

   a) Determine the stoichiometric A/F ratio for its combustion**(10 Marks)**

   b) Find the actual A/F ratio if 25% excess air is supplied **(2 Marks)**

   c) Do a volumetric analysis of combustion products in (b) on a dry basis **(8 Marks)**

3. In the air-cooling system of a jet aircraft, air is bled from the engine compressor at 3bar and is then cooled in a heat exchanger to 105^0C. The air is then expanded to 0.69bar in an air turbine, the isentropic efficiency of the process being 85%. Thereafter, the air is delivered to the cockpit and then leaves the aircraft at 27^0C.

   a) Sketch the schematic diagram and the corresponding T-S diagram **(6 Marks)**

   b) If the refrigerating effect is 4kW calculate the:

   (i) Temperature at which the air enters the cockpit **(6 Marks)**

   (ii) Mass flow rate of air **(4 Marks)**

   c) If the air turbine is used to help drive auxiliaries, calculate its contribution in power **(4 Marks)**

4. A restaurant with a capacity of 100 persons is to be air-conditioned to 23^0C DBT and 55% RH. The outside conditions are 30^0C DBT and 70% RH. The quantity of air supplied is $0.5m^3$ per minute per person. The desired conditions are achieved by cooling, dehumidifying and then heating. The surface temperature of the heating coil is 35^0C.

   a) Show the processes on the psychrometric chart **(6 Marks)**

   b) Determine the following:

      (i) Capacity of the cooling coil (in TR)**(7 Marks)**

      (ii) Capacity of the heating coil (in TR)**(2 Marks)**

      (iii)Amount of water removed by the dehumidifier **(3 Marks)**

      (iv)By-pass factor of the heating coil **(2 Marks)**

5. **(a)**Use the electrical analogy to show that the overall heat transfer coefficient of a composite wall is given by:

$$U = \frac{1}{R_T A}$$

(9 Marks)

(b) A furnace wall consistsof 130mm wide refractory brick, an air gap, and 128mm wideinsulating fire brick. The outside wall is covered with a16mm thickness of plaster. The inner surface of the wall is at 1200^0C and the room temperature is 23^0C. The heat transfercoefficient from the outside wall surface to the air in the room is $17W/m^2K$, and theresistance to heat flow of the air gap is 0.16K/W. The thermal conductivities of therefractory brick, insulating fire brick, and plaster are 1.6, 0.3, and 0.14 W/mK respectively.

Calculate:

(i) The rate at which heat is lost per m^2 of the wall surface **(7 Marks)**

(ii)Each interface temperature of the wall **(3 Marks)**

(iii)The temperature of the outside surface of the wall **(1 Mark)**