# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2017/2018 ACADEMIC YEAR

### THIRD YEAR SECOND SEMESTER
### MAIN EXAMINATIONS

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

**COURSE CODE:** PRD 372

**COURSE TITLE:** THERMODYNAMICS III

**DURATION: 2 HOURS**

**DATE:** 18/10/2018 **TIME: 9-11 AM**

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**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) Mixture strength. **(3 Marks)**

(ii) Proximate analysis. **(3 Marks)**

(iii) Dehumidification. **(2 Marks)**

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

b) Show that the specific humidity of an air mixture can be expressed as:

$$\omega = 0.622 \frac{p_s}{p_a}$$

**(5 Marks)**

c) State Amagat's law. **(2 Marks)**

d) Explain the following terms as applied to air conditioning engineering:

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

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

e) Give the firing order for the following engines:

(i) V6 **(2 Marks)**

(ii) V8 **(3 Marks)**

f) Give two differences between a spark-ignition engine and a compression-ignition engine. **(4 Marks)**

**QUESTION TWO (20 Marks)**

A vessel of $1m^3$ capacity contains $O_2$ at 6 bar and $35^0C$. The vessel is connected to another vessel of $2m^3$ capacity containing CO at 1.5 bar and $12^0C$. A connecting valve is opened and the gases mix adiabatically. Take the $c_v$ values (in kJ/kmol K) for $O_2$ and CO as 21.07 and 20.86 respectively.

Calculate for this mixture:

a) The final temperature. **(13 Marks)**

b) The final pressure. **(7 Marks)**

**QUESTION THREE (20 Marks)**

Air at $10^0C$ DBT and 90% RH is to be heated and humidified to $35^0C$ DBT and $22.5^0C$ WBT. The air is pre-heated sensibly before passing to the air washer in which water is re-circulated.

The RH of air coming out of the air washer is 90%. Air is again re-heated sensibly to obtain the final desired condition.

a) Outline the procedure for plotting points, and sketch the processes on the psychrometric chart. **(5 Marks)**
b) Determine the temperature to which air should be pre-heated. **(1 Mark)**
c) Find the total heating that is required. **(4 Marks)**
d) Determine the make-up water that is added to the air washer. **(4 Marks)**
e) Calculate the humidifying efficiency of the air washer. **(6 Marks)**

**QUESTION FOUR (20 Marks)**

Ethyl alcohol ($C_2H_6O$) is burned in a petrol engine with extreme mixture strengths of 130%.

a) Calculate the:
   i) Stoichiometric air/fuel ratio. **(4 Marks)**
   ii) Actual air/fuel ratio. **(2 Marks)**
b) Determine the analysis by volume of the products in the exhaust gas at the given mixture strength on a dry basis. **(8 Marks)**
c) What volume of the mixture per kg of fuel at a temperature of $60^0$C and a pressure of 2 bar would be required for the stoichiometric mixture? **(3 Marks)**
d) Calculate the actual volume of products of combustion per kg of fuel after cooling to a temperature of $110^0$C at 1.8 bar. **(3 Marks)**

**QUESTION FIVE (20 Marks)**

a) A meat slab of 25mm thickness having a thermal conductivity of 1 W/m$^0$C is heated with the help of a microwave heating for roasting the meat slab. The centre temperature of the slab is maintained at $100^0$C while the surrounding temperature is $30^0$C. The heat transfer coefficient on the surface of the meat slab is 20 W/m$^2$ $^0$C.
   Find out the microwave heating capacity in W/m$^3$.

   Take:

$$t_{max} = t_a + q_g\left(\frac{L}{2h} + \frac{L^2}{8k}\right)$$

**(9 Marks)**

b) A plate which is 2cm thick and 10cm wide is used to heat a fluid at $30^0$C. The heat generation inside the blade is $7\times10^6$ W/m$^3$. The thermal conductivity of the blade is 26 W/m$^0$C. The heat losses from the edge of the plate are negligible.
   Determine the heat transfer coefficient that can maintain the temperature of the plate below $180^0$C. **(11 Marks)**