Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	AY2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Assoc Prof Aravind Dasari
Course Author Email	aravind@ntu.edu.sg
Course Title	Environmental & Thermal Degradation of Polymeric Materials
Course Code	MS7440
Academic Units	2
Contact Hours	26
Research Experience Components	

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This module, while reinforcing the fundamentals of students in the areas of environmental and thermal degradation of polymeric materials, takes a step further by connecting with the practical applications and case studies. As an extension to the topic on degradation, fundamentals of polymer combustion and flame retardancy behaviour of polymers will also be introduced to the students. These topics provide the students with an opportunity to link many concepts they have learnt in different modules during their undergraduate education.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Understand the limitations of different polymeric materials when exposed to environmental conditions.
ILO 2	Predict the type of degradation of different polymers that they might undergo when exposed to environmental conditions.
ILO 3	Elaborate on the importance of existing standards and their significance with respect of new materials.
ILO 4	Understand the various protection methodologies used to guard against environmental degradation, particularly photodegradation.
ILO 5	Explain the basics of polymer combustion and the different approaches that are available to make them flame retardant.
ILO 6	Understand the different case studies presented and apply those concepts in other case studies.

Course Content

- Introduction and applications that demand environmental durability and thermal stability of polymers
- Environmental degradation in polymers and associated mechanisms
    - Hydrolysis
    - Oxidative and photolytic degradation
    - Environmental stress cracking
    - Bacterial and fungal degradation
    - Pro-degradation
    - Kinetics of degradation
- Macroscopic consequences of environmental degradation
- Protection against environmental degradation
- Standards that govern the durability processes
- Importance of different thermophysical properties
    - Thermal conductivity
    - Thermal diffusivity
    - Heat capacity
    - Thermal expansion
    - Thermal degradation and thermo-oxidative stability
- Polymer combustion and basics of flame retardancy

Reading and References (if applicable)

There are plenty of textbooks, reference chapters and peer-reviewed articles available on this field. Explore the library and library databases! Some key books are listed below for you to get going.

- Handbook of UV Degradation and Stabilization, George Wypych, ChemTec Publishing, 2010, ISBN-13: 978-1895198461, ISBN-13: 978-1895198461
- Degradable Polymers: Principles and Applications, G. Scott, Kluwer Academic Publishers, ISBN-13: 978-9048160914
- Engineering Heat Transfer, 3rd Edition, William S Janna, CRC press, 2009
- Heat and Mass Transfer: Fundamentals and Applications, YA Cengel and AJ Ghajar, McGraw Hill, 2011 (Chapters 1 and 2).
- Fire Retardancy of Polymeric Materials, Charles A. Wilkie, Alexander B. Morgan (Ed.), CRC Press, 2009, ISBN: 1420084003

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction and importance of environmental durability and thermal stability of polymers	1	See the listed text books and course slides	In-person	Class debate (physical)
2	Mechanisms of degradation of polymers with examples	1, 2	See the listed text books and course slides	In-person	Consultation and discussions (physical)
3	Consequences of environmental degradation and protection methodologies	1, 2, 4, 6	See the listed text books and course slides	In-person	First Case study discussion (Physical)
4	Importance of Standards that govern the durability processes, and thermophysical properties	1 to 3, 4	See the listed text books and course slides	In-person	Class discussions and Group Projects
5	Combustion of polymeric materials – 1	5	See the listed text books and course slides	In-person	Consultation and discussions (physical)
6	Combustion of polymeric materials - 2	5, 6	See the listed text books and course slides	In-person	Discussion on second case study (physical)

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
7	Group Projects	6	Library databases	In-person	Meeting the individual groups and assessing their projects (Case study: Progress / Mid-term assessment)
8	Students to work on their projects	6	Library databases	In-person	Discussions on project work
9	Students to work on their projects	6	Library databases	In-person	Discussions on project work
10	Continuous Assessment 1 (CA1)	1 to 5	N/A	In-person	Continuous Assessment 1 (CA1)
11	Students to work on their projects	6	Library databases	In-person	CA discussion
12	Final Group Presentations	6	Library databases	In-person	Case study: Final Presentation

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Conceptual understanding	This course emphasizes the fundamental understanding environmental durability and thermal stability of polymeric materials. This conceptual understanding is expected to help in evaluating the service-life of materials. There will be a lot of emphasis on fundamental understanding of the concepts and self-directed learning. Students are encouraged to refer different books and literature while exploring case studies.
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.
Face-to-face discussion sessions	To complement online lecture videos, face-to-face discussion sessions are also arranged that are designed to check and reinforce the students' understanding of various concepts. The discussion sessions will further clarify important concepts/principles covered in lectures, and cultivate critical thinking.
Case study discussions	Three different case studies will be discussed (physical sessions) to connect the concepts discussed in the course to practicality; Biweekly

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Conceptual understanding of the topics)	1 to 5		15	Individual	Holistic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(Continuous Assessment 1 (CA1))	1 to 5		35	Individual	Holistic	Multistructural
3	Continuous Assessment (CA): Presentation(Case study: Progress / Mid-term assessment)	6, supplemented by 1-5		10	Individual	Holistic	Relational
4	Continuous Assessment (CA): Report/Case study(Case study: Progress / Mid-term assessment)	6, supplemented by 1-5		5	Team	Holistic	Relational
5	Continuous Assessment (CA): Presentation(Case study: Final Presentation)	6, supplemented by 1-5		15	Individual	Holistic	Relational
6	Continuous Assessment (CA): Report/Case study(Case study: Final Presentation)	6, supplemented by 1-5		20	Team	Holistic	Relational

Description of Assessment Components (if applicable)

- Conceptual understanding of the topics: This assessment includes online short questions after every lecture topic. The format of the questions vary between MCQs, identification, fill-in-the-blanks, etc.
- Continuous Assessment 1 (CA1): This is an in-person (physical) exam. This will contain short answer questions, problems and critique/analysis based questions.

- Case study: Progress / Mid-term assessment: The deliverable here is a write-up and presentation.
- Case study: Final: Besides the final presentation, the students are required to submit a final report.

Formative Feedback

- Class room discussions will facilitate formative feedback on any of the concepts or questions that students might have regarding the topics that were discussed online.
- Case studies will provide an opportunity to understand the forensic processes involved, and the depth of details to look into while working on their group projects.
- CA formative feedback will be provided through verbal sharing on common mistakes.
- While doing the mid-review of group projects, thorough verbal feedback will be provided to the individual groups on how they can improve the case study.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Collaboration	Intermediate
Communication	Advanced
Problem Solving	Intermediate
Information Literacy	Intermediate
Critical Thinking	Intermediate

Course Policy

Policy (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 recognize 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 of the definitions of any of these terms, you should go to the academic integrity website for more information. 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. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities will support your learning. Absence from class without a valid reason may affect your grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

Policy (Others, if applicable)

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