MSE4176: ENERGY MATERIALS FOR THE CURRENT CENTURY

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Energy Materials for the Current Century

Subject Code
MSE - Materials Science and Engineering
Course Number
4176

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
AP4176 Energy Materials for the Current Century

Exclusive Courses
Nil

Part II Course Details

Abstract

Energy has become a large societal issue due to the current reliance on non-renewable energy resources and their negative impact on the environment. A growing interest in clean and renewable energy resources makes researchers around the globe discover new materials. This course aims to introduce materials that revolutionize the current world with various energy options. The materials that control the performance of various energy sources and energy storage are explored.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the material design and relate to photovoltaic device properties	25		x	
2	Analyse the material design and explain causes on fuel cell properties	25		x	
3	Relate the material design with thermoelectric device properties	25		x	
4	Identify and reflect the material design on energy storage devices	25		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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Explain key concepts on materials design	1, 2, 3, 4	
2	Tutorials	Course work	1, 2, 3, 4	
3	Presentation	Take the role to communicate the skills	1, 2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Individual presentation	1, 2, 3, 4	30	
2	Assignments/tests	1, 2, 3, 4	20	

Continuous Assessment (%)

50

Examination (%)
50

Examination Duration (Hours)
2

Additional Information for ATs
For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained

Assessment Rubrics (AR)

Assessment Task
1. Individual presentation

Criterion
Understanding and explaining fundamental problem. Ability to identify new materials to solve such problems. Ability to explain prospects to solve the problem occurred.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
2. Assignment/tests

Criterion
Understanding the concepts of new energy materials, and their applications.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
3. Examination

Criterion
Provide new materials design with well designed concepts.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Part III Other Information

Keyword Syllabus

- Photovoltaic devices
  - Photovoltaic materials (Materials properties that include light absorption, charge transport properties and stability)
  - Electrochemical devices that involves ionic transport and their respective materials, e.g. dye sensitised solar cells
- Fuel cells
  - Basic device architecture and design on proton transport materials
  - Design on Redox catalysts and co-catalysts
  - Applications of fuel cells
  - Metal air batteries
- Thermoelectric (TE) devices
  - Phonon scattering, low thermal conductivity and high electrical conductivity TE materials
  - TE materials design and Figure of merit
- Energy storage devices
  - Super capacitors
  - Batteries

Reading List

Compulsory Readings

	Title
1	Next Generation Photovoltaics: High Efficiency Through Full Spectrum Utilization - by A Marti, Antonio Luque, Institute of Physics (Great Britain), 2004
2	Organic Photovoltaics: Mechanism, Materials, and Devices by Sam-Shajing Sun, Niyazi Serdar Sariciftci Published by CRC Press, 2005
3	The Materials Science of SemiconductorsBy Angus RockettEdition: illustratedPublished by Springer, 2007

Additional Readings

	Title
1	Journal:Nature Materials, Nature Photonics, Advanced Materials, American Chemical Society Journals, American Institute of Physics Journals and Elsevier Journals