KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER
SPECIAL/SUPPLIMENTARY EXAMINATIONS

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

COURSE CODE: PRD 372

COURSE TITLE: THERMODYNAMICS III

DURATION: 2 HOURS

DATE: 12/10/2018 **TIME:** 8-10AM

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

KIBU observes ZERO tolerance to examination cheating

QUESTION ONE (Compulsory) – 30 Marks

a) Define the following terms:

(i) Stoichiometric combustion. **(2 Marks)**

(ii) Ultimate analysis. **(2 Marks)**

(iii) Humidification. **(2 Marks)**

(iv) Sensible heating. **(2 Marks)**

b) State Gibbs-Dalton law. **(3 Marks)**

c) Define the following terms as applied to air conditioning engineering:

(i) Dew point temperature. **(2 Marks)**

(ii) Dehumidification. **(2 Marks)**

d) Explain the purpose of the following design developments on an ICE:

(i) Eco-fan. **(2 Marks)**

(ii) Replaceable wet sleeves and cylinders. **(2 Marks)**

(iii) Cross-flow aspiration. **(3 Marks)**

(iv) Piston spray cooling. **(2 Marks)**

(v) Turbo-chargers. **(2 Marks)**

e) Give 2 comparisons between a 4-stroke cycle engine and a 2-stroke cycle engine. **(4 Marks)**

QUESTION TWO (20 Marks)

The gas in an engine cylinder has a volumetric analysis of 12% CO_2, 11.5% O_2 and 76.5% N_2. The temperature at the beginning of expansion is 1000^0C, and the mixture expands reversibly through a volume ratio of 7 to 1 according to the law $pv^{1.25}$= constant. The average values of c_p (in kJ/kgK) for CO_2, O_2 and N_2 are 1.271, 1.110 and 1.196 respectively.

If the mass of gas is 1kg, calculate the:

a) Work done. **(12 Marks)**

b) Heat flow. **(8 Marks)**

QUESTION THREE (20 Marks)

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 heating coil. **(2 Marks)**

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

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

QUESTION FOUR (20 Marks)

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)**

QUESTION FIVE (20 Marks)

The rate of heat generation in a slab of thickness 160mm having a thermal conductivity of $180W/m^0C$ is 1.2×10^6 W/m^3. If the temperature of each side of the solid is 120^0C, determine:

a) The temperature at the mid-plane and quarter planes.
Take;

$$t = \frac{q_g}{2k}(L - x)x + t_w$$

(12 Marks)

b) Heat flow and temperature gradients at the mid-plane and quarter planes.

(8 Marks)