MENG442 – Solar Energy Engineering

Eastern Mediterranean University
Faculty of Engineering

Department:
Mechanical Engineering

Program: Mechanical Engineering	**Program Code:** 23	**Year/Semester:** 2019-2020 FALL			
Course Code: MENG442	**Course Title:** Solar Energy Engineering	**Credit hours**			
		Lec.	**Tut**	**Lab/Activity**	**Total**
		4	**1**	**1**	**4**

Criterion 5
Subject Area:

☐ (a) College-level mathematics and basic sciences with experimental experience appropriate to the program.
☒ (b) Engineering topics appropriate to the program, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools.
☐ (c) a broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives.
☐ (d) a culminating major engineering design experience that
- ☐ 1) Incorporates appropriate engineering standards and multiple constraints
- ☐ 2) Based on the knowledge and skills acquired in earlier course work.

Hourly Contribution
☐ Basic Science ()
☐ College-level Mathematics ()
☐ Complex Engineering Problems ()
☐ Engineering Design ()
☐ Engineering Science (4)
☐ Team ()

Type of Course
☐ Engineering or Area Core
☐ Engineering Course offered by other programs
☒ Engineering or Area Elective
☐ Mathematics and Basic Sciences
☐ General Education

Prerequisite(s): MENG345 Heat Transfer

Catalog Description:
Introduction to solar energy, sun-earth geometric relations, solar radiation, energy requirements in buildings, solar energy collectors, energy storage, solar energy process economics, solar cooling processes, passive solar gain systems, solar thermal power, photovoltaics.

Course Web Page: https://staff.emu.edu.tr/muratozdenefe/en/teaching/meng442

Textbook(s): 1) J. A. Duffie, W. A. Beckman, Solar Engineering of Thermal Processes, Wiley and Sons 2013.
3) D. Yogi Goswami, Principles of Solar Engineering 3rd ed., CRC Press Taylor & Francis Group 2015.
2) S. A. Kalogirou, Solar Energy Engineering: Processes and Systems. Elsevier, California 2009.

Topics Covered and Class Schedule:	
Week 1 & week 2	**Solar Radiation:** The sun and solar constant, extraterrestrial radiation, sun-earth geometric relations, angles of tracking surfaces, beam radiation on tilted surfaces and horizontal surfaces, shading, extraterrestrial radiation on horizontal surface.
Week 3 & week 4	**Available Solar Radiation:** Solar radiation measurement, solar radiation data and estimation of solar radiation, distribution of clear and cloudy days, beam and diffuse components of radiation, estimation of hourly radiation from daily data, radiation on sloped surfaces.
Week 5	**Selected Heat Transfer Topics:** Electromagnetic spectrum, photon radiation, infrared radiation exchange between gray surfaces, sky radiation, radiation heat transfer coefficient, natural convection between flat parallel plates and between concentric cylinders, internal flow, wind convection coefficients, ε-NTU method.
Week 6	**Radiation Characteristics of Surfaces and Transmission:** Absorptance and emittance, Kirchhoff's law, reflectance of surfaces, relations of absorptance emittance and reflectance, calculation of emittance and absorptance, reflection of radiation, absorption by glazing, transmittance-absorptance product, absorbed solar radiation**.**
Week 7	**Solar Energy Collectors:** Flat plate collectors, collector loss coefficients, temperature distribution and efficiency factor, collector tests.
Week 8 & week 9	**Midterm Examination Week**
Week 10	**Solar Energy Collectors:** Concentrating collectors, thermal performance of concentrating collectors.
Week 11	**Energy Storage and Solar Process Loads:** Process loads and solar collector outputs, energy storage in solar process systems, water storage, hot water loads, space heating loads and degree days**.**
Week 12	**System Thermal Calculations:** Component models, collector heat exchanger factor, loss factors, collector arrays. **Solar Energy Process Economics:** Costs, design variables, economic figures of merit, time value of money, life cycle savings
Week 13	**Solar Energy Applications:** Building and water heating: active and passive, solar cooling, solar power systems.
Week 14	**Design of Active systems and Photovoltaics:** The f chart method, photovoltaic converters, PV generator characteristics and models, cell temperature, design procedures.
Week 15	**Final Examination Week Starts**

Lecture and Tutorial Outcomes	Student Outcomes	Performed Assessments and Percentage
• Understand the application areas of solar energy such as domestic hot water and space heating, greenhouse and Trombe wall, central receiver thermal power and photovoltaic conversion. • Obtain the equations related with sun-earth geometric relations and understand reckoning of time, sun path diagram and shadow determination. • Understand the fundamentals of solar radiation, including the estimation of terrestrial insolation intercepted and absorbed by tilted surfaces. • Understand the building heat transfer and heating-cooling load calculations. • Analyze the solar collectors of both flat plate and concentrating type. • Develop an intuitive understanding of energy storage particularly water and packed bed systems. • Make life cycle and payback time analysis for determining the economics of solar systems. • Make mathematical modeling of a typical liquid-based solar heating system and design using f-chart design method. • Understand some viable solar cooling methods, including absorption refrigeration and low-temperature Rankine cycles. • Understand solar assisted heat pumps and solar-operated absorption heat pumps. • Understand passive system architecture and perform design analysis of direct gain systems and absorber-storage (Trombe) wall systems.	**(1)** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. **(2)** An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. **(7)** An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Midterm➔30% Final➔40% Quiz 1➔5% Quiz 2➔5% Project➔15%

Lab. Experiment Title and Lab. Equipment Used	Lab Learning Outcome	Student Outcomes	Performed Assessments and Percentage
Exp. title: Determining the instant electrical capacity of the PVT **Equipment:** YE-1035 Photovoltaic-Thermal (PVT) Training Set	To get familiar with the fundamentals of PVs and PVTs as well as to calculate the electrical capacity of the PVT system by measuring the voltage and values.	**(6)** An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	Lab. report➔5%

Important Notes Regarding the Course: University rules and regulations are applied to this course.

Lab. Dates:
1st Lab: Week 13➔ 16-20 December 2019

Quiz Dates:
1st Quiz: During tutorial hour of week 4➔ 17 October, Thursday at 16:30
2nd Quiz: During tutorial hour of week 12➔ 12 December, Thursday at 16:30

Exam and Quiz Policy:
The midterm and final exams are open book (only the course textbook is allowed), whereas quizzes are closed book (students can bring maximum two A4 formula sheets).

NG Policy:
Students,

- who do not attend both mid-term and final exams or
- who do not submit project or
- who have less than 60% lecture attendance and fail (D- or F)

will be given NG.

Appeals:
Any appeal against the marks of any assessment component must be made to the course instructor within one week following the announcement of the marks.
Any appeal concerning a semester grade must be made to the course instructor no later than the end of the registration period of the following semester.

Makeups:
There will be no make up for quizzes or labs.
A student who fails to sit for an examination for a valid reason is given a make-up exam. Within three working days after the examination, students who wish to take a make-up must submit a written statement to the course instructor explaining the reason(s) for his/her request.
The student also must fill in the makeup examination form (available at the course website) and submit to the course instructor within three working days after the examination.