Course Specification
(Bachelor)

Course Title	**Solar Energy**
Course Code:	**PHY 1427**
Program:	**Bachelor of Science in Physics.**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 7 or 8/ Year4)					
4. Course General Description:					
In the solar energy course, you will learn to design a complete photovoltaic system. This course introduces the technology that converts solar energy into electricity, heat and solar fuels with a main focus on electricity generation. Photovoltaic (PV) devices are presented as advanced semiconductor devices that deliver electricity directly from sunlight. This course explores the advantages, limitations and challenges of different solar cell technologies, such as crystalline silicon solar cell technology, thin film solar cell technologies and the latest novel solar cell concepts as studied on lab-scale.					
5. Pre-requirements for this course (if any)**:**					
PHY 1324					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Give the student a basic knowledge of solar energy.**
- **Explain the various concepts to convert solar energy in to electricity, heat and solar fuels.**
- **Explain the physical working principles of photovoltaic conversion in solar cells.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		

No	Mode of Instruction	Contact Hours	Percentage
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)**	**0**
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the scientific method of inquiry to conclude concepts of solar energy conversion.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. Discussions.
1.2	**Describe the scientific method of inquiry to conclude concepts of photovoltaics.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Outline the scientific method of inquiry to conclude concepts solar cell applications.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**State the scientific method of inquiry to conclude concepts of thin film solar cells.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying waves and optical physics.**	**S1, S2**	▪ Lectures. ▪ Class discussions. ▪ Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in**	**S2, S3**	▪ Problem classes and group tutorial. • Homework assignments as well	▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	physics related the topics covered by the course.		as problems solutions.	
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4, S5**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Solar Energy Conversion:** Photovoltaic, Photo electrochemical, Photothermal, Thermoelectric systems, Solar insulation, World energy demand, Current energy consumption from different sources, Environmental and health effects Sustainable energy, Production and storage.	**8**
2.	**Photovoltaics (PV):** Fundamentals of solar cells, Types of solar cells, Semiconducting materials, Band gap theory, Absorption of photons, Excitons and photoemission of electrons, Band engineering, Solar cell properties and design, p-n junction photodiodes, Depletion region, Electrostatic field across the depletion layer, Electron and holes transports, Device physics, Charge carrier generation, Recombination and other losses, I-V characteristics, Output power, Single junction and triple-junction solar panels, Metal-semiconductor heterojunctions, Semiconducting materials for solar cells.	**8**
3.	**Solar Cell Applications:** PV cell interconnection, module structure and module fabrication, equivalent circuits, Load matching, Efficiency, Fill factor, Optimization for maximum power, Design of stand-alone PV systems, System sizing, Device structures, Device construction, Installation, Measurements; DC to AC conversion, Inverters, On-site storage, Grid connections, Solar cell manufacturing processes, Material resources, Chemistry, Environmental impacts; Low cost manufacturing processes.	**8**
4.	**Optical Engineering:** Optical design, Anti-reflection coatings, Beam splitters, Surface structures for maximum light absorption, Operating	**10**

	temperature versus conversion efficiency, Types of solar energy concentrators, Fresnel lenses and Fresnel reflectors, Operating solar cells at high incident energy for maximum power output.	
5.	**Thin film Solar Cells:** Single crystal, Polycrystalline and amorphous silicon solar cells, Cadmium telluride thin-film solar cells, Conversion efficiency, Current trends in photovoltaic research and applications, Nanotechnology applications, Quantum dots, Solution based processes solar cell production.	**10**
6.	**Photoelectrochemical Cells for Hydrogen Production:** Photoelectrochemical electrolysis, Photoelectrochemical cells for hydrogen production, Solar-to hydrogen efficiency, Hydrogen storage, Hydrogen economy.	**8**
7.	**Solar thermal conversion:** Low, Medium and high temperature collectors, Types of solar energy collectors, Heat storage, Storage media, Steam accumulator, Other storage systems, Heat exchangers and applications of stored energy.	**8**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4thweek**	**25 %**
3.	**Midterm Exam 2**	**6thweek**	**25 %**
4.	**Final Exam**	**16thweek**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Green M. A., ***Solar Cells: Operating Principles, Technology and system Applications,*** Published by the University of New South Wales, ISBN 0 85823 580 3 (1998).
Supportive References	Physics of Solar Energy by C. Julian Chen, John Wiley & Sons Inc, 2011.
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms. - Labs.
Technology equipment (projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students Second examiner	Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)
Effectiveness of Students assessment	Instructors	Direct (exams, HW, project, …)
Quality of learning resources	Faculty Students	indirect (surveys)
The extent to which CLOs have been achieved	Instructors Program Leaders	Direct (excel sheet)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024