# SEE6118: EMERGING ENERGY TECHNOLOGIES

**Effective Term**
Semester B 2024/25

## Part I Course Overview

**Course Title**
Emerging Energy Technologies

**Subject Code**
SEE - School of Energy and Environment
**Course Number**
6118

**Academic Unit**
School of Energy and Environment (E2)

**College/School**
School of Energy and Environment (E2)

**Course Duration**
One Semester

**Credit Units**
3

**Level**
P5, P6 - Postgraduate Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
Nil

**Precursors**
Nil

**Equivalent Courses**
SEE8125 Emerging Energy Technologies

**Exclusive Courses**
Nil

## Part II Course Details

**Abstract**
The course aims to provide students with the fundamental knowledge on the emerging energy technologies. This includes technologies that are expected to be the next state-of-the-art in the near future, from innovative clean energy conversion

to energy storage. The acquired knowledge shall equip students for the rapidly evolving energy frontiers, and serve as a common ground for potential innovations in these technologies.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | Describe basic principles in the conversion of fossil fuel (coal and natural gas) to ultraclean fuel, as well as their importance in the future energy equations; describe the process of carbon capture and storage and its importance in the integration of fossil fuel | 20 | x | x | |
| 2 | Describe the various means of solar energy conversion from first to third generation photovoltaic solar cells, and photoelectrochemical conversion; describe the working principles of different types of fuel cells. | 30 | x | x | x |
| 3 | Describe the principles of energy storage through lithium ion batteries and supercapacitors, and their advantages; describe the principles of hydrogen storage such as metal hydrides and carbon nanotubes | 30 | x | x | |
| 4 | Apply the principles to evaluate the performances and challenges in various technologies. | 20 | | x | |

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

**Learning and Teaching Activities (LTAs)**

| | LTAs | Brief Description | CILO No. | Hours/week (if applicable) |
|---|---|---|---|---|
| 1 | Lecture | Regular lectures to enrich students with the required science fundamentals for the applications of emerging technologies in energy conversion and storage | 1, 2, 3 | |

| | | | | |
|---|---|---|---|---|
| 2 | Tutorial | Mathematical-based in-class exercise to consolidate the skills of students in designing energy systems based on emerging technologies | 2, 3, 4 | |
| 3 | Topical Workgroup | In-depth understanding of selected technologies by problem-solving | 2, 3, 4 | |
| 4 | Presentation | General presentation to share research findings with classmates | 2, 3 | |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks (e.g. Parameter for GenAI use) |
|---|---|---|---|---|
| 1 | Assignment | 3, 4 | 85 | |
| 2 | Oral presentation | 1, 2, 3, 4 | 15 | |

**Continuous Assessment (%)**

100

**Additional Information for ATs**

To pass a course, a student must do ALL of the following:
1) obtain at least 30% of the total marks allocated towards coursework (combination of assignments, pop quizzes, term paper, lab reports and/ or quiz, if applicable);
2) obtain at least 30% of the total marks allocated towards final examination (if applicable); and
3) meet the criteria listed in the section on Assessment Rubrics.

**Assessment Rubrics (AR)**

**Assessment Task**

Assignment (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

**Criterion**

Ability to apply mathematical skills in designing energy storage and conversion systems based on emerging technologies

**Excellent**

(A+, A, A-) High

**Good**

(B+, B, B-) Significant

**Fair**

(C+, C, C-) Moderate

**Marginal**

(D) Basic

**Failure**

(F) Not even reaching marginal levels

**Assessment Task**
Oral presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

**Criterion**
Ability to convey research findings orally in a convincing and systematic manner

**Excellent**
(A+, A, A-) High

**Good**
(B+, B, B-) Significant

**Fair**
(C+, C, C-) Moderate

**Marginal**
(D) Basic

**Failure**
(F) Not even reaching marginal levels

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**Assessment Task**
Assignment (for students admitted from Semester A 2022/23 to Summer Term 2024)

**Criterion**
Ability to apply mathematical skills in designing energy storage and conversion systems based on emerging technologies

**Excellent**
(A+, A, A-) High

**Good**
(B+, B) Significant

**Marginal**
(B-, C+, C) Moderate to Basic

**Failure**
(F) Not even reaching marginal levels

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**Assessment Task**
Oral presentation (for students admitted from Semester A 2022/23 to Summer Term 2024)

**Criterion**
Ability to convey research findings orally in a convincing and systematic manner

**Excellent**
(A+, A, A-) High

**Good**
(B+, B) Significant

**Marginal**

(B-, C+, C) Moderate to Basic

**Failure**

(F) Not even reaching marginal levels

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# Part III Other Information

**Keyword Syllabus**

**Ultraclean fossil fuel conversion:**
Gas-to-liquid conversion;
Clean coal technologies;
Carbon capture and storage

**Energy conversion:**
First, second and third generation solar cells;
Photoelectrochemical conversion;
Hydrogen fuel cells, direct methanol fuel cells, solid oxide fuel cells

**Energy storage:**
Lithium-ion batteries;
Supercapacitor;
Hydrogen storage

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | Raimondi, F., Scherer, G.G., Kötz, R., Wokaun, A. Nanoparticles in energy technology: Examples from electrochemistry and catalysis, Angew. Chem. Int. Ed. 2005, 44, 2190. |
| 2 | Somorjai, G.A., Frei, H., Park, J.Y. Advancing the frontiers in nanocatalysis, biointerfaces and renewable energy conversion by innovations of surface techniques, J. Am. Chem. Soc. 2009, 131, 16589. |
| 3 | Kamat, P.V. Meeting the clean energy demand. Nanostructure architectures for solar energy conversion, J. Phys. Chem. C 2007, 111, 2834. |
| 4 | Winter, M., Brodd, R.J. What are batteries, fuel cells, and supercapacitors? Chem. Rev. 2004, 104, 4245. |

**Additional Readings**

| | Title |
|---|---|
| 1 | Nil |