



KISII UNIVERSITY
UNIVERSITY EXAMINATIONS

SPECIAL EXAMINATION
THIRD YEAR EXAMINATION FOR THE AWARD OF THE DEGREE OF
BACHELOR OF SCIENCE RENEWABLE ENERGY
FIRST SEMESTER 2021/2022
(JULY, 2022)

PHRE 311: SOLAR ENERGY THERMAL CONVERSION I

STREAM: Y3 S1

TIME: 2 HOURS

DAY: WEDNESDAY, 11:30 AM – 10:30 PM

DATE: 27/07/2022

INSTRUCTIONS:

- 1. Do not write anything on this question paper.***
- 2. Answer Question ONE (Compulsory) and any other TWO questions.***

QUESTION ONE

- In comparison to other renewable energy sources, what are the unique advantages of solar energy? [4 marks]
- Determine the monthly average solar radiation on a horizontal surface outside the atmosphere at latitude 31.8° north on September 3. [5 marks]
- Calculate the solar declination angle 17th December 2016 [4 marks]
- Your company has been contracted to install flat plate collectors at a local school. What are some of the things you will do before embarking on the project? [5 marks]
- Calculate the instantaneous irradiance for a surface facing south with $\beta = 30^\circ$, at $\phi = 31.8^\circ$ north at 10 a.m. solar time on March 3, when the global radiation measured was 750 W/m^2 and the beam radiation was 650 W/m^2 . On March 3, $\delta = -7.5^\circ$, $\delta r = 0.38$. [4 marks]
- Explain and draw a diagram to indicate what these terms mean. [8 marks]
 - Solar Declination angle
 - Hour angle
 - Latitude

QUESTION TWO

- a. List instruments that are used in measuring solar radiation. [3mks]
- b. Of the instruments listed above, pick two and explain how each is used and the exact parameters that they measure. [12 marks]
- c. What is the solar time in El Paso, Texas (31.8° north; 106.4° west), at 11 a.m. mountain time on March 3? [5 marks]

QUESTION THREE

Calculate the solar incidence and zenith angles on a solar collector located at Nairobi (1.3° South; 36.8° East), at 11:30 a.m. on March 3, if the surface is (a) 30° tilted from the horizontal and pointed 10° west south, (b) $\beta = 40^\circ$ and $\gamma = 10^\circ$, (c) $\beta = 30^\circ$ and $\gamma = 0^\circ$, (d) $\beta = 40^\circ$ and $\gamma = 0^\circ$, (e) $\beta = \varphi - |\delta|$ and $\gamma = 0^\circ$, and (f) $\beta = \varphi - |\delta|$ and $\gamma = 0^\circ$ at solar noon. [20 marks]

QUESTION FOUR

- a. What are the differences between a passive and an active solar thermal system? [4 marks]
- b. Discuss the thermosiphon as a passive solar thermal system. Draw a schematic diagram indicating the flow of hot and cold water in a thermosiphon [16 marks]

QUESTION FIVE

You have been contracted by EZMCC ltd as a .consultant. The Terms Of Reference (TOR) states that you need to determine the performance of flat-plate solar collectors that they recently installed at Kisii University, the company specifically wants you to use: methods documented in ASHRAE 93 (2003), ISO 9806-1 (1994), and EN12975-2 (2001). Discuss the methods. [20 marks]