ANNEX A

MSE4622 Composite Materials

Academic Year	2023	Semester	2
Course Coordinator	Yu Jing		
Course Type	MPE/ UE/ BDE		
Pre-requisites	MS2013 Introduction to Polymer Science		
AU	3		
Grading	Letter Grading		
Contact Hours	Lecture 26 hours, Tutorials 13 hours		
Proposal Date	14 December 2023		

Course Aims

Composite materials are multi-phase materials obtained by artificial combination of different materials so as to attain properties that the individual components by themselves cannot attain. The physical and chemical properties of composites strongly depend not only on their compositions but also on their structure, morphology, phase, shape, size, distribution, and spatial arrangement.

The main objective of this course is not only to enlarge your knowledge in functional composite materials, which includes their structural/traditional, thermal, electrical, electromagnetic, thermoelectric, electromechanical, dielectric, magnetic, optical, electrochemical and biomedical properties, but also to empower the students with the skills needed for the design, manufacture and analysis of composite materials from a material scientist's viewpoint.

Intended Learning Outcomes (ILO)

By the end of this course, student will be able to:

1. Articulate the basic concepts and types of composite materials with examples.
2. Describe basic concepts of the composite matrix (polymer, metal, and ceramic) with pros and cons.
3. Classify the different fiber types and fiber spinning processes.
4. Explain how different types of bonding affect the interfaces.
5. Apply knowledge to explain the behavior of unidirectional composites.
6. Classify the types of metal matrix composites and respective processes.
7. Explain the processing of ceramic matrix composites.
8. Describe the basic processes to fabricate polymer matrix composites.
9. Evaluate various nanocomposites based on their applications.
10. Reflect the concept of biomaterials (biocomposites, biofiber, etc.) to discuss future market opportunities.

Course Content

No	Topic	Hours
1	Introduction to composite materials	3
2	Matrix materials	4
3	Reinforcement	4
4	Interfaces	4
5	Mechanical properties of composite materials	4
6	Polymer based composites	4
7	Metal matrix and ceramic matrix composites	4
8	Carbon based composites and nanocomposites	4
9	Biocomposites	4
10	Functional composite materials	4
	Total	**39**

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. Continuous Assessment 1 (CA1): Quiz	1 to 10	(b) Problem analysis	20%	Individual	N.A. (Standard test)
2. Continuous Assessment 2 (CA2): Quiz	1 to 3	(a) Engineering knowledge and (b) Problem analysis	20%	Individual	N.A. (Standard test)
3. Continuous Assessment 3 (CA3): Quiz	4 to 6	(c) Designing /development of solutions	20%	Individual	N.A. (Standard test)
4. Final Examination (1hr – Close Book Exam)	7 to 9	(b) Schematic Essay: Design Composite Materials	40%	Individual	N.A. (Standard test)
Total			**100%**		

Description of Assessment Components
Continuous Assessment 1 (CA1): Quiz
You will have to complete 1 hour quiz. Your instructors will explain the details in due time.

Continuous Assessment 2 (CA2): Quiz
You will have to complete 1 hour quiz. Your instructors will explain the details in due time.

Continuous Assessment 3 (CA3): Quiz
You will have to complete 1 hour quiz. Your instructors will explain the details in due time.

Final Examination (1hr – Close Book Exam)
You will have to complete 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** 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**

[1] *Reference: EAB Accreditation Manual*

	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.

- CA questions are thoroughly discussed in the class;
- Feedback will be provided to the students on their approaches, common mistakes, and other general issues;
- Class average marks will be posted. Each student will also be informed of his/her CA marks;
- Students are encouraged to drop by coordinator's office during the consultation hours to browse through their papers and discuss any issues, if needed.
- A general feedback on students' 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?
Conceptual understanding	As this course is a key course that relates the composite materials, in particular, to properties, there will be a lot of emphasis on fundamental understanding of the concepts and self-directed learning. Though lecture notes are provided to students, they are encouraged to refer different books and the self-assessment questionnaires are designed to test the students' critical understanding of the subject. Also, the systematic approach of starting at the basics of various composite materials and relating to processing methods, physiochemical characteristics and finally the applications using each characteristics of materials will help students in achieving a comprehensive understanding of the structure-property relationships.
Showing real-world applications	Most of the concepts that are dealt in the course have real-world implications and applications. Therefore, they are used as examples while discussing the related concepts.
Use of Multimedia tools to teach abstract	Multimedia tools such as videos and animations have been prepared exclusively for this course to help students better understand the contents.

concepts and complex processes	E-books with interactive images and videos are available for the students to download.
Face-to-face discussion sessions	For most part of the course, tutorials are replaced with discussion sessions that are designed to check and reinforce the students' understanding of various concepts. The questions posed during the discussion sessions will further clarify important concepts/principles covered in lectures and cultivate critical thinking.

Readings & References

- Krishan K. Chawla, Composite Materials. 2nd Edition, Springer Press, 2001.
- Deborah D. L. Chung, Composite Materials: Science and applications, Springer, 2004.
- Harsuo Ishida Characterization of composite materials, Butterworth Heinemann, 1994.
- Navin Chand and Mohammed Fahim, Tribology of natural fiber polymer composites, CRC Press, 2008.

Course Policy & Student Responsibility

(1) CA

Absentees 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 your learning.

Course Instructors

Instructor	Office	Phone	Email
Yu Jing	N 4.1-01-08	6790 4033	yujing@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/Activities
1	Introduction to composite materials	1	Lecture
2	Matrix materials	2	Lecture & Tutorial
3	Reinforcement	3	Lecture & Tutorial
4	Interfaces & CA 1 (1 hr)	1-3, 4	Lecture
5	Mechanical properties of composite materials	5	Lecture & Tutorial
6	Polymer based composites	6	Lecture & Tutorial
7	Metal matrix and ceramic matrix composites	7	Lecture & Tutorial
	Recess Week	NA	NIL
8	CA2 (1 hr)	4-7	Lecture
9	Carbon based composites and nanocomposites	8	Lecture & Tutorial
10	Biocomposites	9	Lecture & Tutorial
11	Functional composite materials	10	Lecture & Tutorial
12	CA3 (1 hr)	8-12	Lecture