



# Course Specification

## **DIPLOMA**

**Course Title:** Hydrogen Generation

**Course Code:** APRT3213

**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 examines the topic of hydrogen production from a range of different feedstocks and through various production processes. These processes include electrolysis, gasification, pyrolysis, fermentation, photosynthetic algae, as well as through emerging photo- and thermo-electrochemical, high temperature fuel cell, and nuclear cycle-assisted systems. Hydrogen is a widely used industrial molecule and energy carrier that can readily be converted into electricity through fuel cells, now being used in new markets such as vehicle fuel and stationary power production. Hydrogen is expected to be more widely used in the global energy economy moving forward, based on emerging markets and rapid technological progress in production and distribution methods.

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

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

#### 7. Course Main Objective(s):

##### Course Main Objective

1. The main objective of this course

The students will be able to:

1. Demonstrate knowledge of thermodynamics for reacting systems including electron motion
2. Demonstrate knowledge on different methods to store the produced hydrogen
3. Adopt awareness of materials recommended for hydrogen storage.
4. Understand concepts for realizing fuel cell for different applications
5. Employ available resources efficiently

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

| No | Mode of Instruction   | Contact Hours | Percentage |
|----|-----------------------|---------------|------------|
| 1  | Traditional classroom | 5             | 100%       |
| 2  | E-learning            |               |            |





| No | Mode of Instruction  | Contact Hours | Percentage |
|----|--|---------------|------------|
| 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  | Knowledge and understanding  |                                       |   |                                     |
| 1.1  | Figure out a comprehensive knowledge and critical understanding of the main subjects of the Green Hydrogen Generation or specialization, including the main concepts, principles, theories and their current applications in the field of academic research specializing in Green Hydrogen Generation. | 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   | K2                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes,                  |



| Code       | Course Learning Outcomes  | Code of PLOs aligned with the program | Teaching Strategies                                   | Assessment Methods                  |
|------------|---|---------------------------------------|---|-------------------------------------|
|            | to the latest theories, research and professional practice in Green Hydrogen Generation.  |                                       |   | 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 Green Hydrogen Generation of mechanical engineering.  | K4                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| <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        | Produce innovative solutions to contemporary difficulties and problems in complex   | S2                                    | 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                  |
|------|--|---------------------------------------|---|-------------------------------------|
|      | and sophisticated situations, in a discipline, profession, or sector of employment, and critically evaluate, review, and reflect on essential concepts, principles, and theories Utilizing specialist research and inquiry approaches, carry out advanced study or professional projects in a subject area, profession, or line of business. |                                       |   |                                     |
| 2.3  | Plan and execute large projects or part of scientific research independently, applying his theoretical and practical knowledge and using research methods to arrive at valuable conclusions that lead to important additions to current knowledge or professional practices in certain field of Green Hydrogen Generation.                   | S4                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 2.4  | Support and develop cutting-edge research and/or projects related to mechanical engineering field, professional practice, or sector of work, one must choose, use, and adapt cutting-edge digital technology and ICT tools and applications to process and analyze a variety of data and information sets.                                   | S5                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 3.0  | Values, autonomy, and responsibility   |                                       |   |                                     |

| 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 Green Hydrogen Generation.   | V3                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 3.2  | Act with integrity and uphold professional and academic standards when addressing various challenges,   | V1                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 3.3  | Make highly autonomous professional academic and/or professional strategic decisions related to study and/or work. Manage with high autonomy specialized tasks and activities in a discipline, job, or field of practice. | V2                                    | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 3.4  | 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  | Hydrogen Production Science and Technology                    | 3             |
| 2. 2  | Hydrogen Production Through Electrolysis                      | 3             |
| 3     | Electrochemical Hydrogen Production                           | 3             |
| 4     | Hydrogen Production from Biological Sources                   | 3             |
| 5     | Biohydrogen Production from Agricultural Residues             | 3             |
| 6     | Hydrogen Production from Photoelectrochemical Water Splitting | 3             |
| 7     | Hydrogen via Direct Solar Production                          | 3             |
| 8     | Photo-Catalytic Hydrogen Production                           | 3             |
| 9     | Hydrogen Production from High-Temperature Fuel Cells          | 3             |
| 10    | Nuclear-Assisted Hydrogen Production                          | 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     | <p>1. List Required Textbooks</p> <ul style="list-style-type: none"> <li>Timothy E. Lipman, Adam Z. Weber, Fuel Cells and Hydrogen Production, Springer Science+Business Media, LLC, part of Springer Nature, 2019</li> <li>B. Sørensen, "Hydrogen and fuel cells: emerging technologies and applications" 2nd ed., Academic Press is an imprint of Elsevier, Amsterdam, 2012. (ISBN: 978-0-12-387709-3)</li> <li>M. F. Horddeski, "Hydrogen &amp; fuel Cells: Advances in transportation and power", Fairmont Press, Inc., 2009. (ISBN 0-88173-561-2)</li> <li>R.B. Gupta (Editor), "Hydrogen fuel: production, transport and storage", CRC Press - Taylor &amp; Francis Group, LLC, 2009. (ISBN 978-1-4200-4575-8)</li> <li>M. F. Horddeski, "Alternative fuels: the future of hydrogen", 3rd Ed., Fairmont Press, Inc., 2013. (ISBN: 0-88173-687-2)</li> <li>A. Basile, A. Iulianelli (Editors), "Advances in hydrogen production, storage and distribution", Woodhead Publishing is an imprint of Elsevier, Cambridge, 2014. (ISBN: 978-0-85709-768-2 (print) &amp; ISBN 978-0-85709-773-6 (online))</li> </ul> |
| Supportive References    | All the lecture notes   |
| Electronic Materials     | <ul style="list-style-type: none"> <li><a href="http://www.asme.org">www.asme.org</a> &amp; <a href="http://www.sciencedirect.com">www.sciencedirect.com</a> &amp; <a href="http://www.springer.com">www.springer.com</a></li> </ul>  |
| Other Learning Materials |   |

## 2. Required Facilities and equipment

| Items   | Resources  |
|---|------------|
| <b>facilities</b><br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | Classrooms |
| <b>Technology equipment</b><br>(projector, smart board, software)                         | Data show  |
| <b>Other equipment</b><br>(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) |





| Assessment Areas/Issues                     | Assessor            | Assessment Methods        |
|---|---------------------|---------------------------|
| 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                     |

