Annex A

3. GE NEW COURSE CONTENT

Academic Year	AY2023-2024	**Semester**	1
School/Programme	School of Materials Science and Engineering Doctor of Philosophy (MSE)		
Course Coordinator	Professor Hu Xiao		
Course Code	MS7480		
Course Title	Polymer Properties, Design and Sustainability		
Pre-requisites	Students are recommended to have previously taken undergraduate courses with content based on basic polymer and/or organic chemistry.		
No of AUs	1		
Contact Hours	13		
Proposal Date ***i.e. date proposal was drafted***	29 November 2022		
Expected Implementation date of new/revised course	AY2023-2024 Semester 1		
Suggested Class Size	50		
Any cross-listing? ***Is course opened to all Postgraduate students (including IGP) or specific program (please indicate)?***	Master of Engineering (MSE) Master of Science (MSE) Doctor of Philosophy (IGP) Students from the above-stated programmes are not required to seek approval from MSE to be registered for the course.		

Course Aims

This course aims to introduce industrially important polymer products (e.g., polyolefins, vinyl polymers, rubbers, polyesters, polyamides, polyurethanes, and epoxy and phenolic thermosets), their properties and design principles, and potential sustainability. The audience should be graduate students in Materials Science, Chemical Engineering, and Chemistry. The knowledge from this course will get them well-prepared for the industrial career, and stimulate their creativity in designing better products.

Intended Learning Outcomes (ILO)

By the end of this course, you should be able to:

1. Understand the working principles of existing polymer products on the market.
2. Learn the design principles of these polymer products.
3. Design new polymer products to replace existing non-polymeric materials, such as metals, ceramics, glasses, etc.
4. Consider polymer sustainability and end of life analysis.

Course Content

Overview

This course adapts a unique approach to introduce polymer engineering. The emphasis is on correlating polymer structures and architecture with physical properties, which in turn enable the design of various commercial polymer products. Ample examples and case studies will be given from which principles can be drawn concerning molecular design, structure-property relationships

and product design rationale of both commodity and engineering polymers. Aspects of polymer circularity and sustainability will also be discussed.

Course Content

I. Introduction
   1. Course instructors
   2. Course structures
   3. Course overview and schedules
   4. Professional ethics practices

II. Polyester products and design
   1. PET families (drink bottles, textiles, multilayer reflection films, film capacitors)
   2. Polycarbonates (shock-proof windows, car parts, medical containers)
   3. Liquid crystalline polymers (5G flexible PCBs, high-performance electronics)
   4. Unsaturated polyesters (the world largest thermoset for all kinds of products)

III. Polyamide products and design
   1. Aliphatic polyamides (daily goods, stocking, brushes, nanocomposites)
   2. Semi-aromatic polyamides (transparent parts, automobile parts)
   3. Aromatic polyamides (firefighter suits and bullet-proof vests)
   4. Polyimides (flexible PCBs)

Assessment (includes both continuous and summative assessment)

Note: It is advised that Group component and class participation should not be more than 40% and 20% respectively, unless with good justification.

Component	**ILO Tested**	**Weighting**	**Team/Individual**	**Assessment Rubrics**
1. Continuous Assessment 1 (CA1): Quiz and/or Assignment	1, 2, 3, 4	40%	Individual	NA
2. Continuous Assessment 2 (CA2): Final Quiz and/or Final Assignment	1, 2, 3, 4	60%	Individual	NA
Total		100%		

The main content of this course is to link commercially important polymers to their corresponding industrial or consumer products. The treatment of lecturing classes is descriptive and non-quantitative. Accompanying the lecturing classes, students are given a significant number of relevant video clips on how some of these products are manufactured. Therefore, no final examination is proposed for the assessment for this course.

Formative feedback

Feedback is central to this course. Students will receive written and/or verbal feedback from the instructors about their quizzes/assignments. For those in need, one-on-one feedback may be given either face to face or via teleconference.

Learning and Teaching Approach

Note: Please include and indicate TEL component.

Approach	How does this approach support you in achieving the learning outcomes?
Blended learning with active use of multi-media resources such as selected video clips (TEL). Other TEL components may include online interactions between instructors and students, and among students via NTULearn, etc.	This will permit flexibility of access to learning materials, activities and assessments and can help you develop independent learning and critical thinking skills.
Group Work	This will provide opportunity for students to learn from one another and to become active participants in their learning. Group based work helps students develop skills valued by employers (such as problem solving, negotiation, conflict resolution, leadership, critical thinking, and time management).

Reading and References

1. D. Feldman and A. Barbalata, Synthetic Polymers: Technology, Properties, Applications; Chapman & Hall: London, 1996.
2. Polymer Data Handbook, 2nd ed. Edited by James E. Mark (University of Cincinnati, OH). Oxford University Press: New York. 2009.
3. Physical Properties of Polymers, 3rd ed. By James E. Mark, et al. Springer: New York, 2007.

(Optional textbooks – these books can be used as a general reading material, and you are not required to purchase it. If you need the book, you can borrow through library.)

Course Policies and Student Responsibilities

(1) General

Students are expected to complete all assigned pre-class readings and activities, attend all seminar classes punctually and take all scheduled assignments and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements for seminar sessions they have missed. You are expected to participate in all seminar discussions and activities.

(2) Absenteeism

In principle, absence from class without a valid reason will affect your overall course 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. However, for online courses, the progress will be auto-tracked by the online portal on students' participation.

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. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Dr Zhu Lei	N/A	N/A	lxz121@case.edu
Professor Hu Xiao	N4.1-01-28	67904610	asxhu@ntu.edu.sg

Industry Participation

Company Name	Description of involvement (e.g., co-curation of course, speaker or instructor), include no. of course hours if known.	Contact Person	Email
Case Western Reserve University	Co-instructor, co-curation of course materials	Dr Zhu Lei	lxz121@case.edu
TBC	Company visits and invited industrial speakers to discuss topics such as sustainable ways of design, fabrication, use, handling, and waste recycling of polymer-based products. Two companies that are likely to be directly involved are PT Thias Sentosa, which is one of the largest multilayer food packaging materials converters, and RGE or Royal Golden Eagle, which is the world largest viscose manufacturer. Other companies such polyurethane manufacturer COIM and selected university spin-offs may also be involved.	TBC	TBC

Planned Weekly Schedule

Week	Topic	ILO	Readings/ Activities
1	Overview	1, 2, 3, 4	No reading
2	Introduction and PET polyesters	1, 2, 3, 4	No reading
3	Polycarbonates and LCPs	1, 2, 3, 4	Lecture note
4			
5	Unsaturated polyesters	1, 2, 3, 4	Lecture note
6			
7	Aliphatic polyamides	1, 2, 3, 4	Lecture note
8			
9	Semi-aromatic and aromatic polyamides	1, 2, 3, 4	Lecture note
10			
11	Polyimides	1, 2, 3, 4	Lecture note
12			
13	Final Quiz and/or Final Assignment	1, 2, 3, 4	N/A