



## **COURSE** **SyllabusAccording**

**Course Name: Hydrogen & Fuel Cells**

**Course Number: 04085172**

### General Course Information:

Course title	Hydrogen & Fuel Cells
Course number	0408456 + 04085172
Credit hours	( 3Hrs Theory, 0 practical)
Contact hours	(3Hrs in three times weekly)
Prerequisites/corequisites	Chemistry 1101101
Academic Program	Renewable Energy Engineering
Program code	REE
Awarding institution	Isra University
Faculty	Engineering
Department	Renewable Energy Engineering
Level of course	5 <sup>th</sup> Year
Academic year /semester	2 <sup>nd</sup> Semester 2020-2021
Awarded qualification	B. Sc.
Other department(s) involved in teaching the course	-
Language of instruction	English
Date of production/revision	29 Mar 2022

### Course Coordinator:

**Coordinator's Name:** Dr. Ismail Hdaib  
**Office No.:** 4210  
**Office Phone:** 2486  
**Office Hours:** Su. 13.00 – 14.00  
**Email:** ismail.hdaib@iu.edu.jo

### Other Instructors:

**Instructor's Name:**  
**Office No.:**  
**Office Phone:**  
**Office Hours:**  
**Email:**

### Course Description(English/Arabic):

English	Hydrogen & Fuel Cells: (3 semester hours) Lecture course. Understanding basics and principles of Fuel Cells operations and related Energies Processes.
Arabic	خلايا الوقود والهيدروجين: (3 ساعات فصلية دراسية) محاضرات فصلية . فهم أساسيات ومبادئ عمليات خلايا الوقود وعمليات الطاقة ذات الصلة.

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**Text Book: Author(s), Title, Publisher, Edition, Year, Book website.**

Fuel Cell Engines -1<sup>st</sup>Edition. Matthew M. Mench - John Wiley & Sons, Inc, New Jersey, NJ07030. Copyright © 2008 - ISBN : 978-0-471-68958-4

**References: Author(s), Title, Publisher, Edition, Year, Book website.**

Fuel Cell Science and Engineering, Volume 1, Detlef Stolten and Bernd Emonts, Wiley-VCH Verlag & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany. Copyright © 2012 - ISBN : 978-3-527-33012-6.

**Course Educational Objectives (CEOs):**

1.	To cover the basic principles of Fuel Cells.
2.	To present a wealth of real-world engineering applications to give students a feel for engineering applications.
3.	To develop an intuitive understanding of the subject matter by emphasizing the physics and physical arguments.

**Intended Learning Outcomes (ILO's):**

	Intended Learning Outcomes (ILO's)	Relationship to CEOs	Contribution to PLOs
<b>A</b>	<b>Knowledge and Understanding:</b>		
A1	Implement the various Fuel Cell Analysis Techniques – based problem solving for specific applications.	1	1, 2
A2	Develop a sense of underlying Electrochemical Principles and a mastery of identifying practical Fuel Cells an engineer is likely to face in the real world.	2,3	1, 2
<b>B</b>	<b>Intellectual skills:</b>		
B1	Analysis of Fuel Cells Engineering Problems activities	1, 2, 3	1, 2
<b>C</b>	<b>Subject specific skills:</b>		
C1	Understand Hydrogen Fuel Storage and Treatment	1, 2, 3	1, 2

## Weekly Schedule (please chose the type of teaching)

☐ (3 hrs Face – To - Face)

☐ (2 hrs Face – To - Face + 1 hr Asynchronous) (Hybrid)

☐ (3 hrs Online)

Week	First Hour (.....)	Second Hour (.....)	Third Hour (.....)	Ach. ILOs	Ach. PLOs	Descriptors*
1	Introduction to Fuel Cells.	Introduction to Fuel Cells.	Introduction to Fuel Cells.	A1	1,2	K
2	Introduction to Fuel Cells.	Introduction to Fuel Cells.	Introduction to Fuel Cells.	A1	1,2	K
3	Basic Electrochemical Principles.	Basic Electrochemical Principles.	Basic Electrochemical Principles.	A1,A2	1,2	S
4	Basic Electrochemical Principles.	Basic Electrochemical Principles.	Basic Electrochemical Principles.	A1,A2	1,2	S
5	Basic Electrochemical Principles.	Basic Electrochemical Principles.	Basic Electrochemical Principles.	A1,A2	1,2	S
6	Thermodynamics of Fuel Cell Systems.	Thermodynamics of Fuel Cell Systems.	Thermodynamics of Fuel Cell Systems.	A2	1,2	S
7	Thermodynamics of Fuel Cell Systems.	Thermodynamics of Fuel Cell Systems.	Thermodynamics of Fuel Cell Systems.	A2	1,2	S
8	Thermodynamics of Fuel Cell Systems.	Thermodynamics of Fuel Cell Systems.	Thermodynamics of Fuel Cell Systems.	A2	1,2	S
9	Revision & Midterm Exam	Revision & Midterm Exam	Revision & Midterm Exam		1,2	C
10	Performance Characterization of Fuel Cell Systems.	Performance Characterization of Fuel Cell Systems.	Performance Characterization of Fuel Cell Systems.	A1,A2,B <sub>1</sub>	1,2	S
11	Performance Characterization of Fuel Cell Systems.	Performance Characterization of Fuel Cell Systems.	Performance Characterization of Fuel Cell Systems.	A1,A2,B <sub>1</sub>	1,2	S
12	Polymer Electrolyte Fuel Cells.	Polymer Electrolyte Fuel Cells.	Polymer Electrolyte Fuel Cells.	A1,A2,B <sub>1</sub>	1,2	K
13	Polymer Electrolyte Fuel Cells.	Polymer Electrolyte Fuel Cells.	Polymer Electrolyte Fuel Cells.	A1,A2,B <sub>1</sub>	1,2	K
14	Other Fuel Cells.	Other Fuel Cells.	Other Fuel Cells.	A1,A2,B <sub>1</sub>	1,2	K
15	Hydrogen Storage, Generation, and Delivery.	Hydrogen Storage, Generation, and Delivery.	Hydrogen Storage, Generation, and Delivery.	C1	1,2	K
16	Final exam	Final exam	Final exam		1,2	C

\* K: Knowledge, S: Skills, C: Competency

## Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

- (3 hrs Face – To - Face)
- (2 hrs. Face – To - Face +1 hr Asynchronous) ( Hybrid)
- (3 hrs Online)
- Course Videos
- Practice Labs
- Discussion Forums
- Quizzes
- Other Interactive online activities

## Course Policies:

A- Attendance policies:

The maximum allowed absences is 15% of the lectures.

B- Absences from exams and handing in assignments on time:

Midterm exam can be retaken based on approval of excuse by the instructor's discretion.

Not handing assignment on time will incur penalties.

C- Academic Health and safety procedures

D- Honesty policy regarding cheating, plagiarism, and misbehaviour:

Cheating, plagiarism, misbehaviour will result in zero grade and further disciplinary actions may be taken.

E- Grading policy:

- All homework is to be posted online through the e-learning system.
- Exams will be marked within 72 hours and the marked exam papers will be handed to the students.
- Online Activities (Course Videos, Practice labs, Discussion Forums, Quizzes) **20%**
- Midterm **30%**
- Final Exam **50%**

F- Available university services that support achievement in the course: **E-Learning Platform, Labs, Library.**

## Required equipment:

- **PC / Laptop with webcam and mic**
- **Internet Connection**
- **Access to Online Compiles such as:**  
Access to the IU E-Learning Platform at: <https://elearn.iu.edu.jo/>

## Assessment Tools implemented in the course:

Final Exam  
Midterm Exam  
Quizzes  
Practice Labs  
Discussion Forums

## Program Learning Outcome (PLOs):

Program Learning Outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills, and behaviours that students acquire as they progress through the program. A graduate of the ( ) program will demonstrate		Bloom Taxonomy Levels*
<b>a</b>	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1
<b>b</b>	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.	3
<b>c</b>	An ability to communicate effectively with a range of audiences.	3
<b>d</b>	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	4
<b>e</b>	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	2
<b>f</b>	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	2
<b>g</b>	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	3

### \*Bloom Taxonomy Levels

Level#	1	2	3	4	5	6
Level Name	Knowledge	Comprehension	Application	Analysis	Evaluation	Synthesis

## Responsible Persons and their Signatures:

Course Coordinator	D. Ismail Hdaib	Completed Date	29 / 3 / 2022
		Signature	
Received by (Department Head)	D. Zakarya Al Omary	Received Date	29 / 3 / 2022
		Signature	