Subject Description Form

Subject Code	ME5206
Subject Title	Advanced Materials for Clean Energy
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Students are expected to have fundamental knowledge about materials and chemistry.
Objectives	1. To enable students to establish a general concept on the state-of-art clean technologies in renewable energy. 2. To enable students to establish a general concept on the advanced material preparation and characterization for sustainable energy storage and conversion. 3. To provide in-depth knowledge on the typical materials and their specific characteristics and performances towards renewable energy storage and conversion. 4. To enable students to know the practical application scenarios of clean energy.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a have state-of-the-art knowledge of advanced materials and advanced material design and synthesis for clean energy storage and conversion; b apply their knowledge, skills, and hands-on experience to design advanced materials for energy storage and conversion and improve their performances; c. extend their knowledge of the clean energy and material design to different situations of energy context and professional practice; and d. have recognition of the need for, and an ability to engage in life-long learning.
Subject Synopsis/ Indicative Syllabus	***Introduction***: The development of renewable energy technologies; world resources and environmental considerations *versus* materials' selection; future trends in clean energy technology. ***Synthesis and Processing of Sustainable Materials***: Types of sustainable materials; materials structures; materials synthesis and characterization. ***Advanced Materials for Metal-ion Battery***: Cathode materials for Li-ion battery; anode materials for Li-ion battery; Na-ion battery. ***Advanced Materials for Solar Cells***: The principles of solar cells; materials for advanced solar cells including Si-solar cells, dye-sensitized solar cells, organic-inorganic hybrid materials, and perovskite solar cells. ***Advanced Materials for Fuel Cells***: The anode and cathode catalysts for H_2/O_2 fuel cells. ***Advanced Materials for Electrochemical Water Splitting***: Advanced materials for cathodic H_2 production; advanced materials for anodic O_2 production; full cell for water splitting.

	Advanced Biomass and Their Applications: Biomass conversion technologies; corrosion resistant materials compatible with biofuels; catalysts for conversion of biomass to biofuel; coal liquefaction. ***Advanced Materials for CO_2 Capture and Conversion***: Solid sorbents for CO_2 capture; liquid sorbents for CO_2 capture; photo/electro-catalysis for CO_2 conversion.
Teaching/Learning Methodology	The main fundamental principles and key concepts of the subject will be delivered to students through lectures. The tutorials will be provided as complemented protocols to help students to have a deeper understanding of the lecture material. Laboratory visit will be provided to strengthen students' understanding and obtain a real experience on the materials design for energy storage and conversion. Assignments, in-class assignments will be used to evaluate students' ability in applying concepts and skills learned in the classroom.

Teaching/Learning Methodology	Intended subject learning outcomes			
	a	b	c	d
1. Lecture	√	√	√	√
2. Tutorial	√	√	√	
3. Laboratory visit	√	√	√	√
4. Assignment	√	√	√	

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed			
		a	b	c	d
1. Homework assignment	20%	√	√	√	
2. Test	20%	√	√	√	√
3. Case study report & presentation	10%	√	√	√	√
4. Examination	50%	√	√	√	√
Total	100%				

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

0.5 × End of Subject Examination + 0.5 × Continuous Assessment

The continuous assessment consists of three components: homework assignments, test, and case study report & presentation. They are aimed at evaluating the progress of students' study, assisting them in self-monitoring of fulfilling the respective subject learning outcomes, and enhancing the integration of the knowledge learnt.

The examination is used to assess the knowledge acquired by the students for understanding and analyzing the problems critically and independently; as well as to determine the degree of achieving the subject learning outcomes.

<table>
<tr><td rowspan="7">Student Study Effort Expected</td><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>24 Hrs.</td></tr>
<tr><td>▪ Tutorial/Case study/Laboratory/Presentation</td><td>15 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Self-Study</td><td>55 Hrs.</td></tr>
<tr><td>▪ Case study report preparation and presentation</td><td>21 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>115 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2"><u>Textbooks:</u>
1. Bandarenka A.S., Energy Materials: A Short Introduction to Functional Materials for Energy Conversion and Storage, CRC Press, latest edition.
2. Liu J. L. and Bashir S., Advanced Nanomaterials and Their Applications in Renewable Energy, Elsevier, latest edition.
3. Shen P. K., Wang C. Y., Jiang S. P., Sun X. L. and Zhang J. J., Electrochemical Energy, Advanced Materials and Technologies, Taylor & Francis Group, latest edition.
4. Cheong K. and Apblett A., Sustainable Materials and Green Processing for Energy Conversion, Elsevier, latest edition.
5. Tong C., Introduction to Materials for Advanced Energy Systems, Springer, latest edition.
6. Dhoble S., Kalyani N., Vengadaesvaran B. and Arof A., Energy Materials: Fundamentals to Applications, Elsevier, latest edition.

<u>Journals:</u>
1. Joule, Cell press.
2. Advanced Energy Materials, John Wiley & Sons.
3. Energy & Environmental Science, Royal Society of Chemistry.</td></tr>
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July 2023