Sustainability Education at HKUST

2021 Sustainability Course Evaluation Report

November 2021
Report developed by the Sustainable Education Advisory Group (SEAG)

The strategic vision for HKUST is to become a regional leader in sustainability education with a global outreach. As an on-going effort to achieve the Sustainable education goal of ensuring that *all students gain a solid understanding of sustainability concepts and graduate with the capacity and commitment to solve problems locally and globally*, The Sustainability Education Advisory Group (SEAG) has been conducting this analysis annually since 2018 to identify opportunities and gaps in the existing provision of sustainability-relevant courses, providing a basis for the development of sustainability education across Schools and programs.

This report documents the on-going efforts of Sustainability Education Advisory Group (SEAG) to achieve this goal, for assessing the breadth and depth of sustainability education across the curriculum at HKUST. This report includes:

1. Updated results of the sustainability coverage across the 2020-21 UG course catalogue;
2. Updated sustainability course inventory; and,
3. Key findings and recommendations for moving forward.

Highlights from the report:

- In 2020-21, Sustainability Focused or Related courses represented roughly 5% of the *approved new* courses.
- By distribution, all schools and most departments include at least one listed course. SENG has the largest overall number of listed courses among schools, and ENVR and CIVL are the departments with the greatest percentage of sustainability course offerings in 2020-2021.
- In terms of exposure to sustainability concepts, we note that 68% of recent graduates are leaving with a "strong" exposure (completing two or more Sustainability Focused courses). This is an increase of 11% since the first report in 2018. Only 5% of students graduated with no course exposure to sustainability, which remains consistent with the last years.

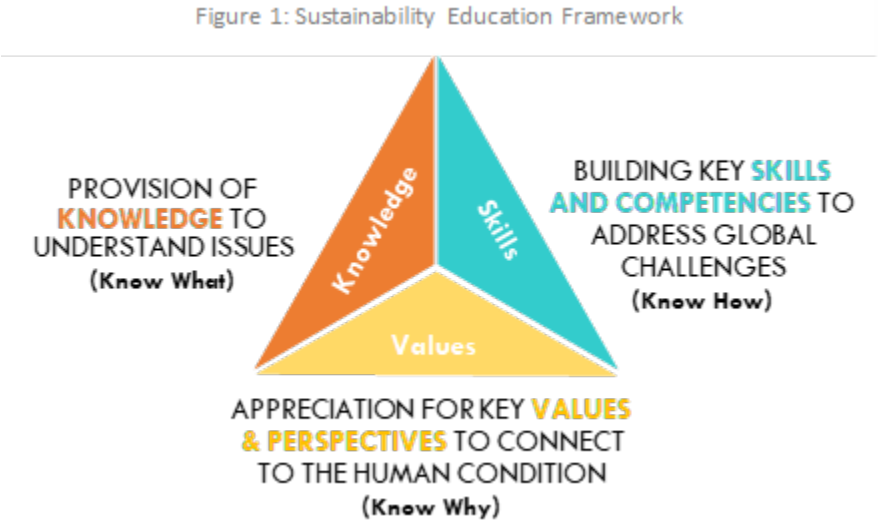
Course Criteria

Sustainability education is the foundation for preparing students to meet the challenge of *sustaining human thriving over time and within planetary boundaries*. As documented in the first Evaluation report in June 2018, SEAG has undertaken several exercises to define the terms relating to sustainability, sustainability education, and sustainability courses.

SEAG agreed that sustainability education is built through the interplay of:

- Relevant **knowledge and understanding** of the issues, supported by…
- An appreciation for **values and perspectives**, creating the foundation to build…
- The **skills and competencies** necessary to address the challenge of a sustainable future

Figure 1: Sustainability Education Framework



The SEAG also further developed a sub-list of criteria to help in evaluating core areas that are associated with sustainability education. The list of criteria is further broken down into key concepts, as detailed in Appendix A.

Values	**Knowledge and Understanding**	**Skills and Competencies**
1. Human responsibility within the environment 2. Human responsibility within society 3. Human behaviour	4. Natural limits 5. Business and economics 6. Science and technology 7. Planning and design 8. Governance	9. Systems thinking 10. Collaboration & communication 11. Futures thinking 12. Critical thinking & complex problem solving

Sustainability course inventory update

As an on-going effort for assessing the breadth and depth of sustainability education across the curriculum at HKUST, we have evaluated all our existing undergraduate courses against the list to develop a sustainability course inventory. This report will give an update of the annual exercise to update the sustainability course inventory to include the newly offered courses in the academic year of 2020-2021.

Preliminary Evaluation

The evaluation process starts with a preliminary review which includes identifying any keywords or concepts in the course descriptions which suggest the course may cover sustainability concepts throughout its delivery. Apart from courses that had keywords in their description which overlap with the pre-defined sustainability course criteria, courses which has no overlap in wordings but the descriptions itself suggested that it may be sustainability related were also shortlisted for further investigation.

Faculty Self-Assessment Exercise

In order to assess the shortlisted courses and ensure they are properly designated as "sustainability focused" or "sustainability related" courses, each course instructor is invited to complete a self-assessment survey which asks them to provide detailed information of their courses. The survey is developed based on the previously defined sustainability criteria and helps clarify how much class time is dedicated to teaching sustainability concepts.

The courses are separated into two categories: "sustainability focused," and "sustainability related."

1. Sustainability focused courses – these courses may be broad and cover a wide breadth of sustainability concepts, content, issues, and contemporary thinking, or they may be narrowly focused and address one or more sustainability issues or concepts in depth. In both cases, the course is primarily focused on sustainability.
    - ✓ A focused course must concentrate on sustainability in **at least 75%** of class time, and incorporate elements of sustainability criteria within the course material (readings, discussions, and assignments).
2. Sustainability related courses – these courses are focused on a topic other than sustainability, but have sustainability ideas, principles, or content embedded within specific parts of the curriculum.
    - ✓ A sustainability related course spends **at least 25%** of class time covering one or more of the sustainability criteria within the course material (readings, discussions, and assignments).

A total of 93 newly offered courses were reviewed and an addition of four new courses were added to the Sustainability course inventory, representing 5% of the newly offered course in the academic year of 2020-2021.

The courses are distributed somewhat evenly by level (Table 1).

	Sustainability Focused	Sustainability Related
1000 level	18	9
2000 level	17	4
3000 level	13	9
4000 level	10	12
TOTAL	58	34

Table 1: Updated Sustainability Course Designations (distribution by level)

In order to gain more insight, we then look into the distribution of sustainability courses offered in the academic year of 2020-2021 to see the distributions by department.

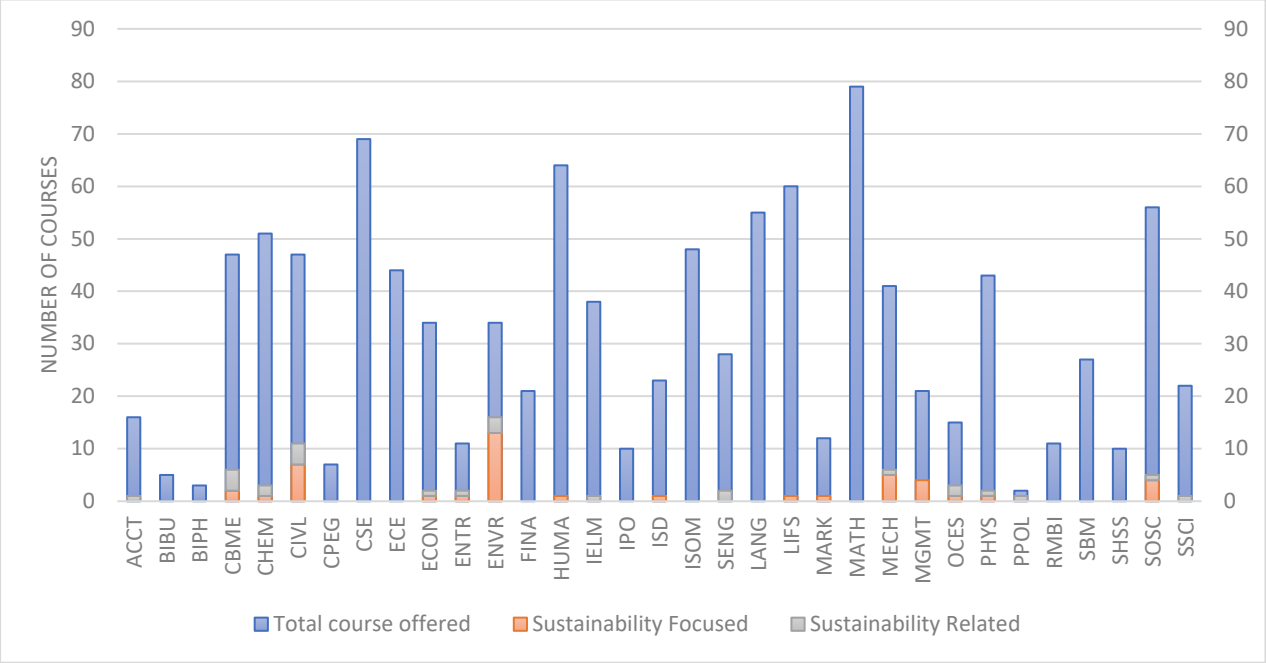


Figure 2: Distribution of Sustainability courses offered in 2020 - 2021 (by Department)

In the academic year of 2020 – 2021, a total of 1,073 UG courses were offered, 71 of which were sustainability courses (6.6% of all the courses offered).[1] By department, ENVR and CIVL have the greatest number of sustainability course offerings in 2020-2021 (47% and 24.4% respectively), while 13 of the 33 departments (39%) offer no sustainability courses.

[1] Excluding special topics courses, 11 sustainability focused, and 3 sustainability related courses were not offered in the academic year of 2020 – 2021, which followed a similar trend from last year. According to the record from ARO, there were 52 sustainability courses in total offered in Spring 2019, but the number dropped to 46 in Spring 2020 and 44 in Spring 2021. As classes were conducted via mixed-mode or pure online delivery in Spring 2020 and 2021, this may be caused by the pandemic situation.

By School, IPO has the greatest % offering of sustainability courses (37% of courses offered). The remaining Schools (excluding JS/UST) offer a range of 3.2%-7.8% of courses relevant to sustainability (Figure 3).

Figure 3: Distribution of Sustainability courses offered in 2019 - 2020 (by School)

Out of the all the schools, SENG offers the most sustainability courses (27 courses), followed by IPO (17 courses).

However, with reference to Figure 2, we should note that most of the courses offered by SENG are clustered under CIVL, CBE and MAE, while 3 out of 9 course offering department under the school of engineering did not offer any sustainability courses in the academic year of 2020 – 2021. This indicates that the exposure of sustainability education to engineering students may be dependent on their individual majors, which is similar to the findings from the previous report. In order to expand the sustainability exposure to Engineering students, the Division of Environment and Sustainability has developed a module on Life Cycle Thinking, a significant way to encourage responsible long-term decision-making, which has adopted for students across all engineering disciplines. More modules are planned to be developed for other discipline

Evaluation of Sustainability Exposure

With the help from ARO, we then retrieved the enrolment data for the recent graduates (any students who graduated from 2020 Fall to 2021 Summer) and mapped those data against the 92 identified "sustainability focused" and "sustainability related" courses. The data was then analysed for the purpose of evaluating the level of exposure to sustainability concepts for students throughout their studies at HKUST.

In 2020/21 academic year, 2,113 graduates (95.3%) had enrolled in at least 1 sustainability course during their four years of study. Of those, 602 graduates (27.1% of all graduates) completed only 1 sustainability course. 1,511 graduates (68.1% of all graduates) completed 2 or more Focused courses.

From this preliminary result, we can assume that at least 27.1% of graduates are gaining an elementary understanding of sustainability, while 68.1% are potentially gaining a medium to substantial exposure of sustainability concepts by taking two or more courses. And around 5% of students are potentially receiving little to no understanding or exposure to sustainability upon graduating—at least not in their coursework.[2]

[2] There are numerous other ways to gain exposure to sustainability concepts at HKUST; UST Connect, for example, provides activities and service-learning opportunities that are aligned with UN Sustainable Development Goals (SDGs). There are also many UROP projects that are related to sustainability which are not included in this analysis.

According to our previously defined designation, any courses that are listed as "sustainability focused" implies that over 75% of class time is dedicated to covering sustainability concepts, while "sustainability related" courses imply at least 25% of class time is spent on sustainability related concepts.

Based on this, we believe that for student to gain a strong exposure of sustainability concepts, a student should complete at least 2 "sustainability focused" courses. While students who only enrolled in "sustainability related" courses can be considered as having an elementary to medium exposure to sustainability.

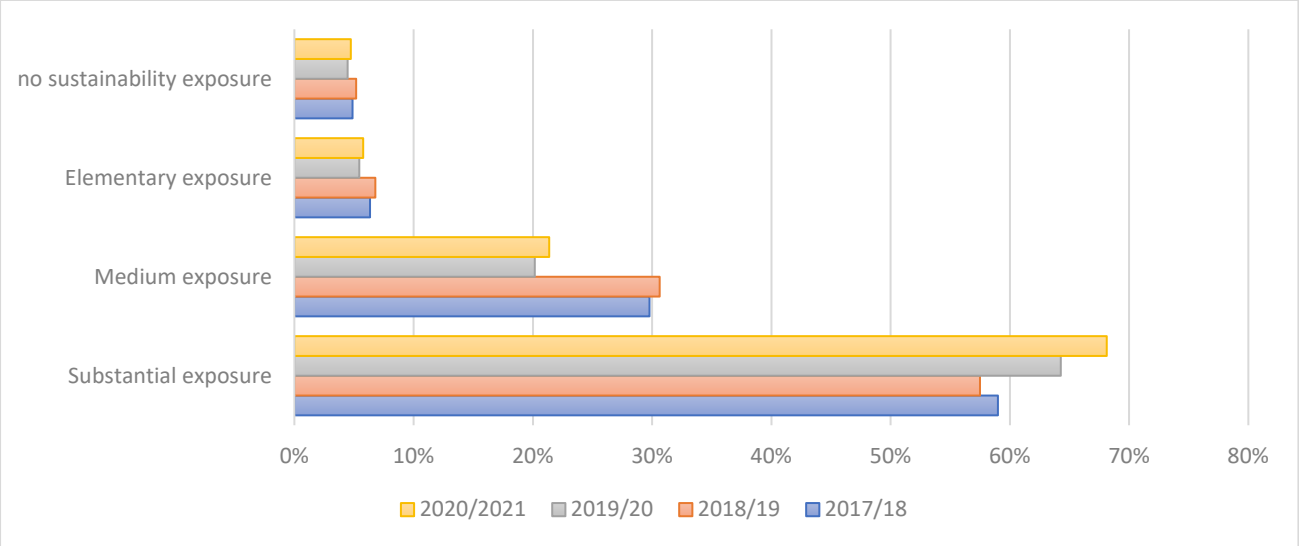


Figure 4. Level of exposure to sustainability education of graduates over the years

With reference to figure 4, we can see that there's a steady increase in the percentage of students graduating with a substantial exposure of sustainability, with a 4% increase from the year of 2019/20 to 2020/21.

However, the figure also shows that the percentage of graduates with medium exposure have dropped, with 21% in the academic year of 2020/21 as opposed to 25% and 31% from 2019/20 and 2018/19 respectively. Additionally, there's no significant changes in the percentage of graduates with no or elementary exposure.

This indicates that while there is an increase in number of students taking more sustainability courses, we may need to focus more on engaging the students that are receiving little to no sustainability concepts.

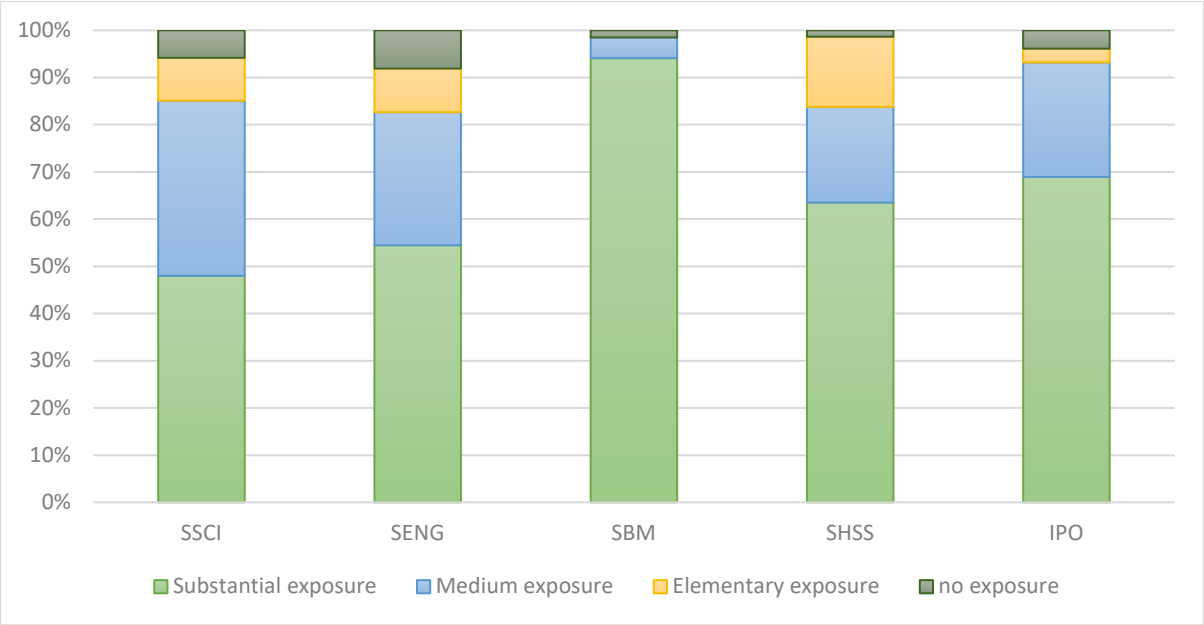


Figure 5. Level of exposure to sustainability education of graduates by school (2020/2021 academic year)

From figure 5, it is apparent that SBM has the highest percentage (94.1%) of graduates with substantial exposure to sustainability in comparison to the other school, followed by IPO (68.9%) and SHSS (63.5%). While both SBM and SHSS have the least percentage of graduates with no exposure (1.5% and 1.4% respectively).

It's also important to note that SBM has the highest number of graduates amongst all 5 school, meaning that only 12 students out of 799 graduates did not take any sustainability course during their course of study, while all the others are receiving a medium to substantial exposure to sustainability concepts.

Out of all the schools, SHSS has the least percentage of graduates with substantial exposure (42.37%). However, we can observe that all schools have over 80% of their students graduating with either substantial or medium exposure to sustainability.

Comparing to last year, there's a decrease in graduates with no exposure to sustainability for IPO, SBM and SHSS, however, there's a slight increase in the graduates with no exposure to sustainability for SSCI and SENG.

Conclusion and recommendation

The overall result shows that a high percentage of graduates are receiving medium to substantial exposure to sustainability concepts. However, a small portion of graduates are still graduating with no exposure to sustainability. We also observed that from SENG and SSCI, the percentage of the students with different level of exposure did not differ much compared to the result from the previous report, suggesting that more work is needed to increase the sustainability exposure to those students.

In addition, this shows that there is clear work still needed to ensure that *all students* graduate with a solid understanding of sustainability concepts.

Another important thing to note is that while this exercise is useful for assessing the exposure of sustainability courses to students, it doesn't allow us to evaluate the performance of the students or give us any information about how well the student understood the concept they were exposed to. In the long term, we should continue to discuss about how we may potentially evaluate the performance and include factors such as intended learning outcome into the analysis.

In order to meet the university's overarching education goal, we would recommend the following four initiatives for reaching a higher level of sustainability literacy.

1. ***Develop a branding system for easily identifying sustainability coursework.***

   By developing a branding scheme for distinguishing the sustainability-focused in the course catalogue, we can enable the students to identify sustainability easily and quickly for designing their own sustainability learning pathway.

   A branding scheme would also act as an incentive for faculty to (a) complete the self-assessment, and (b) adjust their course materials in order to qualify for a designation, thus contributing to the university education goal.

2. ***Implementing a sustainability literacy test on an annual basis.***

   As concluded in the report, while this annual exercise is exceptionally effective for us to assess the exposure of sustainability education to students before they graduate from HKUST, it does not provide a good insight of how well the students are receiving these concepts. As an effort to gain a better understanding of the sustainability literacy of students, SEAG has developed a survey, called the "Sustainability literacy test", which comprise of 18 multiple choice questions covering various areas of sustainability.

   The first trial was conducted in Spring 2021 and invited students from all school to participate on a voluntary basis. In the long-term, we believe it would be beneficial to implement the test on an annual basis into a longitudinal study. It also gives us a much clearer picture of how well the students are understanding the sustainability concepts, rather than just exposing to it.

3. ***Investigate ways to capture sustainability learning from outside the classroom,***

   Leaning is increasingly happening outside of the classroom and experiential learning opportunities can provide excellent foundations for learning about sustainability concepts and approaches. While difficult, it will be important to assess the impact on understanding sustainability from activities such as sustainability-centered student societies, service learning, or participation in hackathons or student competitions (such as the Sustainable Smart Campus as a Living Lab).

Appendix A: Sustainability Criteria

	Criteria	Key Concepts
VALUES	**Human responsibility within the environment** *Exploring the morality underlying how humans interact with natural surroundings, particularly through the lens of fairness and responsibility for future generations*	• Environment-related Sustainable Development Goals • Environmental justice • Valuing eco-system services for future generations • Ecological citizenship in terms of protection of the public environmental good • Appreciation, empathy, and nurturing of environmental values
	Human responsibility within society *Exploring the social factors that limit human thriving and global quality of life*	• Social justice and responsibility • Social-focused Sustainable Development Goals • Universal Declaration of Human Rights • Poverty reduction • Equity (e.g., income distribution, Gini coefficient) • Gender equality • Actions that degrade human well-being
	Human behaviour *Exploring how culture, social networks, and personal identity can shape human behaviours in ways that impact our ability to act in sustainable ways*	• Institutional theory and dynamics of social change • Behaviour economics • Change management • Strategies for pro-environmental behaviors (e.g., Community-Based Social Marketing) • Environmental psychology • Reflecting upon diverse perspectives (e.g., moral relativism, social norms, identities)
KNOWLEDGE	**Natural limits** *Exploring the finite capacity of natural ecosystems (including the global ecosystem) and their ability to support human needs*	• The Anthropocene • The biosphere, ecological risks, biodiversity • Understanding of planetary systems (air, water, or soil) • Food systems • Demographic trends • Natural capital and limits to growth
	Business and economics *Exploring the market conditions that create "market failures" with respect to the environment or society, and examining business and economic strategies that can better maintain the integrity of ecosystems*	• The circular economy • Sustainability business strategies (e.g., auditing, reporting, green finance) • Tragedy of the commons, externalities, or other market failures • Global patterns of production and consumption
	Science and technology *Exploring the role of basic science and technology (broad and individual technologies) specifically in mitigating harmful impacts to humans and the natural world*	• Transitions to renewable, zero-carbon energy • Green technologies to preserve oceans, forests, and agriculture • Technologies to generate efficiency, conservation, and productivity • Mitigating pollution, waste, and effluence • Smart cities strategies
	Planning and design *Exploring concepts from local and regional planning, infrastructure development, and*	• Sustainable urban environments • Green building design • Product design for sustainability outcomes

	product design to mitigate harmful impacts to humans and the natural world	• Urban infrastructure (e.g. transport, waste management)
	Governance *Exploring how legal frameworks and government policies impact society and the natural world*	• Political and economic organisations • Policy for sustainability (e.g., codes, standards, and regulations) • Governing for public good (e.g., public investment, incentives, public relations campaigns) • Legal frameworks (e.g., property rights, trade agreements)
SKILLS	**Systems thinking** *Building a holistic perspective, recognising interconnectedness and interdependence across multiple scales*	• Resilience and robustness • System dynamics (e.g., feedback loops, tipping points) • Unanticipated consequences and trade-offs • Qualitative / quantitative systems analysis • Life-cycle thinking and whole-life cost analysis
	Collaboration & communication *Building interdisciplinary thinking and a capacity to work with others to resolve sustainability problems*	• Communicating for sustainability outcomes • Negotiation, mediation, or conflict resolution • Team-building for sustainability causes • On/off-site experiential learning • Stakeholder engagement
	Futures thinking *Building an orientation to the long-term, with the ability to anticipate future challenges, risks, and opportunities*	• Assessing sustainability-related risks • Forecasting / backcasting • Scenario planning • Simulation modelling • Strategic planning • Adaptation and mitigation strategies
	Critical thinking and complex problem-solving *Building a foundation for evaluating the credibility of data and ideas, and the capacity to develop and implement meaningful solutions*	• Analysis of news cycles and media depictions of events • Objective development of judgements and persuasive arguments • Principled reasoning • Multi-criteria assessment models • Impact assessment methods • Creativity and innovation • Critical data analysis and interpretation

Appendix B : Updated sustainability courses *(Newly added courses this year are highlighted)*

SUSTAINABILITY FOCUSED		SUSTAINABILITY RELATED	
CENG4130	Plant Design and Economics	ACCT1010	Accounting, Business and Society
CENG4720	Environmental Impact Assessment and Management Systems	**CENG3150**	**Integrated Chemical Process and Product Design**
CENG4912	Chemical and Environmental Engineering Project	CENG3230	Reaction and Reactor Engineering
CHEM1004	Chemistry in Everyday Life	CENG4710	Environmental Control
CIVL/ENVR1150	Climate Change Impacts and Extreme Weather Events	CHEM4310	Environmental Chemistry
CIVL1140	Environmental Quality Control and Improvement	CHEM4320	Environmental Analytical Chemistry
CIVL1170	Big History, Sustainability and Climate Change	CIVL1160	Civil Engineering and Modern Society
CIVL3420	Water and Wastewater Engineering	CIVL2410	Environmental Assessment and Management
CIVL3510	Hydrosystems Engineering	CIVL3610	Traffic and Transportation Engineering
CIVL4450	Carbon Footprint Analysis and Reduction	CIVL4100H	Water, Energy and Climate Challenges in Smart Cities
CIVL4460	Process Design of Environmental Engineering Facilities	CIVL4440	Environmental Systems Analysis
ECON4434	Economic Development and Growth	CIVL4620	Transportation System Operations
ENTR3030	Social Innovations & Entrepreneurship	ECON2310	Introductory Environmental and Health Economics
ENVR/SOSC2310	Introductory Environmental and Health Economics	**ENEG 4210**	**Optimization of Energy Systems**
ENVR1030	Environment and Health	ENEG/MECH3110	Materials for Energy Technologies
ENVR1040	The Environment and Society - A Comprehensive Perspective	ENGG1110	Engineering Solutions to Grand Challenges of the 21st Century
ENVR1050	The Sustainable Citizen	ENGG1130	The Impact and Value of Technology Innovation
ENVR1070	Thinking Big: Systems Thinking for Environmental Problems	ENGG2990J	Systems Design Engineering
ENVR1080	The Smart Consumer - Uncovering the Hidden Story behind the Product Label	ENTR1001	Entrepreneurship 1001: Building Your Own Future
ENVR2002B	Life Cycle Analysis	ENVR3220	Energy Resources and Usage
ENVR2010	Environmental Science Fundamentals	ENVR4000O	Climate Modelling and Risk Assessment

ENVR2020	Urban Air Pollution
ENVR2040	Life Cycle Assessment
ENVR2050	Sustainability Thinking
ENVR3003	Green Buildings and Energy Efficiency
ENVR3010G	Sustainability Thinking
ENVR3010O	Sustainable Urban Development and Responses to Climate Change
ENVR3110	Sustainable Development
ENVR3310	Green Business Strategy
ENVR3410	Economics for Environmental Policy and Management
ENVS2001	Environmental Conservation and Sustainability in Practice
ENVS2004	Introduction to Ocean Science
ENVS4301	Environmental Conservation
HUMA2595	Science, Technology and Modern Life
HUMA2597	Environmental History
HUMA2621	Culture and Environment
HUMA2623	Cultural Sustainability in South China
ISDN2200	**Systems Thinking and Design**
ISOM1700	Critical Issues in Business Operations
LIFS/OCES2011	A Practicum on Wetland Conservation
LIFS1030	Environmental Science
MARK1220	Marketing and Society
MECH1902	Energy Systems in a Sustainable World
MECH1905	Buildings for Contemporary Living
MECH1906	Mechanical Engineering for Modern Life
MECH4000N	Solar Energy Conversion Technology
ENVR4320	ESG Management and Reporting
ENVR4330	Environmental Geographical Information System
ENVS3004	Global Climate Change
ENVS4001	Environmental Impact and Risk Assessment
ENVS4905	Marine Molecular Biology and Ecology
HUMA1000E	Cultures and Values: Freedom, Justice, and the Good
IELM/IEDA2150	Product Design
MECH3420	Engineering Materials II
OCES1001	The Earth as a Blue Planet
PHYS1001	Physics and the Modern Society
PPOL3210	**Energy Policy**
SCIE1120	Chemistry and Life
SOSC3880	Social Inequality and Social Mobility

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MECH4350	Indoor Air Quality in Buildings
MGMT2010	Business Ethics and the Individual
MGMT2130	Business Ethics & Social Responsibility
MGMT3160	Environmental Business Strategies
MGMT3170	Managing CSR (Corporate Social Responsibility)
PHYS1003	Energy and Related Environmental Issues
SOSC1860	Population and Society
SOSC2170	Environment, Sustainability and Business: A Design Approach
SOSC3260	Sustainability Science: Problems and Perspectives
SOSC3540	Psychology of Environmental Sustainability
SOSC4290	China's Sustainable Development
SUST1000	Introduction to Sustainability

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