COURSE CONTENT

Academic Year	AY2022/23	**Semester**	2
Course Coordinator	Prof. Lim Teik Thye		
Course Code	EN4002		
Course Title	Environmental Systems Analysis		
Pre-requisites	Year 3 Standing		
No of AUs	3		
Contact Hours	Lecture (39 hrs); Tutorial (0 hr); Laboratory (0 hr)		
Proposal Date	05 Feb 2022		

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.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

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

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team / Individual	Assessment rubrics
1. Continuous Assessment 1 (CA1): Quiz	1,2,3,4	ENE SLOs* a, b, c, e, g	30%	Individual	-
2. Continuous Assessment 2 (CA2): Quiz	1,2,3,4	ENE SLOs* a, b, c, e, g	30%	Individual	-
3. Group Project	4,5	ENE SLOs* a, b, c, d, e, g, i, j	40% x MF (Teams 28%; Individual 12%)	Team & Individual	Appendix 1 & 2
Total			100%		

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.

Learning and Teaching approach

Approach	**How does this approach support students 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.

Reading and References

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. Springer Verlag

Course Policies and Student Responsibilities

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.

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
Prof Lim Teik Thye	N1-01b-47	+65 67906933	cttlim@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings / Activities
Week 1	Integrated environmental issues: water, air, soil, industrial waste, environmental impacts	1	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 2	Integrated environmental issues: water, air, soil and industrial waste	1	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 3	Material flow analysis (MFA); Life cycle assessment (LCA)	2	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 4	Life cycle assessment (LCA)	2	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 5	Cost-benefit analysis (CBA)	2	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 6	Environmental site assessment (ESA)	1,3	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 7	Environmental risk assessment (ERA), Quiz	3	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Recess week			
Week 8	Industry ecology and eco-industrial parks	1,2	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 9	Special topics	4	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 10	Special topics	4	Course materials by instructors; ppt as the main reading material and reference materials as supplementary materials.
Week 11	Project work discussion and Quiz	5	NA
Week 12	Project presentations	5	NA
Week 13	Project presentations	5	NA

Appendix 1: Rubrics for Group project marking

Please note that in most cases, you will receive the same score as your team. However, your score may vary if there are evidence that you did not contribute equally to the team.

The mark range indicated are for each criterion which will be marked out of 40 marks each and rescaled to the weightage allocated.

Criteria	Good (>30)	Ave (24-30)	Fair (16-23)	Poor (<16)	Remarks
Report – Introduction on Background (15%)					Brief background; well defined problem; clear objectives
Report – Approaches or Mitigation Measures (20%)					A balanced summary of approaches or measures to tackle the problem
Report - Conclusions and References (10%)					Clear and concise; proper and well-formatted in-text citations and the list of references
Presentation – PPT Slide Content (10%)					Clear and concise; minimal language mistakes with appropriate Tables//Figures
Presentation – Teamwork (15%)					Good coordination between the team members. Good transitions and connections between slides. Well pace and finish on time
Presentation - Individual Contribution (15%)					Able to present and answer questions clearly and correctly
Individual - Variable Components (15%)					Class activities, contributions to group
TOTAL					

Appendix 2: Criteria for Peer Assessment to obtain Multiplication factor (MF)

Criteria	Outstanding: 4	Good: 3	Average, meet expectation: 2	Below expectations: 1
Collaborative behaviour	Cooperative and always delivered assigned tasks on time. Take initiative to help other to ensure success of team project.	Cooperative and always delivered assigned tasks on time. Willing to assist others upon request.	Stop short at delivering assigned tasks, sometimes after reminder(s).	Uncooperative, non-committed, always miss deadlines.
Quality of works	Quality of works higher than overall group quality, or go extra miles to assist teammate to enhance the quality of group works.	Good quality of deliverables under individual responsibility.	Acceptable quality of deliverables under individual responsibility.	Quality of works not acceptable.
Ideas & participations	Active participation and initiatives, good ideas & suggestions in enhancing the quality of group works.	Contributed suggestions and ideas to enhance the quality of group works.	Somewhat contributed in enhancing the quality of group works.	Did not participate in group works.

Average Peer Assessment Score	MF
3.51 to 4.00	1.05*
3.01 to 3.50	1.00
2.51 to 3.00	0.95
2.00 – 2.50	0.9
Below 2.0	Separate Assessment

Note: * - The moderated score will be cap at 100%

Peer assessment exercise will be anonymous and done towards the end of the semester.

For student who has average peer assessment score below 2.0, Course Coordinator might contact/call up the student as well as the other team member(s) to further assess the appropriate MF.

In addition to peer assessment, MF will be moderated by Course Coordinator and panel judges from the interaction during consultation, and feedbacks from the team members.