



# Course Specification

## **DIPLOMA**

**Course Title:** Photovoltaic Systems

**Course Code:** APRT3211

**Program:** Renewable energy technologies

**Department:** Diploma Department

**College:** The Applied College

**Institution:** Umm Al-Qura University

**Version:** 1

**Last Revision Date:** 10 February 2025



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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: (3<sup>rd</sup> Level / 2<sup>nd</sup> Year)

#### 4. Course General Description:

##### 1. Course Description

This course aims to introduce concepts of the photovoltaic (PV) systems -Solar energy potential for PV -irradiance, solar radiation and spectrum of sun -Photovoltaic effect, conversion of solar energy into electrical energy -behavior of solar cells -Solar cells, basic structure and characteristics: Single crystalline, multi-crystalline -thin film silicon solar cells -Electrical characteristics of the solar cell-equivalent circuit, modeling of solar cells including the effects of temperature--solar cell arrays, PV modules, PV generators, shadow effects and bypass diodes, Interfacing PV modules to loads, direct connection of loads to PV modules -connection of PV modules to a battery and load together - Energy storage alternatives for PV systems -types of Storage batteries, properties and modeling of batteries -Power conditioning and maximum power point tracking (MPPT) algorithms based on buck-and boost-converter topologies -Maximum power point tracking (MPPT) algorithms -Inverter control topologies for stand-alone and grid-connected operation -Analysis of the inverter -Feasible operating region of inverter at different power factor values for grid-connected systems -Stand-alone PV systems. Consumer applications, residential systems -PV water pumping-PV powered lighting, Grid-connected (utility interactive) PV systems -Modeling and simulation of stand-alone and grid-connected PV systems.

5. Pre-requirements for this course (if any):

6. Co-requisites for this course (if any):

7. Course Main Objective(s):



### Course Main Objective

The main objective of this course:

- To gain an understanding of the state of the art and current primary research focuses in all common and emerging photovoltaic technologies.
- To learn how solar cell operation is modeled to diagnose and optimize devices.
- To gain an overview of methods to produce solar cells and some of the problems and solutions in manufacturing the devices.
- To understand how photovoltaics fit into future energy generation schemes.
- To know the different algorithms to extract maximum power from the PV system

### 2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	5	100%
2	E-learning		
3	Hybrid <ul style="list-style-type: none"> <li>• Traditional classroom</li> <li>• E-learning</li> </ul>		
4	Distance learning		

### 3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	30
2.	Laboratory/Studio	45
3.	Field	
4.	Tutorial	
5.	Others (specify)	
Total		75

## 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	<b>Knowledge and understanding</b>			
1.1	Figure out a comprehensive knowledge and critical understanding of the main subjects of the <b>Photovoltaic Technology</b> or specialization, including the main concepts, principles, theories and their current applications in the field of academic research specializing in <b>Photovoltaic Technology</b> .	K1	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam
1.2	Understand deeply one or more areas of specific specialization in relation to the latest theories, research and professional practice in <b>Photovoltaic Technology</b> .	K2	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam
1.3	Describe the most current advancements in one or more mechanical engineering sectors, professional specialties, or professions with sufficient level of competence and comprehension.	K3	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam
1.4	Demonstrate knowledge and awareness of a number of well-known and specialized research and/or inquiry methodologies, as well as experience in the <b>Photovoltaic</b>	K4	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam





Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	<b>Technology</b> of mechanical engineering.			
<b>2.0</b>	<b>Skills</b>			
2.1	Apply continuously theoretical and practical knowledge in dealing with a variety of contexts, new and unexpected scientific, and provide authentic and innovative responses to problems and issues. Make convincing and informed judgments in situations where complete or consistent information is not available.	S1	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam
2.2	Extracts from published research or professional reports in <b>Photovoltaic Technology</b> . and can apply them, develops important new ideas and integrates them into their knowledge or experiences. Applies specialized and general research methods in the creative analysis of complex issues and in the development of results and proposals related to its academic field.	S5	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam
<b>3.0</b>	<b>Values, autonomy, and responsibility</b>			



Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.1	Ability to self-learning about engineering problems in <b>Photovoltaic Technology</b>	V3	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam
3.2	Contribute to improving the quality of life in the community.	V4	Lectures, tutorials and independent study assignments	Homework, Quizzes, Midterm and Exam

### C. Course Content

No	List of Topics	Contact Hours
1. 1	PV -irradiance, solar radiation and spectrum of sun -Photovoltaic effect, conversion of solar energy into electrical energy -behavior of solar cells -Solar cells, basic structure and characteristics: Single crystalline, multi-crystalline -thin film silicon solar cells -Electrical characteristics of the solar cell.	3
2. 2	Equivalent circuit, modeling of solar cells including the effects of temperature- solar cell arrays, PV modules, PV generators, shadow effects and bypass diodes, Interfacing PV modules to loads, direct connection of loads to PV modules	6
3	connection of PV modules to a battery and load together -Energy storage alternatives for PV systems -types of Storage batteries, properties and modeling of batteries -Power conditioning and maximum power point tracking (MPPT) algorithms based on buck-and boost-converter topologies	6



4	Maximum power point tracking (MPPT) algorithms -Inverter control topologies for stand-alone and grid-connected operation -Analysis of the inverter –Feasible operating region of inverter at different power factor values for grid-connected systems -Stand-alone PV systems.)	6
5	Consumer applications, residential systems -PV water pumping-PV powered lighting, Grid-connected (utility interactive) PV systems - Modeling and simulation of standalone and grid-connected PV systems	6
6	System design and performance; predicted energy savings and related economics	3
7	Lab Work	45
Total		75

#### D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.1	Quizzes and Exercise	3-8	%10
2.2	Report & Presentation	3-8	%20
3.3	Mid-term	9	%20
4	Final exam	17/18	50%

\*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	<ul style="list-style-type: none"> <li>Abtahi, Amir; Messenger, Roger "Photovoltaic Systems Engineering"4th edition CRC Press-2017</li> <li>Ali Sayigh "Photovoltaics for Sustainable Electricity and Buildings", Springer International Publishing –2017.</li> </ul>
Supportive References	<ul style="list-style-type: none"> <li>Solar Energy, ISSN: 0038-092X Elsevier</li> <li>Applied Photovoltaic Technology ISSN: 0003-701X (print version) ISSN: 1934-9424 (electronic version springer</li> </ul>
Electronic Materials	<ul style="list-style-type: none"> <li>All the lecture notes</li> </ul>
Other Learning Materials	

##### 2. Required Facilities and equipment

Items	Resources
<b>facilities</b> (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms





Items	Resources
<b>Technology equipment</b> (projector, smart board, software)	Data show
<b>Other equipment</b> (depending on the nature of the specialty)	

## F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Faculty	Direct (project, HW, Quiz, midterm and final exam)
Effectiveness of Students assessment	Students	Indirect (Student Survey)
Quality of learning resources	Program Coordinator	Direct analysis
The extent to which CLOs have been achieved	Program Coordinator	Direct analysis
Other		

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

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval

<b>COUNCIL /COMMITTEE</b>	Umm Al-Qura University Council
<b>REFERENCE NO.</b>	851141114462/190394
<b>DATE</b>	22/11/1446

