ES2G6-15 Materials Technology for Sustainable Energy

25/26

Department
School of Engineering
Level
Undergraduate Level 2
Module leader
Nicholas Grant
Credit value
15
Module duration
10 weeks
Assessment
30% coursework, 70% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Energy efficiency is becoming ever more important as we seek to mitigate the effects and extent of global warming. While solar and wind generation are obvious replacements to traditional fossil fuel energy sources, there are a wealth of material technologies that can offer substantial advantages in terms of energy management. While it is unlikely that any single material can offer significant efficiency improvements, a sum of their parts could have a profound impact on how we manage energy in the future. Therefore in this module we will examine how a combination of materials technology can offer solutions to enhance energy storage, generation, deployment and even directionality. While we will explore more traditional materials for harvesting and storing energy (e.g. silicon/perovskite photovoltaics, lithium/sodium ion batteries), more emphasise will focus on the design, fabrication and deployment of metamaterials, a class of material that has been engineered to have properties that go beyond any material found in nature (e.g. cloaking).

Module aims

The principle aims of the module are to develop an understanding of sustainable materials technology, and how they can be used collectively to solve real world problems. Furthermore, the module aims to provide the foundations necessary to design, fabricate and deploy materials

technology for any given application.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

The following outlines a brief overview of the syllabus.

1. Energy: past & present
2. Identifying the problems
3. Conventional materials for sustainable energy
   i. Generation
   ii. Storage
   iii. Harvesting
4. Metamaterials for sustainable energy
   i. Generation
   ii. Storage
   iii. Harvesting
5. Designing materials for sustainable energy
6. Manufacturing materials
7. Deploying, controlling and maintaining materials
8. End of life and recycling

Learning outcomes

By the end of the module, students should be able to:

- Apply engineering principles, which include mathematics, statistics and natural science knowledge, to complex problems involving sustainable materials for energy generation and storage. [C1, M1]
- Analyse and evaluate the performance of materials for sustainable energy applications, and thus apply engineering principles and judgment to discuss limitations of the technology in the context of efficiency and sustainability. [C2, M2]
- Develop an ability to read technical papers/journals, and be able to critically evaluate the literature in order to derive new approaches for improving efficiency for any given materials technology, while also considering sustainability. [C4, M4]
- Be able to evaluate the environment and societal impacts for new materials technology. [C7, M7]
- Be able to select and apply appropriate materials, equipment, engineering technologies and processes to solve energy generation and storage problems for any given location, while considering their limitations. [C13, M13]
- Knowledge and understand of quality management, continuous improvement and control. [C14, M14]
- Ability to communicate effectively on materials technology using technical and non-technical language. [C17, M17]

Indicative reading list

(1) S. J. Dhoble, N. T Kalyani, B. Vengadaesvaran and A. K. Arof, 2021, Energy Materials: Fundamentals to Applications, Elsevier Science Publishing Co Inc, ISBN 9780128237106

(2) D. Sabba, 2018, Metamaterials and their Applications, Arcler Press, ISBN 9781773610535

(3) Y. Jaluria, 2018, Advanced Materials Processing and Manufacturing, Springer International Publishing A&G, ISBN 9783319769820

Subject specific skills

1. Plan and manage the design process, including cost drivers, evaluating outcomes, and working with technical uncertainty
2. Knowledge and understanding of the need for a high level of professional and ethical conduct in engineering and the use of technical literature, other information sources including appropriate codes of practice and industry standards
3. Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk, risk assessment and risk management techniques and an ability to evaluate commercial risk
4. Knowledge of professional codes of conduct, how ethical dilemmas can arise, relevant legal and contractual issues.

Transferable skills

1. Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions
2. Apply problem solving skills, information retrieval, and the effective use of general IT facilities
3. Communicate (written and oral; to technical and non-technical audiences) and work with others
4. Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
5. Exercise initiative and personal responsibility, including time management, which may be as a team member or leader
6. Awareness of the nature of business and enterprise in the creation of economic and social value
7. Overcome difficulties by employing skills, knowledge and understanding in a flexible manner
8. Ability to formulate and operate within appropriate codes of conduct, when faced with an ethical issue
9. Appreciation of the global dimensions of engineering, commerce and communication
10. Be professional in their outlook, be capable of team working, be effective communicators, and be able to exercise responsibility and sound management approaches.

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (13%)
Seminars	10 sessions of 1 hour (7%)
Other activity	2 hours (1%)
Private study	118 hours (79%)
Total	150 hours

Private study description

110 hours private study

Other activity description

2 x 1 hour Examples/revision/Examination Advice classes

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time	Eligible for self-certification
Mid-term QMP & Group presentation	30%		No
(a) 1 hr QMP test based on first half of module. (b) A 5min video recorded group presentation.			
Examination	70%		No
2 hour written examination to be done on campus.			

- Answerbook Pink (12 page)
- Students may use a calculator

Feedback on assessment

Exam advice class. • Briefly written feedback on group presentations. • Model solutions to past

papers. • Support through advice and feedback hours. • Examples clinics. • Cohort feedback on examinations.

Past exam papers for ES2G6

Availability

Courses

This module is Core for:

- Year 2 of UESA-H315 BEng Mechanical Engineering
- UESA-H316 MEng Mechanical Engineering
    - Year 2 of H315 Mechanical Engineering BEng
    - Year 2 of H316 Mechanical Engineering MEng

This module is Optional for:

- Year 2 of UESA-H113 BEng Engineering
- UESA-H112 BSc Engineering
    - Year 2 of H112 Engineering
    - Year 2 of H112 Engineering
- Year 2 of UESA-H114 MEng Engineering