



MACHAKOS UNIVERSITY

University Examinations 2020/2021 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)
SPH 357: RENEWABLE ENERGY TECHNOLOGY

DATE: 11/8/2021

TIME: 8.30-10.30 AM

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

You may need to use;

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m,}$$

$$h = 6.626 \times 10^{-34} \text{ m}^2 \text{ kg/s,}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A,}$$

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J.}$$

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) List the five parts of a;
 - i. Wind turbine (2.5 marks)
 - ii. Solar PV system (2.5 marks)
- b) Identify the factors affecting the optimal tilt of a solar panel in a month. (2 marks)
- c) Name the two agencies mandated with regulation of standards and global energy. (2 marks)
- d) Identify the properties of a perfect white body (2 marks)
- e) Define the terms;
 - i. Albedo effect (2 marks)
 - ii. Tip speed ratio (2 marks)
 - iii. Heliostat (2 marks)
- f) State the inverse square law and identify its relevance to solar trapping. (3 marks)
- g) If the current global energy consumption is 613 Quadrillion BTUs, determine the projected energy consumption after in 2056? (3 marks)
- h) Name the three types of solar collectors (3 marks)
- i) Discuss the main negative impacts of using fossil fuels to the environment. (4 marks)

QUESTION TWO (20 MARKS)

- a) Describe the working principle of a thermosyphon. (4 marks)
- b) Discuss how advances in energy technologies has enhanced sustainable development in Kenya. (4 marks)
- c) Describe resource formation, harnessing and electricity generation of the following types;
 - i. Coal (3 marks)
 - ii. Natural gas (3 marks)
 - iii. Biogas (3 marks)
 - iv. Geothermal energy (3 marks)

QUESTION THREE (20 MARKS)

- a) You recently purchased a solar collector for your client. While using a drawing, identify and describe the different parts of a solar collector. (5 marks)
- b) Describe how reflection losses in a solar collector can be reduced. (4 marks)

- c) Identify any four long-term strategies that can be used to enhance energy conservation. (4 marks)
- d) Describe the photovoltaic effect (7 marks)

QUESTION FOUR (20 MARKS)

- a) Name the three types of Silicon-based PV cells. (3 marks)
- b) Owino intends to install a solar power system in his home for domestic use and water-pumping but he is torn between using the already available KPLC connection and having his individual power. Identify the convincing major factors that will influence the design of his solar PV array. (4 marks)
- c) Describe the working principle of a power tower system (4 marks)
- d) Differentiate between the following solar PV designs;
 - i. Battery-based grid-tied (3 marks)
 - ii. PV direct (3 marks)
 - iii. Battery-less grid tied (3 marks)

QUESTION FIVE (20 MARKS)

- a) Show that the power of a wind turbine is given by;

$$P = \frac{1}{2} \rho A v^3$$
 (10 marks)

Where ρ is the density, A is the sweep area and v is the speed of wind
- b) Discuss energy conversion and generation using the following technologies
 - i. Hydroelectricity (5 marks)
 - ii. Ocean thermal energy conversion (5 marks)