KIBABII UNIVERSITY

2019/2020 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATIONS

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

COURSE CODE: IET 311

COURSE TITLE: Solar, Photovoltaics and OTEC Energy

DATE: 5/2/2021 **TIME:** 2:00 – 4:00 PM

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]**

(iii) Solar Cell **[4 Marks]**

(c) Briefly explain the use of solar energy in

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

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

(iii) Water pumping **[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]**

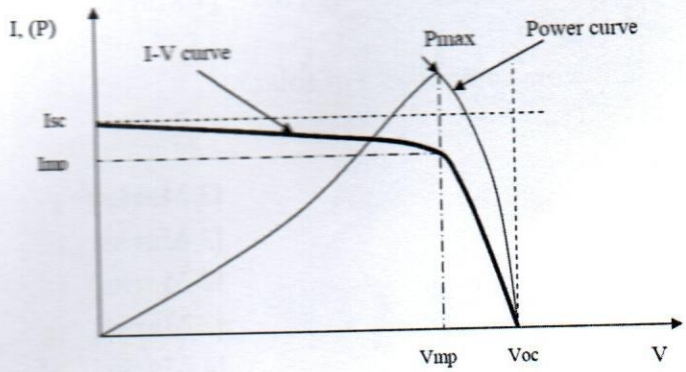
(iii) State what the Sun loses through the generation of energy **[1 Mark]**

(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) The figure below shows an I-V curve, with a superimposed power curve for a solar cell. Explain the following shown on the figure



(i) I_{sc} **[2 Marks]**

(ii) V_{oc} **[2 Marks]**

(iii) P_{max} **[2 Marks]**

(iv) I_{mp} **[2 Marks]**

(v) V_{mp} **[2 Marks]**

(b) Calculate the efficiency (in %) of a silicon based solar cell having short-circuit current density of J_{sc}=42.2mA/cm^2, open-circuit voltage V_{oc}=706mV and fill factor FF=0.828. Take the irradiation at standard test conditions as 100mW/cm^2. **[5 Marks]**

(c) State the advantages of a Grid connected Solar PV system compared to stand alone PV system **[5 Marks]**

Question Three

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

Question Four

(a) State the main methods of attenuation of solar energy through the atmosphere **[4 Marks]**

(b) Explain the purpose of each of the following components of solar PV systems

(i) Solar cell, module, array **[3 Marks]**

(ii) Storage batteries **[2 Marks]**

(iii) Charge regulators **[2 Marks]**

(iv) Inverters **[2 Marks]**

(v) Wiring and support structures **[4 Marks]**

(c) Calculate the maximum power (in mW) of a solar cell having current and voltage values of 30mA and 0.7V respectively at the maximum power point of the solar cell **[3 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]**