MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN PHYSICS WITH APPROPRIATE TECHNOLOGY

COURSE CODE: SPH 354

COURSE TITLE: SOLAR THERMAL ENERGY

DATE: WEDNESDAY 27TH APRIL, 2022   **TIME:** 12.00 PM – 2.00 PM

INSTRUCTIONS TO CANDIDATES

- TIME: 2 Hours
- Answer question one and any two of the remaining.
- Symbols used hold usual meaning
- Refractive index for glass = 1.5

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over. ▶

QUESTION ONE (30 MARKS)

(a) Give two uses of *selective absorbers* in solar thermal applications   [2 marks]

(b) The *sensible heat storage system* has a few disadvantages over the *latent heat storage system*. Mention three (3) of them.   [3 marks]

(c) *Silica saturated fluosilic acid solution* is good medium for treatment of top glazing as an anti-reflective coating in a Flat Plate Collector. What unique properties does this solution have for this application?   [3 marks]

(d) Briefly discuss the effects of each of the following parameters on the performance of a *solar thermal collector*.   [4 marks]
    (i)   Insulation
    (ii) Inclination angle
    (iii) Inlet fluid temperature
    (iv) Incident solar radiation

(d) Mention two advantages and two disadvantages of Fresnel lens as a solar concentrator over the *Compound parabolic concentrator* (CPC).   [4 marks]

(e) Write down 4 factors that determine the selection and design of a thermal storage system.   [4 marks]

(f) Briefly explain the characteristics of materials used in the following parts of a *solar concentrator*.   [4 marks]
    (i)   Absorber plate
    (ii) Transparent cover plate
    (iii) Absorber surface coating
    (iv) Reflecting surface

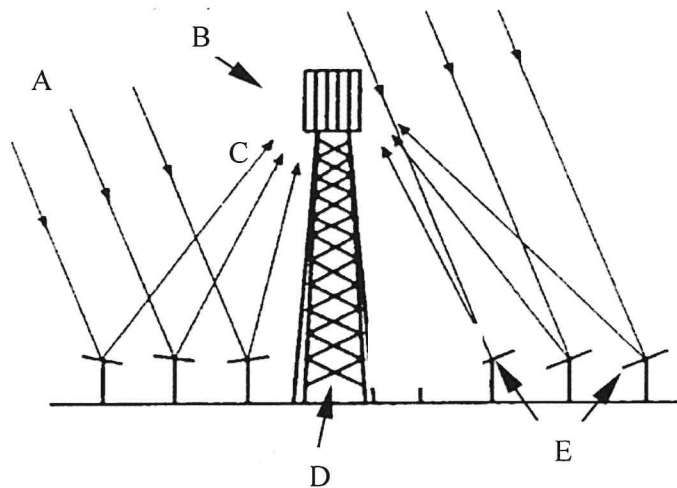(g) Identify *the collector* in Fig. 1 below and name the parts A, B, C, D, E.   [6 marks]

Fig. 1

QUESTION TWO (20 MARKS)

(a) For normal incidence, the *reflectance* (ρ) of the glass cover of a FPC is 0.04 times that of the incident radiation, Explain.   [8 marks]

(b) The diagram in Fig. 2 below shows the *heat transfer process* through a solar thermal collector. Explain the details of this process.   [12 marks]
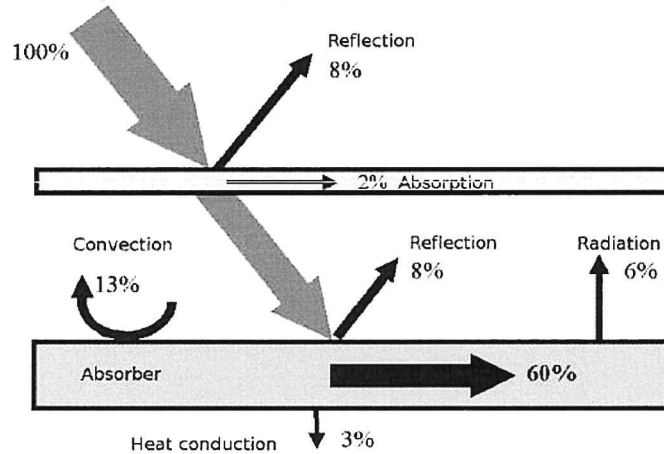

Fig. 2

QUESTION THREE (20 MARKS)

(a) Briefly discuss the reasons why we install *thermal energy storage systems* (TES) [15 marks]
(b) Mention the various types of TES   [3 marks]
(c) Give their benefits to the society   [2 marks]

QUESTION FOUR (20 MARKS)

(a) In your final year project, you are tasked with designing and fabricating a *parabolic trough solar collector*, briefly describe the procedure you would take to carry out this project to completion.   [16 marks]

(b) What are the uses and benefits of such a project   [4 marks]

QUESTION FIVE (20 MARKS)

(a) With reasons, which of these two solar collectors is more efficient; *Flat plate collector, Evacuated tube collector*?   [4 marks]

(b) Explain analytically the fact that *the effective transmissivity-absorptivity product* ($\tau\alpha_e$) of a FPC with two transparent covers is given by;   [16 marks]

$$\tau\alpha_e = \frac{\tau\alpha}{1 - (1 - \alpha)\rho_d}$$

~END~

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