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

Course Overview

Expected Implementation in Academic Year (New format)	AY2022-2023
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Lee-Chua Lee Hong
Course Author Email	clhlee@ntu.edu.sg
Course Title	Environmental Systems Analysis
Course Code	EN4002
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	Year 3 Standing
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This course aims at describing the human-environment interactions and environmental repercussions of defined human activities. The course combines qualitative, quantitative and transdisciplinary analysis of environmental issues including air quality, water quality, waste, energy and resource management. It integrates knowledge from natural, social and engineering sciences, which is further developed into cost-benefit analysis, environmental risk assessment and systems management strategies. The course covers environmental assessment tools and methods including life cycle assessment (LCA), material flow analysis (MFA), environmental risk assessment (ERA), strategic environmental assessment, cost-benefit analysis (CBA), and topics of emerging interest. You will be able to apply these concepts and methods/tools for the various environmental systems. This course covers several fundamental concepts that will reinforce your learning of other environmental engineering and sustainability courses in the aspects of analyzing and solving complex problems.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Describe how environmental pollution including air, water, solid waste and industrial hazards is formed during industrial or other anthropological processes.
ILO 2	Conduct life cycle assessment (LCA) and material flow analysis (MFA) for different industrial processes.
ILO 3	Conduct environmental risk assessment (ERA) for different human activities.
ILO 4	Analyze emerging issues of environmental concern and identify potential solutions.
ILO 5	Conduct investigations of complex environmental issues using research-based knowledge and methods.

Course Content

S/N	Topic	Lecture Hrs	Tutorial Hrs
1.	Integrated environmental issues: water, air, soil, industrial waste and environmental impacts	6	0
2.	Material flow analysis (MFA)	2	0
3.	Life cycle assessment (LCA)	4	0
4.	Cost benefit analysis (CBA)	3	0
5.	Environmental site assessment (ESA)	3	0
6.	Environmental risk assessment (ERA)	3	0
7.	Industry ecology and eco-industrial parks	2	0
8.	Special topics	6	0
9.	Quizzes and project	10	0
	Total:	39	0

Reading and References (if applicable)

Text: Nil

References:

Lecture materials by individual instructors

Recommended journal papers and reports by individual instructors

Canter L.W. (1997). Environmental Impact Assessment, McGraw-Hill

Masters, G.M. and Ela, W.P, (2008). Introduction to Environmental Engineering and Science, Prentice Hall

Davis, M.L. and Cornwell, D.A. (2008). Introduction to Environmental Engineering, McGraw-Hill

Joseph Cascio, Gayle Woodside and Philip Mitchell (1996). ISO 14000 Guide: The New International Environmental Management Standards, McGraw-Hill

W.Lee Kuhre (1995). ISO 14001 Certification: Environmental Management Systems, Prentice Hall

S.E. Manahan Industrial Ecology (1999). Environmental Chemistry and Hazardous Waste, Lewis Publishers

T.E. Graedel and B.R. Allenby (2010). Industrial Ecology and Sustainable Engineering, Prentice Hall

Klopffer, Walter (2014). Background and Future Prospects in Life Cycle Assessment.

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Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Integrated environmental issues: water, air, soil, industrial waste, environmental impacts	1	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
2	Integrated environmental issues: water, air, soil and industrial waste	1	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
3	Material flow analysis (MFA); Life cycle assessment (LCA)	2	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
4	Life cycle assessment (LCA)	2	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
5	Cost-benefit analysis (CBA)	2	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
6	Environmental site assessment (ESA)	1, 3	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
7	Environmental risk assessment (ERA), Quiz	3	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
8	Industry ecology and ecoindustrial parks	1, 2	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
9	Special topics	4	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
10	Special topics	4	In-person		Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials
11	Project work discussion and Quiz	5	In-person		
12	Project presentations	5	In-person		
13	Project presentations	5	In-person		

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lecture	Conduct 3 hours of TEL-based or normal lectures or open interactions per week for 11 weeks.
Quizzes	The first quiz will be conducted after 50% of lectures are covered, while the second quiz will be conducted after 100% of lectures are covered.
Projects	The projects will be conducted after 100% of the lectures are covered.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(CA1: Quiz)	1,2,3,4	ENE SLOs* a, b ,c ,e ,g	30		Individual	Analytic	Relational
2	Continuous Assessment (CA): Test/Quiz(CA2: Quiz)	1,2,3,4	ENE SLOs* a, b ,c ,e ,g	30		Individual	Analytic	Relational
3	Continuous Assessment (CA): Project(Group Project)	4,5	ENE SLOs* a, b ,c ,d ,e ,g, i, j	40		Team	Holistic	Relational

Description of Assessment Components (if applicable)

Notes: The group project assessment for this course is also reliant on you working closely as a team to complete the project. Hence, the Modification Factor (MF) will be applied to account for your individual contribution to the group project work. The MF is derived from panel judges' feedback, weekly discussion session and peer assessment. For more details on the MF calculation, please see Appendix 2.

* ENE SLOs stands for the Student Learning Outcomes (2018) of B.Eng (Environ Eng) program.

a) Engineering knowledge: Apply the knowledge of mathematics, natural science, engineering fundamentals, and environmental engineering specialisation to the solution of complex environmental engineering problems.

b) Problem Analysis: Identify, formulate, research literature, and analyse complex environmental engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) Design/development of Solutions: Design solutions for complex environmental engineering problems and design system components or processes with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

d) Investigation: Conduct investigations of complex problems using research-based knowledge and 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 environmental engineering activities with an understanding of the limitations.
f) The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and the need for the sustainable development.

h) Ethics: Apply ethical principles and commit to professional and moral responsibilities in the environmental 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 environmental engineering activities with the engineering community and with society at large, be able to comprehend and write effective reports and design documentation, and make effective presentations.

k) Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to work, as a member and leader in a multidisciplinary team.

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 evolution.

Formative Feedback

Two quizzes will be conducted. You will be given your scores and discussion on the questions and solution will be provided if permitted.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Care for Environment	Advanced
Care for Society	Intermediate
Global Perspective	Advanced
Transdisciplinarity	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)

Policy (Absenteeism)

The Quizzes are conducted during regular lecture sessions, which is a form of in-class activities. Absence from Quizzes without a valid reason will result in zero mark. Valid reasons include falling sick supported by a genuine 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)

This course will adopt NTU's policy on the use of AI for take-home assignments and reports, and project reports and presentation slides. More details could be found via the link https://entuedu.sharepoint.com/sites/Student/dept/ctlp/SitePages/Exploring-the-Impact-of-Generative-Artificial-Intelligence-(GAI)-Tools-on-Education.aspx#1-proper-citations-and-acknowledgements

Last Updated Date: 07-05-2026 16:25:57

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