KIBABII UNIVERSITY

2020/2021 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER

MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: REN 311

COURSE TITLE: Solar Energy 1

DATE: 15/07/2021 **TIME: 2:00-4:00PM**

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 4 printed pages. Please Turn over

Question One

(a) Briefly explain how solar energy is related to the following:

(i) Wind energy **[1 Mark]**

(ii) Biomass **[1 Mark]**

(iii) Hydropower **[1 Mark]**

(iv) Ocean thermal energy **[1 Mark]**

(b) With the help of sketches explain operation of the following

(i) Flat plate collector **[4 Marks]**

(ii) Evacuated tube collector **[4 Marks]**

(c) Briefly explain the use of solar energy in

(i) Cooking **[2 Marks]**

(ii) Crop drying **[2 Marks]**

(d) (i) Name the two elements that are the main components the Sun **[1 Mark]**

(ii) State the physical process through which the Sun generates energy **[1 Mark]**

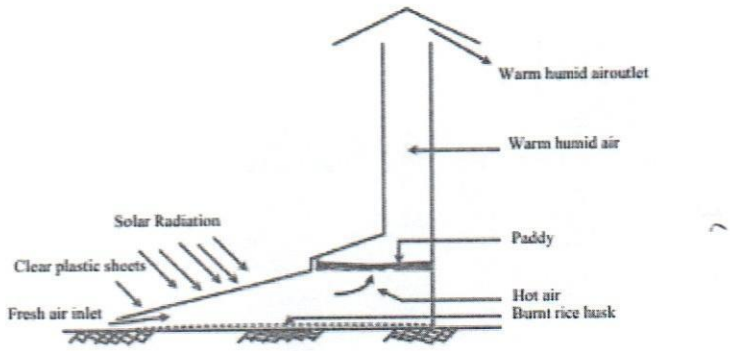
(iii) State what the Sun loses through the generation of energy **[1 Mark]**

(e) (i) The world electricity consumption is roughly 20300TWh per year. We want to cover the total electricity demand of the world by installing solar thermal power in the Sahara Desert, where the average solar insolation is: 6.3kWh/m^2 day. Assuming that the overall efficiency of a solar thermal power plant is 20%, calculate the area in km^2 needed to cover the world electricity demand **[3 Marks]**

(ii) If the area of the Sahara Desert is 9,400,000km^2, find the percentage of the Sahara Desert area that would cover **[2 Marks]**

Question Two

(a) High moisture content in different foodstuffs presents a variety of challenges. It may promote bacterial growth leading to spoilage through rotting. Reduction of moisture content (drying) is therefore employed as a food preservation strategy, in addition to other purposes in food preparation. Solar dryers like the one shown below could be used to dry foodstuffs.



(i) Explain how the drying function is accomplished in the dryer shown **[6 Marks]**

(ii) Suggest an improvement on the dryer so that it can used for larger quantities of material **[2 Marks]**

(iii) In what ways is solar drying superior to traditional direct sun drying? **[2 Marks]**

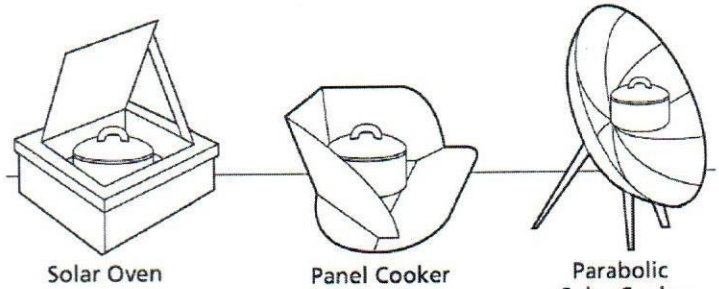
(b) Explain the working principle of a solar tunnel greenhouse dryer, and suggest how it can be used to increase value of agricultural products in rural areas **[10 Marks]**

Question Four

(a) State and explain the main methods of attenuation of solar energy through the atmosphere **[6 Marks]**

(b) List the different design factors that affect the thermal losses from a solar thermal collector heater and indicate the steps that can be taken to minimise these. **[4 Marks]**

A **solar collector** is a device that collects and/or concentrates solar radiation from the Sun. These devices are primarily used for active solar heating and allow for the heating of water and for other purposes. Three examples of solar collectors used for cooking are illustrated below. Each device operates differently from the others.



(ii) Explain the principle of operation in each case, paying attention to how heat is trapped and how losses are minimized **[7 Marks]**

(iii) It may be desirable for a household to own a variety of solar cookers to satisfy different cooing requirements. Explain. **[3 Marks]**

Question Three

Describe the generation of electricity using Ocean Thermal Technology **[20 Marks]**

Question Five

A solar collector of $1.5m^2$ is installed on the rooftop of a house. Assuming that the radiated energy arriving from the sun is $1000W/m^2$, the collector reflects 10% of the energy arriving on its surface. Also, the collector is not perfectly insulated, and losses occur. The collector has a heat transfer coefficient h of $2W/m^2$ K. The side areas of the collector are assumed to be negligible. The ambient temperature is 20 °C and the collector is assumed to be at a temperature of 50 °C. Consider that this temperature is constant throughout the whole collector. The collector is assumed to behave like a black body.

(a) Determine the power output of the collector in W **[16 Marks]**

(b) Find the percentage of the total losses caused by radiation **[4 Marks]**