# Subject Description Form

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| **Subject Code** | ME5205 |
| **Subject Title** | Advanced Energy Storage Technologies |
| **Credit Value** | 3 |
| **Level** | 5 |
| **Pre-requisite/ Co-requisite/ Exclusion** | Students should have basic knowledge in thermofluids and electrochemistry. |
| **Objectives** | 1. To enable students to establish a broad concept of energy storage.<br>2. To provide students with knowledge of advanced energy storage technologies. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br><br>a. recognize the significance and benefits of energy storage.<br><br>b. describe the underpinning principles and characteristics of different energy storage technologies.<br><br>c. evaluate the performance and identify the limitations of various energy storage technologies.<br><br>d. have recognition of the need for, and an ability to engage in life-long learning. |
| | ***Renewable Energy and Energy Storage:*** energy and sustainability; renewable energy sources and characteristics; role of energy storage; classifications of energy storage technologies.<br><br>***Mechanical Energy Storage:*** Pumped storage hydropower; compressed air energy storage; flywheel energy storage.<br><br>***Thermal Energy Storage:*** Sensible heat storage; latent heat storage; thermo-chemical energy storage.<br><br>***Electrochemical Energy Storage:*** lead-acid batteries; lithium-ion batteries and beyond; molten-salt batteries; redox flow batteries; metal-air batteries.<br><br>***Chemical Energy Storage:*** hydrogen storage; liquid fuel storage. |

**Teaching/Learning Methodology**

1. The teaching and learning methods include lectures/tutorial sessions, homework assignments, test, case study report/presentation and examination.
2. The continuous assessment and examination are aimed at providing students with integrated knowledge required for energy storage technologies.
3. Technical/practical examples and problems are raised and discussed in class/tutorial sessions.

| Teaching/Learning Methodology | Intended subject learning outcomes to be assessed | | | |
|---|---|---|---|---|
| | a | b | c | d |
| 1. Lecture | ✓ | ✓ | ✓ | ✓ |
| 2. Tutorial | ✓ | ✓ | ✓ | |
| 3. Homework assignment | ✓ | ✓ | ✓ | |
| 4. Case study report and presentation | ✓ | ✓ | ✓ | ✓ |

**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. Test | 10% | ✓ | ✓ | ✓ | |
| 2. Homework assignment | 20% | ✓ | ✓ | ✓ | |
| 3. Case study report and presentation | 20% | ✓ | ✓ | ✓ | ✓ |
| 4. Examination | 50% | ✓ | ✓ | ✓ | |
| Total | 100% | | | | |

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

Overall Assessment:

**0.50 × End of Subject Examination + 0.50 × Continuous Assessment**

The continuous assessment consists of three components: homework assignments, interim 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.

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| **Student Study Effort Expected** | Class contact: | |
| | ▪ Formal lecture | 24 Hrs. |
| | ▪ Tutorial/case study | 15 Hrs. |
| | Other student study effort: | |
| | ▪ Self-study | 55 Hrs. |
| | ▪ Case study report preparation and presentation | 21 Hrs. |
| | Total student study effort | 115 Hrs. |
| **Reading List and References** | 1. Huggins R.A., *Energy Storage*, Springer, latest edition.<br>2. Dincer I. and Rosen M., *Thermal Energy Storage: Systems and Applications*, Wiley, latest edition.<br>3. Barnes F.S. and Levine J.G., *Large Energy Storage Systems Handbook*, CRC Press, latest edition.<br>4. Tarascon J.M. and Simon P., *Electrochemical Energy Storage*, Wiley-ISTE, latest edition.<br>5. Brun K., Allison T.C. and Dennis R., *Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems*, Academic Press, latest edition.<br>6. Sahoo U., *Energy Storage (Advances in Renewable Energy Series)*, Wiley-Scrivener, latest edition.<br>7. Jeguirim M., *Recent Advances in Renewable Energy Technologies*, Volume 1, Elsevier, latest edition.<br>8. Ting D. and Stagner J.A., *Compressed Air Energy Storage: Types, systems and applications*, The Institution of Engineering and Technology, latest edition.<br><br><u>*Journals*</u><br><br>• Journal of Energy Storage, Elsevier Science Ltd.<br>• Energy Conversion and Management, Elsevier Science Ltd.<br>• Energy, Elsevier Science Ltd.<br>• Applied Thermal Engineering, Elsevier Science Ltd.<br>• International Journal of Energy Research, John Wiley & Sons, Inc.<br>• IEEE Power & Energy Magazine, IEEE.<br>• Journal of Electrochemical Energy Conversion and Storage, American Society of Mechanical Engineers, USA. | |

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