MASTER SYLLABUS

COURSE NUMBER – COURSE NAME
AREA 321 - SOLAR ENERGY UTILIZATION

Created by: Michael Kingsley, Ph.D.

Updated by: Kibria Roman, Ph.D, P.E.

Canino School of Engineering Technology

Department: Mechanical & Energy Technology

Semester/Year: Fall/2018
A. **TITLE**: Solar Energy Utilization

B. **COURSE NUMBER**: AREA 321

C. **CREDIT HOURS**: (Hours of Lecture, Laboratory, Recitation, Tutorial, Activity)
   
   # Credit Hours: 3  
   # Lecture Hours: 3 per week  
   # Lab Hours: per week  
   Other: per week  

   Course Length: 15 Weeks

D. **WRITING INTENSIVE COURSE**: Yes ☐ No ☒

E. **GER CATEGORY**: None: ☒ Yes: GER !  
   *If course satisfies more than one: GER !*

F. **SEMESTER(S) OFFERED**: Fall ☒ Spring ☒ Fall & Spring ☐

G. **COURSE DESCRIPTION**:

Solar Energy Utilization is an introductory course on solar energy with an emphasis on thermal processes. Topics include solar radiation, heat transfer, flat-plate collectors, thermal energy storage, and solar thermal applications.

H. **PRE-REQUISITES**: None ☐ Yes ☒ If yes, list below:

MECH 225, Introduction to Thermodynamics or permission of instructor

   **CO-REQUISITES**: None ☒ Yes ☐ If yes, list below:
I. **STUDENT LEARNING OUTCOMES:** *(see key below)*

By the end of this course, the student will be able to:

<table>
<thead>
<tr>
<th>Course Student Learning Outcome [SLO]</th>
<th>Program Student Learning Outcome [PSLO]</th>
<th>GER [If Applicable]</th>
<th>ISLO &amp; SUBSETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>determine angles to locate the sun based on location, time, and date.</td>
<td>SO # 6 An ability to identify, analyze and solve technical problems.</td>
<td>2-Crit Think 5-Ind, Prof, Disc, Know Skills ISLO</td>
<td>PS Subsets Subsets</td>
</tr>
<tr>
<td>calculate incident radiation for a flat or sloped surface.</td>
<td>SO #2 An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology by applying these areas to renewable energy systems</td>
<td>2-Crit Think 5-Ind, Prof, Disc, Know Skills ISLO</td>
<td>PS Subsets Subsets</td>
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<td>evaluate the performance of flat-plate and other solar collectors and explore the current and future state of solar thermal technologies.</td>
<td>SO # 11 A commitment to quality, timeliness, and continuous improvement</td>
<td>2-Crit Think 5-Ind, Prof, Disc, Know Skills ISLO</td>
<td>CA Subsets Subsets</td>
</tr>
<tr>
<td>estimate hourly and annual energy output of solar collectors.</td>
<td>SO # 6 An ability to identify, analyze and solve technical problems.</td>
<td>2-Crit Think 5-Ind, Prof, Disc, Know Skills ISLO</td>
<td>CA Subsets Subsets</td>
</tr>
<tr>
<td>calculate energy storage requirements for solar thermal processes.</td>
<td>SO # 6 An ability to identify, analyze and solve technical problems.</td>
<td>2-Crit Think 5-Ind, Prof, Disc, Know Skills ISLO</td>
<td>PS Subsets Subsets</td>
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**KEY**

<table>
<thead>
<tr>
<th>ISLO #</th>
<th>Institutional Student Learning Outcomes [ISLO 1 – 5]</th>
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<tbody>
<tr>
<td>1</td>
<td>Communication Skills</td>
</tr>
<tr>
<td>2</td>
<td>Critical Thinking</td>
</tr>
<tr>
<td>3</td>
<td>Foundational Skills</td>
</tr>
<tr>
<td>4</td>
<td>Social Responsibility</td>
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<tr>
<td>5</td>
<td>Industry, Professional, Discipline Specific Knowledge and Skills</td>
</tr>
</tbody>
</table>

*Include program objectives if applicable. Please consult with Program Coordinator!
J. **APPLIED LEARNING COMPONENT:**  Yes ☒ No ☐

If YES, select one or more of the following categories:

☒ Classroom/Lab
☐ Internship
☐ Clinical Placement
☐ Practicum
☐ Service Learning
☐ Community Service
☐ Civic Engagement
☐ Creative Works/Senior Project
☐ Research
☐ Entrepreneurship (program, class, project)

K. **TEXTS:**


L. **REFERENCES:**


M. **EQUIPMENT:** None ☒ Needed:

N. **GRADING METHOD:** A-F

O. **SUGGESTED MEASUREMENT CRITERIA/METHODS:**

Grading may include homework, quizzes, exams, and a design project.

P. **DETAILED COURSE OUTLINE:**

1. Solar Radiation
   i. The sun and solar radiation spectrum
   ii. Direction of beam radiation (solar angles)
   iii. Shading
   iv. Extraterrestrial radiation on a horizontal surface

2. Available Solar Radiation
   i. Measuring solar radiation
   ii. Solar radiation data
   iii. Atmospheric attenuation of solar radiation
   iv. Beam and diffuse components of solar radiation
   v. Radiation on sloped surfaces

3. Selected Heat Transfer Topics
   i. Radiation and radiation heat transfer coefficient
   ii. Natural convection between flat parallel plates
   iii. Wind convection coefficients
   iv. Heat exchanger effectiveness
4. Radiation on Opaque Materials
   i. Kirchoff’s law
   ii. Absorptance, emittance, and reflectance
   iii. Selective surfaces

5. Radiation Transmission Through Glazing
   i. Optical properties of glazing
   ii. Transmittance and transmittance-absorptance product
   iii. Absorbed solar radiation

6. Flat-Plate Collectors
   i. Collector overall heat loss coefficient
   ii. Temperature distribution and collector efficiency
   iii. Collector heat removal factor and flow factor
   iv. Critical radiation level
   v. Mean plate and fluid temperatures
   vi. Effective transmittance-absorptance product
   vii. Measuring collector performance
   viii. Practical considerations

7. Concentrating Collectors
   i. Collector configurations
   ii. Thermal performance
   iii. Optical performance

8. Energy Storage
   i. Comparing loads to collector output
   ii. Energy storage in solar thermal processes
   iii. Energy storage techniques

   i. Hot water loads
   ii. Space heating loads
   iii. Swimming pool loads

10. System Considerations and Calculations
    i. System component models
    ii. Collector heat exchanger factor
    iii. Duct and pipe losses
    iv. Controls
    v. Other system considerations

11. Solar Thermal Applications
    i. Solar water heating
    ii. Industrial process heat
    iii. Solar thermal power systems
    iv. Solar cooling

Q. LABORATORY OUTLINE: None ☒ Yes ☐