MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	**Solar Photovoltaic Conversion**			**Module Delivery**	
Module Type	**Core**			☒ **Theory** ☐ **Lecture** ☒ **Lab** ☒ **Tutorial** ☐ **Practical** ☐ **Seminar**	
Module Code	**RE 401**				
ECTS Credits	**7**				
SWL (hr/sem)	**175**				
Module Level	4		**Semester of Delivery**	7	
Administering Department	PM		**College**	TEMO	
Module Leader	Bashar Abdullah Hamad		**e-mail**	bashar.hamad@ntu.edu.iq	
Module Leader's Acad. Title	Lecturer		**Module Leader's Qualification**	M.Sc.	
Module Tutor	Name (if available)		**e-mail**		
Peer Reviewer Name	Name		**e-mail**		
Scientific Committee Approval Date	01/6/2023		**Version Number**	1.0	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents

أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	This course of photovoltaic energy systems will focus on the fundamentals of solar energy conversion, photovoltaic, and environmental impacts, and cover topics including shading, energy storage, and emerging PV technologies. Stand-alone PV system components. Designing stand-alone PV systems and sizing. Analysis of the efficiency of solar cells. PV power system. Grid-connected PV.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Important: Write at least 6 Learning Outcomes, better to be equal to the number of study weeks. Upon completion of this course, the student will be ... 1. Able to describe markets and applications for photovoltaic systems. 2. Able to identify safety hazards of photovoltaic systems. 3. Able to identify practices and protective equipment used for PV systems installation and maintenance. 4. Able to define and demonstrate solar energy fundamentals 5. Able to conduct site assessments and planning for PV systems installations 6. Able to explain the characteristics of different PV system configurations 7. Able to explain and calculate PV module parameters using module specifications 8. Able to explain the differences between various PV technologies. 9. Able to describe the purpose and operation of PV balance-of-system (BOS) components 10. Able to calculate photovoltaic array and BOS component sizing 11. Able to conduct PV systems electrical design/integration per National Electrical Code (NEC) requirements 12. Able to conduct photovoltaic system mechanical design/integration 13. Able to calculate and analyze photovoltaic system performance 14. Able to understand proper installation and troubleshooting procedures
Indicative Contents المحتويات الإرشادية	Indicative content includes the following. Part A - **Introduction to Photovoltaic Energy Conversion Energy from Solar Photovoltaic (PV) Conversion, Solar PV Modules, Solar PV Systems, Advantages and Challenges of Solar Photovoltaic Energy Conversion.** **Solar Cells ,** How Solar Cells are Better than any Conventional Sources of Electricity? , What is a Solar Cell?, How Solar Cell Generates Electricity? , Parameters of Solar Cells , Solar Cell Technologies , Factors Affecting Electricity Generated by a Solar Cell [15 hrs] **Solar PV Modules, What is a Solar PV Module? Ratings of PV Module, Standard PV Module Parameters, I-V and P-V Characteristics of SPV Module** **Solar PV Module Arrays, Connection of Modules in Series, Estimating Number of PV Modules Required in Series and Their Total Power, Connection of Modules in Parallel Combination** [15 hrs] **PV Module Shading** **- Causes and effects of shading in PV systems** **- Bypass diodes for mitigating shading effects** [6hrs]

	Part B – **Applications of Batteries in Solar PV Systems, Why to Connect Batteries Together? Estimating Number of Batteries Required in Series** **Charge Controller, MPPT and Inverters, Need for BoS, Power Converters and Their Efficiency, AC to DC Converters** **Solar PV System Design and Integration, Types of Solar PV Systems, Standalone SPV System, Grid-connected SPV System, Hybrid SPV Systems** [15 hrs]

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	Type something like: The major approach used to offer this module will be to promote student engagement in the exercises while also enhancing and broadening their critical thinking abilities. This will be accomplished through lectures, interactive tutorials, and the consideration of various sorts of easy experiments incorporating some engaging sampling exercises for the students.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ أسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	78	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	97	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	6
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**175**		

Module Evaluation
تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	4	10% (10)	2, 4 and 9 ,14	LO #1, #3and #8, #9, #13
	Assignments	5	10% (10)	3, 5, 7 and 8, 15	LO #2, #4 and #6, #7, #11, #14
	Projects / Lab.	6	15% (15)	Continuous	All
	Report	1	5% (5)	14	LO #5, #10, #12
Summative assessment	**Midterm Exam**	3hr	10% (10)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)
المنهاج الاسبوعي النظري

	Material Covered
Week 1	**Introduction to Photovoltaic Energy Conversion Energy from Solar Photovoltaic (PV) Conversion, Solar PV Modules, Solar PV Systems, Advantages and Challenges of Solar Photovoltaic Energy Conversion**
Week 2	**Fundamentals of Semiconductor Materials** **- Introduction to semiconductor materials** **- Properties of semiconductors** **- Formation of P-N junctions and basic operation of diodes**
Week 3	**Solar Cells ,** How Solar Cells are Better than any Conventional Sources of Electricity? , What is a Solar Cell?, How Solar Cell Generates Electricity? , Parameters of Solar Cells , Solar Cell Technologies , Factors Affecting Electricity Generated by a Solar Cell
Week 4	**Solar PV Modules, What is a Solar PV Module? Ratings of PV Module, Standard PV Module Parameters, I-V and P-V Characteristics of SPV Module, How Many Cells in Module? , Estimating or Designing Wattage of a PV Module , Factors Affecting Electricity Generated by a Solar PV Module**
Week 5	**Solar PV Module Arrays, Connection of Modules in Series, Estimating Number of PV Modules Required in Series and Their Total Power, Connection of Modules in Parallel Combination**
Week 6	**Connected in Parallel and Their Total Power, Connection of Modules in Series and Parallel (Mixed Combination), Estimation Number of Modules to be Connected in Series and Parallel and Their Total Power**

Week 7	**PV Module Shading** **- Causes and effects of shading in PV systems** **- Bypass diodes for mitigating shading effects** **- Strategies for minimizing shading effects**
Week 8	**Basics of Batteries, Some Basics about Batteries, How Does a Battery Work? Types of Batteries, Parameters of Batteries**
Week 9	**Applications of Batteries in Solar PV Systems, Why to Connect Batteries Together? Estimating Number of Batteries Required in Series, Estimating Total Energy Stored in Series Connected Battery Array**
Week 10	**Estimating Maximum Power from Series Connected Batteries, Parallel Connection, Estimating Number of Batteries Required in Parallel**
Week 11	**Charge Controller, MPPT and Inverters, Need for BoS, Power Converters and Their Efficiency, AC to DC Converters**
Week 12	**DC to AC Converter (Inverters), DC to DC Power Converters, Charge Controllers**
Week 13	**Solar PV System Design and Integration, Types of Solar PV Systems, Standalone SPV System, Grid-connected SPV System, Hybrid SPV Systems**
Week 14	**Grid-connected Solar PV Power Systems, Introduction to Grid-connected PV Systems, Grid-connected PV Systems for Small Power Applications, Grid-connected PV Systems for Large Power Applications,**
Week 15	**Configuration of Grid-connected Solar PV Systems, Grid-connected PV System Design for Small Power Applications, Steps of System Design**

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Effect of solar radiation changing on V_{OC} and I_{SC} measurements
Week 2	Characteristics of a Single Solar Cell
Week 3	Series Connections of Solar Cells
Week 4	Effect of PV Module Shading and Bypass diode Series Connections of Solar Cells
Week 5	Parallel Connections of Solar Cells
Week 6	Characteristics of a Single Solar Cell with solar radiation changing
Week 7	

Learning and Teaching Resources
مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts	Solanki, Chetan Singh. *Solar photovoltaic technology and systems: a manual for technicians, trainers and engineers*. PHI Learning Pvt. Ltd., 2013	No
Recommended Texts	Shepherd, William, and David William Shepherd. *Energy studies*. World Scientific Publishing Company, 2014.	No
Websites		

Grading Scheme
مخطط الدرجات

Group	Grade	التقدير	Marks %	Definition
Success Group (50 - 100)	**A** – Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C – Good	جيد	70 - 79	Sound work with notable errors
	D – Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E – Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

Code	Course/Module Title	ECTS	Semester
RE 401	Solar Photovoltaic Conversion	7	7
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/sem)**
2	3	78	97

Description

The Solar Photovoltaic Conversion course offers a comprehensive study of the principles and technologies involved in converting solar energy into electricity using photovoltaic (PV) systems. This course explores the design, operation, and optimization of PV systems for various applications.

Students will delve into the physics of solar energy conversion, including the behavior of semiconductor materials and the working principles of solar cells. They will learn about the different types of PV technologies, such as crystalline silicon, thin-film, and emerging solar cell technologies. The course will cover topics including PV system components, system sizing, performance analysis, and integration into the electrical grid.

Students will gain hands-on experience through laboratory exercises and simulations, enabling them to design and evaluate PV systems for residential, commercial, and utility-scale applications. They will also explore topics like solar resource assessment, system economics, and the environmental impacts of PV systems.

By the end of the course, students will have a solid understanding of solar photovoltaic conversion and the ability to design, analyze, and optimize PV systems. They will be well-prepared for careers in the renewable energy industry, as PV system designers, project managers, or researchers in the field of solar energy.