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(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

UNIVERSITY EXAMINATIONS 2020/2021 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN PHYSICS

COURSE CODE: SPH 362

COURSE TITLE: APPROPRIATE TECHNOLOGY III

DATE: WEDNESDAY 27TH APRIL, 2022 **TIME:** 3:00PM – 5:00PM

INSTRUCTIONS TO CANDIDATES

TIME: 2 Hours

Answer question ONE and any TWO of the remaining.

Symbols used bear the usual meaning.

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (30 MARKS)

(a) Outline the characteristics that describe populations that are energy impoverished. **(4 marks)**

(b) The average per person annual energy consumption in a country is 26.6 GJ. Calculate the average daily consumption in Kilowatt-hours. **(4 marks)**

(c) Explain the following influencers of the appropriate technology movement

i) Government **(4 marks)**
ii) Self-organizing groups **(4 marks)**
iii) Education **(4 marks)**
iv) Communication **(4 marks)**

d) The global carbon dioxide emissions due to human activity in 2012 were 35 billion tonnes, approximately 40% of which were related to the electric power sector. The total electricity consumption in 2012 was 23,815 TWh. If the 1.1 billion people presently without electricity access were given a grid connection and each consumed a modest 100 kWh per year, what is the percent increase in global carbon dioxide emissions? Assume the electricity supplied produced the same amount of carbon dioxide per unit energy as the global average. **(6 marks)**

QUESTION TWO (20 MARKS)

(a) Define the two general approaches to provision of electricity. **(4 marks)**
(b) Explain the tip speed ratio (TSR) in wind energy conversion systems **(2 marks)**
(b) State four energy conversion technologies applied in appropriate technology designs **(4 marks)**
(c) Discuss the advantages of using wind energy converters (WECs) for off-grid applications. **(10 marks)**

QUESTION THREE (20 MARKS)

(a) Differentiate between Irradiance and Insolation stating their respective units **(4 marks)**
(b) A biomass gasification system serves 400 houses with each house consuming 300 Watt-hours of electricity per day. The gasification system is 60% efficient, and the combined efficiency of the engine and generator is 33.3%. The energy content of the dry husk feedstock is 12.6 MJ/kg, and costs Kes 2500 per metric ton. Compute the mass of husk required each day and cost of fuel per Kilowatt-hour of electricity consumption. **(6 marks)**
(c) Outline the favourable characteristics Photovoltaic (PV) power systems **(10 marks)**

QUESTION FOUR (20 MARKS)

(a) Explain the three Biomass derived fuels used in off-grid electrification **(6 marks)**
(c) Describe the seven key attributes of electricity supply **(14 marks)**

QUESTION FIVE (20 MARKS)

(a) Explain the three attributes that influence the decision to use a particular fuel. **(6 marks)**
(b) Describe the following electricity supply systems

i) off-grid **(1 mark)**
ii) mini-grid **(1 mark)**
iii) Hybrid **(1 mark)**
iv) Stand-alone **(1 mark)**

(d) A household's consumption is 60 GJ per year using fuel wood and kerosene. Of this, 36 GJ from fuel wood is used for cooking and water heating on a stove with an efficiency of 12%, and 20 GJ from fuel wood is used for space heating. Kerosene is used for lighting, with an annual consumption of 4 GJ. If the electric cook stove is 75% efficient and the electric lamps consume 45 kWh per year,

i) Compute the annual energy required, in kilowatt-hours, to replace the fuel with electricity from the national grid. **(8 marks)**

ii) the percentage change caused by this replacement. **(2 marks)**