KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (ENERGY ENGINEERING)

SET 439: SOLAR –THERMAL ENERGY

DATE: Monday 5th December 2011 TIME: 11.00a.m -1.00p.m

INSTRUCTIONS

1. This paper contains five questions
2. Attempt any three questions
3. All questions carry equal marks
4. State assumptions made and define all symbols used

Q1. a) You have been assigned a job to design a solar heating system for swimming pool with 20,000 liters capacity in Timboroa Country hotel in Kenya. The average water temperature throughout the year is 12°C, describe how you would go with about designing the size of the solar water heating system needed (10 marks)

b) Describe the basic principles of various solar cookers around the world. Describe step by step how we can go about improving these designs for domestic cooking in Kenya (10 marks)

Q2 a) Describe methods for storing solar energy and give any examples you know (10 marks)

b) A solar heating system has a water storage tanks with loss coefficient area product of 24 W/K. The tank contains 6400 liters of water having a uniform temperature at 60°C at 6:30 am when the sun rises. The environment is at constant temperature of 20°C. The hourly heating load by the solar collector to the tank via the heat exchanger is 24 MJ/hr. Using energy balance equation, determine the final temperature of water in the storage tanks after 12 hours (10 marks)

Q3.a) a) Describe the major components of solar radiation (5 marks)

b) What is the day length on 12th April at the equatorial plane (5 marks)

c) Determine the days solar radiation incident on a horizontal surface in the absence of atmosphere at latitude 43°N on April 15th (10 marks)

Q4. a) Double glazing solar water heating system is designed to minimize heat losses to environment. Using the solar heating systems component data in the table below, calculate the overall loss coefficient for a flat collector.

S/N	Solar heating system component	Parameter
1	Size of collector absorber plate	0.90 m x 1.90 m
2	Spacing between absorber plate and the first glass cover	4 cm
3	Spacing between first glazing and second glass cover	4 cm
4	Absorber plate emissivity	0.92
5	Glass cover emissivity	0.88
6	Flat plate collector tilt	20°
7	Mean absorber plate temperature	70°C
8	Ambient temperature	24°C
9	Wind speed	2.5m/s
10	Back insulation thickness	8 cm
11	Side insulation thickness	4 cm
12	Thermal conductivity of the insulation	0.05 W/m.K

(10 marks)

b) Using illustration, describe the major types of solar crop dryers and their components and describe their principles of operation (10 marks)

Q5. a) Using illustration, describe the major components of natural convection solar water heating flat plate collector and describe its principles of operation (10 marks)

b) A natural circulation solar water heating system operates with nearly constant increase in water temperature at 10°C. The square solar collector has the length of 2 m and an overall loss coefficient of 4.2 W/sq-m °C and collector efficiency factor of 0.91. If the water entering the collector is 30°C and ambient temperature is 15°C and absorbed solar radiation by collector is 780W/sq-m, what is the useful heat gain from the solar collector? (10 marks)