



Course Specification

DIPLOMA

Course Title: Energy Conversion and Storage

Course Code: APRT3210

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: (3rd Level / 2nd Year)

4. Course General Description:

1. Course Description

The course provides the Principal Forms of Stored Energy, the applications of Energy Storage, the Specifying Energy Storage Devices, the Specifying Fuels, the direct Electric Storage, the electrochemical Energy Storage, the mechanical Energy Storage, the direct Thermal Storage, the thermochemical Energy Storage, the Pumped Storage Hydroelectricity (PHS), the Compressed Air Energy Storage (CAES), the Electrolysis of water and Methanation, the Hydraulic Hydro Energy Storage (HHS), the Flywheels, the Superconducting Magnetic Energy Storage (SMES).

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 learn the Principal Forms of Stored Energy
- To learn the applications of Energy Storage
- To know the Specifying Energy Storage Devices
- To study the direct Electric Storage
- To gain the electrochemical Energy Storage
- To learn the mechanical Energy Storage
- To study the direct Thermal Storage
- To know the thermochemical Energy Storage

2. Teaching mode (mark all that apply)

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





| No | Mode of Instruction | Contact Hours | Percentage |
|----|--|---------------|------------|
| 3 | Hybrid <ul style="list-style-type: none"> Traditional classroom E-learning | | |
| 4 | Distance learning | | |

3. Contact Hours (based on the academic semester)

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

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 subject matter or specialization, including the main concepts, principles, theories and their current applications in the Energy Storage of academic research specializing in mechanical engineering | K1 | 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 |
|------------|---|---------------------------------------|---|-------------------------------------|
| 1.2 | Understand deeply one or more areas of specialization in relation to the latest theories, research and professional practice in mechanical engineering | K2 | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 1.3 | Understand how modern knowledge is composed and how it is applied, as well as the impact of modern research on knowledge stocks in mechanical engineering and related professional practices | K3 | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 2.0 | Skills | | | |
| 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 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 the Energy Storage . | S2 | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 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 | S3 | 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 |
|------------|---|---------------------------------------|---|-------------------------------------|
| | current knowledge or professional practices. | | | |
| 3.0 | Values, autonomy, and responsibility | | | |
| 3.1 | Practice knowledge and skills to identify, independently and responsibly, the real problem by realizing a given problem statement, perform Literature Review to establish the need to solve the problem, define the real problem and develop technical objectives and a mission statement based on assumptions and realistic constraints to guide him / her to solve the problem in the Energy Storage . | V3 | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |
| 3.2 | Communicate individual work well in written / oral form for diversified audience. | V1 | Lectures, tutorials and independent study assignments | Homework, Quizzes, Midterm and Exam |

C. Course Content

| No | List of Topics | Contact Hours |
|------|--|---------------|
| 1. 1 | The Principal Forms of Stored Energy, The applications of energy storage, The Specifying Energy Storage Devices. | 6 |
| 2. 2 | The direct Thermal Storage (latent heat storage, sensible heat storage) | 3 |
| 3 | The mechanical Energy Storage:(The Pumped Storage Hydroelectricity (PHS), The Compressed Air Energy Storage (CAES), the Flywheels) | 3 |
| 4 | The Hydraulic Hydro Energy Storage (HHS), the Superconducting Magnetic Energy Storage (SMES) | 3 |
| 5 | Hydrogen generation- Hydrogen Storage | 3 |
| 6 | The direct Electric Storage, The electrochemical Energy Storage, the Electrolysis of water and Methanation | 3 |



| | | |
|--------------|---|-----------|
| 7 | The Thermochemical Energy Storage (Biomass Solids, Ethanol, Biodiesel, Syngas,) | 3 |
| 8 | Electrochemical Energy Storage- non rechargeable Batteries | 6 |
| 9 | Electrochemical Energy Storage- rechargeable Batteries | 6 |
| 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"> -Power plant Technology: M.M. El-Wakil -Energy Conversion: D. Yogi Goswami, Frank Kreith -Energy Storage Technologies & Their Role in Renewable Integration: Andreas Oberhofer Research Associate, Global Energy Network Institute (GENI) |
| Supportive References | <ul style="list-style-type: none"> -EAC. 2017. High Penetration of Energy Storage Resources on the Electricity System; EAC. 2016. 2016 Storage Plan Assessment; EAC. 2013. A National Grid Energy Storage Strategy. -Umweltbundesamt Für Mensch Und Umwelt. Energieziel 2050: 100% Strom Aus Erneuerbaren Quellen. FKZ 363 01 277. July 2010. Web. 18 Apr. 2012. - "Renewable Energy and Electricity." World-nuclear.org. Web. 18 Apr. 2012. - "Neue Speicher Für Die Energiewende." Energy-storage-online.com. Web. 18 Apr. 2012. - "Factsheet to Accompany the Report "Pathways for Energy Storage in the UK". "Lowcarbonfutures.org. Web. 30 Apr. 2012. -Gatzen, Christoph. The Economics of Power Storage. Vol. 65. München: Oldenbourg Industrieverlag, 2008. Web. 30 Apr. 2012. - "About Flywheel Energy Storage." Beaconpower.com. Web. 24 Apr. 2012. - "Pros and Cons of a Lead Acid Car Battery." CarsDirect.com. 28 May 2010. Web. 23 Apr. 2012. - "Fraunhofer: Riesen-Batterien Für Ökostrom-Speicherung." Energie-und-technik.de. 28 Mar. 2011. Web. 14 May 2012. - "Lead Acid Batteries." BatterySpace.com. Web. 20 Apr. 2012. |



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| Electronic Materials | http://science.howstuffworks.com/environmental/energy/power.htm http://www.powertogas.info/power-to-gas/strom-speichern.html http://www.world - http://www.vonwentzel.net/Battery/00.Glossary/ - http://www.beaconpower.com/products/about-flywheels.asp http://batteryuniversity.com/partone-5-german.htm http://www.ibm.com/smarterplanet/us/en/smart_grid/article/battery500.html http://www.basf.com/group/corporate/de/news-and-media-relations/podcasts/chemistry-of-innovations/lithium-ion http://www.zswbw.de/fileadmin/ZSW_files/Infoportal/Informationsmaterial/docs/Risikoanalyse%20Lithium_05_08_2010.pdf http://www.americanvanadium.com/vanadium-flow-batteries.php <ul style="list-style-type: none"> • http://www.sustainableplant.com/2012/05/vanadium-flow-battery-to-provide-grid-level-storage-for-gills-onions/ |
| Other Learning Materials | According the class requirements |

2. Required Facilities and equipment

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

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

