MS4665 Sustainable Development in Water, Agriculture and Aquaculture

Academic Year	AY 2023-2024	Semester	2
Course Coordinator	Michael Tam		
Course Type	MPE/UE/BDE		
Pre-requisites	NIL		
AU	2		
Grading	Letter Grading		
Contact Hours	26 hours		
Proposal Date	28 November 2023		

Course Aims

In this prescribed elective, students will be introduced to critical industrial sectors, namely water, agriculture and aquaculture, where sustainable development concepts that integrate these three sectors will be discussed. The students will learn key concepts on water, agriculture and aquaculture, and how materials science and engineering can be applied to manage and advance these sectors in a sustainable manner. The course will integrate knowledge learnt with practical applications through a team project that allows these students to analyze and propose solutions that facilitate sustainable development in these three sectors. Student teams will be encouraged to collaborate with industry in scoping the project, analyze and propose solutions that address the specific problem encountered by industry.

Intended Learning Outcomes (ILO)

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

1) Acquire knowledge relating to water, agriculture and aquaculture, and understand the inter-relationship between these three sectors.
2) Understand the principles relating to the sustainable development in water, agriculture and aquaculture.
3) Critically assess problems relating to the sustainable development in water, agriculture and aquaculture
4) Apply knowledge and critical thinking to develop solutions that promote the sustainable development in these three sectors.
5) Demonstrate their capacity to work in teams, and to network and collaborate with practitioners of these industrial sectors.
6) Deliver clear and compelling oral presentation of their analyses and results and defend their proposed solutions.

Course Content

No	Topic	Hours
1.	Introduction to water, agriculture and aquaculture	**4**
2.	Sustainability concepts and their relationship to water, agriculture, and aquaculture	**5**
3.	Sustainable development in water: water conservation, purification and recycling. Application and use of sustainable materials on water treatment systems	**5**
4.	Sustainable development in agriculture: nutrients delivery and management, pesticide delivery and applications, water management and control, nutrients and pesticide leaching and management of pollution of water bodies	**4**
5.	Sustainable development in aquaculture: water and nutrient management, sustainable antimicrobial system to manage infection and health of marine animals	**4**
6.	Relationship between water, agriculture and aquaculture- application of sustainable concepts in the three sectors.	**4**
	Total	**26**

Assessment (Includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weightage	Team/ Individual	Assessment Rubrics
1. Class participation in discussion on flip lectures	1-4	EAB SLO a, b, c, j	10%	Individual	Appendix 1
2. Class discussion on field trip/video	1-4	EAB SLO a, b, c, j	10%	Individual	Appendix 1
3. Design project-report	2-4	EAB SLO b, c, d, f, g, h, i	40% Team 30%, Individual 10%	Team & Individual	Appendix 2, 3, and 4
4. Design project - presentation	2, 3, 5, 6	EAB SLO b, c, d., f, g, h, i	40% Team 30%, Individual 10%	Team & Individual	Appendix 2, 5, and 6
Total			100%		

Description of Assessment Components

Class participation in discussion on flip lectures (10%)
You will be assessed based on your participation in the classroom and your understanding of the topics covered in the flip lectures.

Class discussion on field trip/video (10%)
You will be assessed based on your participation in the class discussion on field trip/ video. You will need to contribute to the discussion to demonstrate that you have a good grasp of the topics covered in the class and can connect the concepts to the observation during the field trip.

Design project- report (40%)
You will have to work in a group to submit a 10–15-page report by the team and you will be graded based on the quality of the project, the report itself, and your contribution to the project as a team member.

Design project- presentation (40%)
Your group will be assessed based on the preparation, content, and quality of the presentation. All members must speak during the presentation.

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.

[1] *Reference: EAB Accreditation Manual*

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** 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

Learning is a continuous and cumulative process, thus you are encouraged to approach the instructor, during class break or at end of class, to discuss the course materials and to clarify any doubt you may have.

Consultation hours will be through the assigned office hours that will be provided by the instructor, or appointment via email.

Active participation in team project group is expected and strongly encouraged. Marks will be counted towards your continuous assessment for the project section of the course.

Feedback on your design project will be given to project teams during the mid-term consultation. This will help the students in preparing their project report and also the project presentation at the end of the course.

Learning & Teaching Approach

Approach	How does this approach support students in achieving the learning outcomes?
Flip classes via lectures available on LMS -	The key concepts of this course will be delivered via recorded lectures using the flip classroom mode. Notes in the form of Power Point slides will be uploaded to LEARN, and students are encouraged to review the recorded lectures according to the prescribed schedule
Questions and Answers	The best way to learn is to ask questions and participate in interactive class discussion. Students should engage with the instructor, and communicate any concepts or knowledge that needs further elaboration.
Using videos and animations for illustration	Videos and animations will be used to expand and illustrate the concepts, especially for specific applications. These are embedded within the recorded lecture materials, and the links to the videos are posted on LMS. Opinions on social impact of sustainability will be featured through videos of debates and discussion.
Examples and case studies	The course content will be closely linked to specific example and application, particularly those that are relevant to Singapore.
Design project	Students will be assigned to a team of 2-4 students, and they will work on an open-ended project. Guidance will be provided by the instructor during the consultation process with the team
Project presentation	A practice presentation will be conducted and feedback to the team's presentation will be provided by the instructor.

Readings & References

- Charlesworth, Susanne; Booth, Colin; Adeyeye, Kemi, editors., Sustainable Water Engineering, Elsevier, Netherlands, 2021 (ISBN: 978-0-12-816120-3)
- Brassley, Paul; Soffe, Richard, Agriculture: A Very Short Introduction, Oxford University Press, 2016 (ISBN-13: 978-0-19-872596-1)
- Mohammed, Stephanie, Tomorrow's Agriculture "NFT Hydroponics"-Grow within Your Budget, Springer, 2018 (ISBN13: 978-0-86-417527-4)
- Hai, Faisal I.; Visvanathan, Chettiyappan; Boopathy, Ramaraj, Sustainable Aquaculture, Springer International Publishing, 2018 (ISBN: 978-3-31-973257-2)

Course Policy & Student Responsibility

Absentee in continuous assessment must be supported by a medical certificate submitted through the University online system.

Attendance is taken for every tutorial class for information on student's participation of class discussion.

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.

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 Location	Phone	Email
Michael Tam	N4.1	-	MichaelTam@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1.	a) Introduction to water, agriculture and aquaculture b) Assignment of students to project teams and balloting of projects	1-3	Recorded Lectures using the flip classroom model – 3hrs, Project discussion – 1hr
2.	Sustainability concepts and their relationship to water, agriculture, and aquaculture	1-3	Recorded Lectures using the flip classroom model – 3hrs, Project discussion & consultation – 2hrs
3.	Sustainable development in water: water conservation, purification and recycling. Application and use of sustainable materials on water treatment systems	1-3	Recorded Lectures using the flip classroom model– 3hrs, Project discussion & consultation – 2hrs
4.	Sustainable development in agriculture: nutrients delivery and management, pesticide delivery and applications, water management and control, nutrients and pesticide leaching and management of pollution of water bodies	1-4	Recorded Lectures using the flip classroom model– 2hrs, Project discussion & consultation – 2hrs
5.	a) Sustainable development in aquaculture: water and nutrient management, sustainable antimicrobial system to management infection and health of marine animals b) Project presentation 1	1-3, 5-6	Recorded Lectures using the flip classroom model – 2hrs, Project presentations – 2hrs
6.	a) Relationship between water, agriculture and aquaculture- application of sustainable concepts in the three sectors. b) Project presentation 2	1-3, 5-6	Recorded Lectures using the flip classroom model **–** 2hrs, Project presentations – 2hrs