LANDMARK UNIVERSITY, OMU-ARAN

COURSE COMPACT

COLLEGE: SCIENCE AND ENGINEERING
DEPARTMENT: AGRICULTURAL AND BIOSYSTEMS ENGINEERING
PROGRAMME:
COURSE COMPACT for: ABE 534

Course

Course code: ABE 534
Course title: **Solar Energy Applications to Processing and Storage**
Credit unit: 2 Credits
Course status: Elective (E)

Lecturer's Data

Name of the lecturers: Engr Alhassan, Elijah Aina
Qualifications obtained: B. Eng; M. Eng; COREN Regd.
Department: Agricultural and Biosystems Engineering
College: College of Science and Engineering
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Office Location: B021 Engineering workshop

Consultation Hours: Wednesday (10 -12)

INTRODUCTION TO THE COURSE

Course Description:

To give an in depth study into the fundamentals of solar radiation, solar heating and cooling, heat transfer, solar energy conversion efficiency. Principles of solar collectors. Solar heat storage and storage systems for tropical crops. This will help to understand solar energy as one of the key renewable energy that can be used for processing and storage of agricultural produce.

Course Justification:

Secure, reliable and affordable energy supplies are fundamentals to global economic stability and growth. The challenges of sustainable development are great and the importance of energy in achieving sustainable development goals cannot be overstated. Access to affordable energy services is fundamental to human activities, development, and economic growth.

The increase in world population and advancement has led to an ever increasing demand for fossil fuels. Depleting oil reserves, rising petroleum prices and growing international concern for reducing carbon emissions in an age of climate change have

catalyzed international efforts to identify alternative and renewable sources of energy capable of meeting increasing global demand. The concern about our dependence on fossil fuels is gaining ground worldwide, our continued existence on this planet cannot be sustained indefinitely unless there is a change of attitude and behaviour to our current lifestyle.

Solar energy is the most promising of the renewable energy sources in view of its apparent limitless potential. According to Sambo, (1988), the sun radiates its energy at the rate of about 3.8×10^{23} kW/s. Most of this energy is transmitted radially as electromagnetic radiation which comes to about $1.5kW/m^2$ at the boundary of the atmosphere. After traversing the atmosphere, a square metre of the earth's surface can receive as much as 1kW of solar power, averaging to about 0.5 over all hours of daylight. Situated approximately between 4°N and 13°N, Nigeria is geographically favourably located to tap unlimited solar energy, the most dependable renewable energy source. It has been estimated that a yearly average of about 2,300 kwh/m^2 of solar energy tails on a horizontal surface in Nigeria.

Course Objectives:

At the end of this course, the students would be able to appreciate solar energy as applicable to processing and storage of agricultural produce through an in–depth analysis of the above stated course contents.

Course Content:

Fundamentals of solar radiation. Solar heating and cooling, Heat transfer, solar energy conversion efficiency. Principles of solar collectors. Solar heat storage and storage systems for tropical crops.

Course Expectations:

S/N	GRADING	SCORE(%)
1.	Continuous Assessments • C.AI • C.AII (Mid-Semester Test) • C.AIII	 7% 15% 8%
2.	Assignment	
3.	Practical (Laboratory work)/ Case Studies	
4.	Final Examination	70%
5.	Total	100

Course Delivery Strategies:

The general method of lecturing; use of writing board, marker, duster and use of teaching aids will be adopted. It will be through face to face contact, assignments and feedback mechanism.

Course Duration:

Two hours per week for 15 weeks (30 hours)

LECTURE CONTENT

Module 1

General overview of the course
Fundamentals of solar radiation. **4 WKS**

Week 1: Course introduction

- **Objectives**

The students at the end of the lecture for the week should be able to:

i. Explain what the course is about.
ii. To know the course description, content, expectation, delivery strategies, objectives and justification

- **Description**

First hour:
General Introduction to the course

Second hour
General course overview continues
Feedback from the lecture

- **Study Question:**

Discuss briefly solar energy development in Nigeria.

- **Reading List –**

i. **Principles of solar Engineering.** Goswami, D. Yogi

ii. **Physics of solar energy.** Chen, C. Julian
iii. **Principles of photovoltaic energy conversion.** Musa, A.O
iv. **Design of smart power grid renewable energy systems.** Keyhani, Ali
v. Proceeding of International conference of the solar energy society of Nigeria. National solar Energy forum

- **Week 1I:** Fundamentals of solar radiation
- **Objectives**

The students at the end of the lecture for the week should be able to:

i. State an overview of energy sources available for agricultural processes.

ii. Define solar energy.

iii. State the forms of solar Energy

iv. State its advantages and disadvantages.

v. State and explain the uses of solar energy

- **Description**

  First hour:

  Overview of energy sources

  Definition of solar energy

  Second hour

  Forms of solar energy

  Advantage and disadvantages of solar energy

  Uses of solar energy.

  Feedback from the lecture

- **Study Question:**

  In what way can solar energy be utilized in solving Nigeria power problem?

- **Reading List –**

  i. **Principles of solar Engineering.** Goswami, D. Yogi

  ii. **Physics of solar energy.** Chen, C. Julian

  iii. **Principles of photovoltaic energy conversion.** Musa, A.O

  iv. Proceeding of International conference of the solar energy society of Nigeria. National solar Energy forum

Week III: Solar radiation continues

- **Objectives**

  The students at the end of the lecture for the week should be able to:

  i. Define solar radiation

  ii. Explain the structure of the sun

  iii. Explain solar radiation and it spectra distribution

- **Description**

  First hour:

  Definition of solar radiation

  Structure of the sun

  Second hour

  Solar radiation and it spectra distribution

  Feedback from the lecture

- **Study Question:**

  i. Explain the concept of solar radiation

ii. Enumerate the factors that affect solar radiation on earth.
iii. Make further study on beam and diffuse radiation

- **Reading List -**

i. **Principles of solar Engineering.** Goswami, D. Yogi

ii. **Physics of solar energy.** Chen, C. Julian

iii. **Design of smart power grid renewable energy systems.** Keyhani, Ali

Week IV: Solar radiation continues

- **Objectives**

The students at the end of the lecture for the week should be able to:

Define angles that describe geometric of solar radiation

State the relationship and representative symbols

Define solar time

Calculate solar time

- **Description**

First hour:

Definition of terms that describe geometric of solar radiation, symbols and expression

Second hour

Definition of solar time
Worked example on solar time
Feedback from the lecture

- **Study Question:**

Calculate the solar time for your birthday, standard time of 10:30 am for a leap year, using the longitude of your place of birth.

- **Reading List -**

i. **Principles of solar Engineering.** Goswami, D. Yogi

ii. **Physics of solar energy.** Chen, C. Julian

Module 2

Heat transfer **2 wks**

- **Week V:** Heat transfer
- **Objectives**

i. This topic is meant to give a very elementary knowledge of heat transfer as it applies to solar energy collection and collectors
ii. Explanation of the principles involve in solar energy harvesting

- **Description**

First hour:

Definition of heat transfer and it forms

Second hour
Explanation of the principles involve in solar energy harvesting

- **Study Question:**
  Starting from the first principle give the overall heat transfer coefficient for heat flow through a wall separating two fluids.

- **Reading List**
  i. **Principles of solar Engineering.** Goswami, D. Yogi
  ii. **Physics of solar energy.** Chen, C. Julian
  iii. **Principles of photovoltaic energy conversion.** Musa, A.O

- **Week VI:** Heat transfer continues and CA I

- **Objective**

  Detail description of heat transfer by conduction, convention and radiation.

- **Description**
  First hour:
  Detail description of heat transfer by conduction and convection
  Second hour
  Detail description of heat transfer by radiation
  CA I administration

- **Study Question:**
  Explain the following terms as applied to heat transfer:- Reflectivity; absorptivity and transmissivity
  What is the governing equation for black bodies called? State and give the expression, stating what each parameter represents

- **Reading List**
  I. **Principles of solar Engineering.** Goswami, D. Yogi
  II. **Physics of solar energy.** Chen, C. Julian
  III. **Principles of photovoltaic energy conversion.** Musa, A.O

Module 3

Principles of solar collectors, Solar heating and cooling, solar energy conversion efficiency and CA II **7WKS**

- **Week VII:** Principle of solar collector

- **Objectives**
  i. To explain to the students the technologies and processes of solar energy utilization
  ii. Explanation for solar collectors
  iii. Types of solar collector and their components

- **Description**

  First hour:

  Definition of solar collectors

  Types of solar collector

  Second hour

  Types of solar collector and their components

  Feedback from the lecture

- **Study Question:**

  With the aid of diagram, describe the components and mode of utilization of a flat- plate collector

  Highlight the type of fluids used in a flat- plate collector

- **Reading List -.**

i. **Principles of solar Engineering.** Goswami, D. Yogi

ii. **Principles of photovoltaic energy conversion.** Musa, A.O

iii. **Design of smart power grid renewable energy systems.** Keyhani, Ali

iv. Proceeding of International conference of the solar energy society of Nigeria. National solar Energy forum

- **Week VIII:** Solar collectors continues

- **Objectives**

  The students at the end of the lecture for the week should be able to:

i. Explain absorber performance

ii. Describe collector efficiency and general guiding principles on collector parameters

- **Description**

  First hour:

  Absorber performance

  Second hour

  Collector efficiency

- **Study Questions:**

  I. Explain the following terms:- radiation concentration, principal plane and chief rays

  II. State the equation used in calculating the collection efficiency of an absorber

  III. Highlight the factors necessary in the evaluation of the efficiency of solar collector

- **Reading List –**

i. **Principles of solar Engineering.** Goswami, D. Yogi

ii. **Physics of solar energy.** Chen, C. Julian

iii. **Principles of photovoltaic energy conversion.** Musa, A.O

- **Week IX:** Solar collectors continues

- **Objectives**

The students at the end of the lectures for the week should be able to:

i. Solve mathematical problems in solar collector

- **Description**

First hour:

Worked example on solar collector

Second hour

Worked example and class exercise

- **Study Question:**

What are solar collectors?
In a clear statement, distinguish between the two types of collectors with convincing reasons
Mention the types of collector you will suggest suitable to power a tricycle

- **Reading List**

i. **Principles of photovoltaic energy conversion.** Musa, A.O
ii. **Design of smart power grid renewable energy systems.** Keyhani, Ali

- **Week X:** Solar heating

- **Objectives**

The students at the end of the lecture for the week should be able to:

i. Explain the concept of solar heating
ii. State the application solar heating for domestic and industrial use

- **Description**

First hour:

Concept of solar heating

Second hour

Application of solar heating

- **Study Question:**

Make extensive study on solar thermal power generation

- **Reading List –**

i. **Principles of solar Engineering.** Goswami, D. Yogi

ii. **Physics of solar energy.** Chen, C. Julian
iii. **Design of smart power grid renewable energy systems.** Keyhani, Ali

- **Week XI:** Solar cooling
- **Objectives**

The students at the end of the lectures for the week should be able to:

i. Explain the concept of solar cooling
ii. State the application solar cooling for domestic and industrial use

- **Description**

  First hour:
  Concept of solar cooling

  Second hour:
  Application of solar cooling

- **Study Question:**
  With a well label diagram, explain the working principle of solar refrigerator (continuous type)

- **Reading List**

i. **Physics of solar energy.** Chen, C. Julian
ii. **Principles of photovoltaic energy conversion.** Musa, A.O
iii. **Design of smart power grid renewable energy systems.** Keyhani, Ali

- **Week XII: Topic for the week**
  CA II
- **Objectives**

This is basically to test the students understanding of the course so far.

i. **Description**

First hour:
CA question administration
Second hour
Collection of script and review of question(s) with the students

ii. **Study Question:**
Outline five major areas of applications of solar collectors

iii. **Reading List –**

i. **Principles of photovoltaic energy conversion.** Musa, A.O

Week XIII: Topic for the week
Solar energy conversion efficiency

- **Objectives**

The students at the end of the lectures for the week should be able to:

i. Define solar energy conversion efficiency
ii. Understand expression for estimating solar energy conversion efficiency
iii. Solve exercise on solar energy related problems

- **Description**

First hour:

Introduction to solar energy conversion efficiency.
Second hour

Detail analysis of the topic with work examples

- **Study Question:**

i. What are the major drawbacks peculiar to solar utilization

- **Reading List**

i. **Principles of solar Engineering.** Goswami, D. Yogi

Module 4

Solar heat storage and storage systems for tropical crops, CA III and revision

2 wks

- **Week XIV:** Solar heat storage and storage systems for tropical crops.
- **Objectives**

The students at the end of the lectures for the week should be able to:

i. Emphasis the applications of solar energy to cooling and refrigeration using horticultural crops as a case study

ii. Explain the various classifications of solar dryers based on certain criteria

- **Description**

First hour:

Description of operation and components of solar refrigeration (continuous and intermittent type

Principles, Classification and selection of solar dryer

Second hour

Work examples on solar dryer and C.A. III

- **Study Question:**

Explain the following terms

i. Sun drying

ii. Direct solar dryer

iii. Indirect solar dryer

iv. Solar energy drying

- **Reading List –**

i. **Principles of solar Engineering.** Goswami, D. Yogi

- **Week XV:** Revision and tutorials section

Tutorial questions drawn from each module and conducted during lectures

- Week XV: Topic for the week
  Revision and tutorials section
  Tutorial questions drawn from each module and conducted during lectures

HOD's COMMENTS: Course compact is adequate

Name: Dr. A.A. Okuneye Signature [signature] Date: 25/8/2017

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