MS4664: Environmental Sustainability and Materials

Academic Year	2023-24	Semester	2
Course Coordinator	Andrew Clive Grimsdale		
Course Type	MPE/UE/BDE		
Pre-requisites	Pre-ICC Students: MS1013 Materials Chemistry I ICC Students: MS1013 Materials Chemistry I MS1017 Introduction to Materials Science		
AU	3		
Grading	Letter Grading		
Contact Hours	Lectures 26 hours Tutorials 13 hours.		
Proposal Date	15 December 2023		

Course Aims

The objectives of this course are to introduce you to the environmental aspects of materials, and the role materials engineers play in building a sustainable environment, including topics such as the principles of green design, industrial ecology, product life cycle assessment, and relevant materials research for environmental and energy applications.
This course will be helpful to students intending to specialize in environmentally conscious product design and manufacturing processes involving the usage of modern materials.

Intended Learning Outcomes (ILO)

1. Understand the broad principles of environmental engineering.
2. Understand the environmental impacts of materials and chemical processing.
3. Evaluate and critically assess environmental life cycles of various materials.
4. Evaluate and describe advanced material usage in energy and environmental applications.

Course Content

No	Topic	Hours
1	Introduction to environmental issues and sustainability	3
2	The essential natural environmental cycles	3
3	Carbon cycle and climate change	3
4	Environmental remediation – Soil and Water	3
5	Sustainable concepts for food production	3
6	Competing energy sources	3
7	Renewable energy sources	3
8	Energy transport and storage	3
9	Materials life cycles, life cycle analyses, and eco-audits 1	3
10	Materials life cycles, life cycle analyses, and eco-audits 2	4
11	Case studies and materials selection 1	4
12	Case studies and materials selection 2	4
	Total	**39**

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. Assignment 1: Written Assignment and Presentation	1-4	a,b	20%	Team or Individual	Appendix 1 and 3
2. Assignment 2: Report and Presentation	1-4	a, b, g	20% Report 10% in Team and Presentation 10% individual	Team & Individual	Appendix 1, 2, and 3
3. Continuous Assessment: Quiz 1	1-4	a,b	20%	Individual	N.A. (Standard test)
4. Final Examination (1 hr)	1-4	a, b, g	40%	Individual	
Total			**100%**		

Description of Assessment Components

CA: Quiz 1

You will have to complete a 35-minutes quiz. Your instructors will explain the details in due time.

Assignment 1: Written Assignment and Presentation

You will have to submit an individual or group (depending upon class size) written assignment and present their assignment. Your instructors will explain the details in due time.

Assignment 2: Report and Presentation

In groups, you will have to complete a report and present your assignment. Your instructors will explain the details in due time.

Final Examination (1 hr)

You will have to complete a 1-hour Close Book Exam examination for this course. The exam will be held according to NTU examination policy.

EAB Graduate Attributes[1]	
a)	**Engineering Knowledge** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation as specified in WK1 to WK4 respectively to the solution of complex engineering problems.
b)	**Problem Analysis** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c)	**Design/Development of Solutions**

[1] *Reference: EAB Accreditation Manual*

	Design solutions for complex engineering problems and design systems, components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d)	**Investigation** Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e)	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering problems, with an understanding of the limitations.
f)	**The Engineer and Society** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.
g)	**Environment and Sustainability** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.
h)	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i)	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j)	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k)	**Project Management and Finance** Demonstrate knowledge and understanding of engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l)	**Life-long Learning** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Formative Feedback

Describe how you would be giving feedback to students on how they are learning in this course.

- Feedback will be provided to the students on their approaches, common mistakes, and other general issues;
- Class average marks will be posted. Each of you will also be informed of your CA marks;
- A general feedback on your performance in final examination will also be provided after the release of final exam results.

Learning & Teaching Approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures with embedded self-checking quizzes	The quizzes allow you to check whether you have mastered key concepts taught in the lectures. It is designed to help you master basic terms, concepts and principles at your own pace.
Face-to-face tutorials with discussion components	In the tutorials, after briefly going through tutorial question solutions, tutors will pose questions, which are typically based on the tutorial solutions, to spark discussion. These questions can help to further clarify important concepts/principles covered in lectures, and cultivate critical thinking.

Readings & References

Textbook
Michael Ashby, *Materials and the Environment*, Butterworth-Heinemann, **2013**

References

1. Edward S. Rubin, *Introduction to Engineering and the Environment,* McGraw Hill, 2001.
2. Myer Kutz, *Environmentally Conscious Materials and Chemicals Processing*, Wiley, 2007
3. Rolando M.A. Roque-Malherbe, *The Physical Chemistry of Materials : Energy and Environmental Applications*, CRC Press, 2010

Course Policy & Student Responsibility
For CAs, all non-attendance must be supported by a medical certificate or other valid official documents.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognise your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain about the definitions of any of these terms, you should refer to the Academic Integrity Handbook for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

On the use of technological tools (such as Generative AI tools), different courses/assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help their learning.

Course Instructors

Instructor	Office	Phone	Email
Andrew Clive Grimsdale	N4.1-01-13	6790 6728	acgrimsdale@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/Activities
1	Introduction to environmental issues and sustainability	1	Lecture
2	The essential natural environmental cycles	1	Lecture & Tutorial 1
3	Carbon cycle and climate change	1	Lecture & Tutorial 2
4	Environmental remediation – Soil and Water	1,2	Lecture & Tutorial 3
5	Sustainable concepts for food production	1,2	Assignment 1
6	Competing energy sources	2	Assignment 1
7	Renewable energy sources	2-4	Assignment 1 presentations
8	Energy transport and storage	2-4	Assignment 1 presentations
9	Materials life cycles, life cycle analyses, and eco-audits 1	2-4	Lecture & Tutorial 4
10	Materials life cycles, life cycle analyses, and eco-audits 2	3-4	Lecture & Tutorial 5
11	Case studies and materials selection 1	3-4	Assignment 2 presentations
12	Case studies and materials selection 2	3-4	Assignment 2 presentations
13	Continuous Assessment	3-4	