MODULE SPECIFICATION

Originating Institution, Department	Module Co-ordinator(s)
University of Moratuwa Department of Civil Engineering	Prof. R.U. Halwatura

TITLE OF THE MODULE

Title of the module	Module code[1]
Engineering Response to Climate Change	CE 4620

PROGRAMME(S) IN WHICH TO BE OFFERED:

Bachelor of Civil Engineering

LEVEL OF STUDIES[2]

First cycle (BSc/BA) ☒	**Second cycle (MSc/MA) ☐**	**Third cycle (PhD) ☐**

CREDITS AND LEARNING HOURS

Credit Value[3]	ECTS Value[4]	Indicative academic learning hours[5]	Length (in Semesters)[6]	Year in which to be offered
3	6	150	0.5	4th Year

* European Credit Transfer and Accumulation System (ECTS), 1 credit in Sri Lanka equals 2 in ECTS
* Sri Lanka Qualifications Framework (SLQF) 1 Credit equals 50 notional learning hours
* The notional learning hours include direct contact hours with teachers and trainers, time spent in self-learning, preparation for assignments, carrying out assignments and assessments.

[1] To be indicated by the Institution
[2] According to the Framework of Qualifications for the European Higher Education Area, Annex 8: http://www.aic.lv/ace/ace_disk/Bologna/Bergen_conf/Reports/EQFreport.pdf
[3] Permissible credit values as set out in Institution's Academic Regulations
[4] European Credit Transfer System, 1 ECTS = 25-30 academic learning hours. Please refer to ECTS Users' Guide: https://ec.europa.eu/education/ects/users-guide/docs/ects-users-guide_en.pdf
[5] 1 academic learning hour is equal to 45 minutes
[6] Indicate 0.5, 1, 1.5 or 2

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ANNOTATION OF THE MODULE[7]

The course Engineering Response to Climate Change provides an insightful and holistic understanding of climate change and improves the decision making ability with respect to moral and ethical problems posed by current production and consumption towards climate change. It also provides a deep understanding of how industries in various sectors are incorporating engineering design principles into their strategies and operations while applying alternative design methodologies to achieve sustainability in projects and mitigate climate change.
Initially causes, effects, consequences and controversies surrounding global climate change are introduced and the mechanisms that cause global warming and the approaches for addressing climate change: mitigation and adaptation are discussed. Environmental ethics and Engineer's responsibilities are introduced and alternative technologies are presented and finally 6R concepts discussed. The theory and methodology of the subject is learned, and certain specific and general skills are developed at the BECK Simulated Big Data Interuniversity Networked Affective Educational Centre by using computer learning systems, big data mining, an affective tutoring system, e-sources and the Moodle Virtual Learning Environment.

AIM OF THE MODULE[8]

This module aims to develop understanding of climate change and its catastrophic consequences for the whole planet.
Further, the aims are extended to develop the understanding of climate change and adaptation-induced engineering design, alternative design methodologies and innovations.

MOOC LEARNING AND TEACHING STRATEGIES

The MOOC course has to contribute to an opening up of education to the benefit of both learners and the society at large while reflecting values such as equity, quality and diversity. The common features of the course are:

- Openness to learners: open entry (no formal prerequisites), freedom to study at the time, place and pace of your choice, flexible pathways, fit for a wide variety of lifelong learners;
- Digital openness: courses available online;
- Learner-centred approach: courses aid students to construct their own learning from a rich environment, and to share and communicate it with others;
- Independent learning: a MOOC provides high quality materials to enable the progress of an independent learner through self-study;
- Media-supported interaction: course materials make best use of online affordances (interactivity, communication, collaboration) as well as rich media (video and audio) to engage students with their learning.
- Recognition options: successful course completion will be recognised as indicating worthwhile educational achievement.
- Quality focus: focus on quality in the production and presentation of a MOOC.
- Spectrum of diversity: the course is inclusive and accessible to very diverse citizens.

The delivery of the new certificated and recognized adaptive BECK MOOCs is enabled by the use of the innovative Simulated Big Data Interuniversity Networked Affective Educational Centre.

[7] Please provide brief summary of the module, up to 200 words
[8] Aim of the module must correspond to the BECK Capacity Building Framework

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Affective computing technologies and neuro decision matrices, big data and text analytics, and an adapted Yerkes–Dodson law are the foundation of the BECK system. Affective computing is the study and development of systems and devices that can recognize, interpret, process and simulate human effects. The BECK system will interpret the emotional state of a student and adapt the learning process to that particular student by providing an appropriate response to relevant emotions and requirements.

Six major components have been identified for the development of the Simulated Big Data Interuniversity Networked Affective Educational Centre (the BECK Centre):

1) Adaptive MOOCs;
2) Computer learning systems;
3) Big Data Mining;
4) Affective Tutoring System;
5) Access to e-sources;
6) Moodle Virtual Learning Environment.

The computer learning system is understood as an object (with its components) for managing and investigating data, information, and expressed and unexpressed knowledge. It is a modelling system that accumulates data and information from various resources and then processes that data and information by means of various mathematical, logical and informational models.

The data mining will enable integrated analysis of the following data and information from multiple locations: weather, climate, dwelling envelope, utilities, occupancy, market data (government data, trade association data, financial data from major players, customer surveys), climate change, best practices, human influences, the behaviour of users, etc.

The Affective Tutoring System integrates the student self-assessment procedures with biometric (facial expression analysis) and intelligent techniques and technologies.

The centre will offer open-source videos, simulators (calculators and software), case studies from the best universities around the world to enhance the module.

The following main features have been identified for the development of the Moodle Virtual Learning Environment: adaptable design, modern and easy to use interface, personalized dashboard, collaborative tools and activities (Assignments, Chat, Choice, Database, Feedback, Forum, Glossary, Lesson, Quiz, Survey, Wiki, Workshop), all-in-one calendar, convenient file management, simple and intuitive text editor, notifications, progress track, secure authentication and mass enrolment, multilingual capability, high interoperability, user role and permission management, etc.

MOOC is accessible for various target groups. Its activities aid participants to construct their own learning and communicate it to others. The activities, tasks and routes are designed in such a way that they can be performed at specific levels of difficulty or complexity, to accommodate the broad spectrum of participants' knowledge and skills that is expected. The course contains sufficient interactivity (learner to content, learner to learner and learner to teacher) to encourage active engagement. The feedback of the academic tutor is limited and scalable. The course provides learners with regular feedback through self-assessment activities, tests or peer feedback. The MOOC has possibilities to follow the score and progression.

The pedagogical model of the course is such that the efforts of all services do not increase significantly as the number of participants increases. All aspects of the course are delivered online. Learning outcomes are assessed using the balance of formative and summative assessment appropriate to the level of certification.

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INTENDED LEARNING OUTCOMES AND ASSESSMENT

Learning Outcomes of the module[9]	***Methods of studies***	***Assessment methods of student achievements[10]***	***Assessment criteria of student achievements by assessment levels***
O1. Apply holistic concepts of climate change in engineering	Blended learning, integrated affective tutoring and affective computing methods.	☒ Problematic questions ☒ Intelligent tests ☐ Regular tests ☒ Problematic tasks ☒Projects (Individual) ☒ Peer evaluation ☐ Automated feedback ☐ Final evaluation ☒ Other: assessment of a written group essay ☒ Other: Forum discussions (e-testing)	<u>Typical achievement level</u> *(Achieving the medium order thinking skills in Bloom's Taxonomy)* *After completion of this module, students will be able to appraise the holistic concepts of climate change in engineering.*
O2. Evaluate moral and ethical problems posed by current production and consumption towards climate change.	Blended learning, integrated affective tutoring and affective computing methods.	☒ Problematic questions ☐ Intelligent tests ☐ Regular tests ☒ Problematic tasks ☒ Projects (Individual) ☐ Peer evaluation ☒ Automated feedback ☐ Final evaluation ☒ Other: In video quiz (e-testing) ☒ Other: Group/Individual Forum discussions (e-testing)	<u>Excellent achievement level</u> *(Achieving the higher order thinking skills in Bloom's Taxonomy)* *After completion of this module, students will be able to evaluate moral* and ethical problems posed by current production and consumption towards climate change.
O3. Evaluate how industries in various sectors are incorporating engineering design principles into their strategies and operations.	Blended learning, integrated affective tutoring and affective computing methods.	☒ Problematic questions ☐ Intelligent tests ☐ Regular tests ☒ Problematic tasks ☒ Projects (Group/Individual) ☒ Peer evaluation ☐ Automated feedback ☐ Final evaluation	<u>Excellent achievement level</u> *(Achieving the higher order thinking skills in Bloom's Taxonomy)* *After completion of this module, students will be able to analyse creative approaches for* various

[9] Learning outcomes are specified in three categories – as **knowledge, skills and competence**. This signals that qualifications – in different combinations – capture a broad scope of learning outcomes, including theoretical knowledge, practical and technical skills, and social competences where the ability to work with others will be crucial. Please refer to Cedefop (2017). Defining, writing and applying learning outcomes: a European handbook. Luxembourg: Publications Office of the European Union. https://www.cedefop.europa.eu/files/4156_en.pdf. Learning outcomes of the module must correspond to the BECK Capacity Building Framework.

[10] Please select from the list. Additional assessment methods may be added.

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		☒Other: activity assessment ☒ Other: Group/Individual Forum discussions (e-testing)	strategies and operations in the sectors incorporating engineering design.
04.Create alternative design methodologies to achieve sustainability in projects and mitigate climate change.	Blended learning, integrated affective tutoring and affective computing methods.	☒ Problematic questions ☐ Intelligent tests ☐ Regular tests ☒ Problematic tasks ☒ Projects ☒ Peer evaluation ☐ Automated feedback ☐ Final evaluation ☒Other: activity assessment ☒ Other: Group/Individual Forum discussions (e-testing)	<u>Excellent achievement level</u> (Achieving the higher order thinking skills in Bloom's Taxonomy) After completion of this module, students will be able to create various alternative design methodologies to achieve sustainability in projects and mitigate climate change.

MODULE MARK CALCULATION[11]:

Assessment components (in chronological order of submission/examination date)				
Type of assessment[12]	Weighting, %	Duration *(if exam)*	Word count *(if essay or similar):*	Component pass required[13]
Assessment of the degree of interaction and participation of the students 1. <u>Week 01-</u> ▪ In-video quiz ▪ Forum discussion 2. <u>Week 02-</u> ▪ Forum discussion ▪ Coursework#01 3. <u>Week 03-</u> ▪ Forum discussion 4. <u>Week 04-</u> ▪ Forum discussion ▪ Coursework#02 5. <u>Week 05-</u> ▪ Forum discussion	30%			Yes ☒ No ☐

[11] Please list all components, sum must be equal to 100%. Note that successful course completion should be recognised as indicating worthwhile educational achievement.
[12] Please indicate in chronological order of submission date each assessment component by type, e.g. examination, home work, coursework, project
[13] Indicate Yes to specify the assessment component(s) to be passed in order to pass the module

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6. <u>Week 06-</u> ▪ Project report (Group)#01 7. <u>Week 07-</u> ▪ Forum discussion ▪ Quiz 8. <u>Week 08-</u> ▪ Forum discussion ▪ Coursework#03 9. <u>Week 09-</u> ▪ Forum discussion ▪ Online presentation (Group)#01 10. <u>Week 10-</u> ▪ Forum discussion ▪ Coursework#04 11. <u>Week 11-</u> ▪ Project report (Individual)#01 12. <u>Week 12-</u> ▪ Forum discussion 13. <u>Week 13-</u> ▪ Coursework#05 14. <u>Week 14-</u> ▪ Project report (individual)#02				
<u>Written reports</u> ▪ Project report (group)#01 ▪ Project report (individual)#01 ▪ Project report (individual)#02	50%		5000 for each report	Yes ☒ No ☐
Online examination (test)	20%	20 minutes		Yes ☒ No ☐
Total:	100%			

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SYLLABUS OUTLINE

No.	Topic[14]	Number of hours[15]
1.	Introduction of causes, effects, consequences and controversies surrounding global climate change.	20
2.	Mechanisms that are causing global warming and the approaches for addressing climate change: mitigation and adaptation. ➢ Natural and enhanced greenhouse gas effect and its impact ➢ Main greenhouse gases, their origin and global warming potential ➢ Reducing sources of greenhouse gases ➢ Alternative technology ➢ Carbon capture and storage technology ➢ International treaties for climate mitigation ➢ Measures for climate change mitigation	50
3.	6R concepts ➢ Design for reuse and recycling ➢ Avoiding resources depletion ➢ Minimizing manufacturing impacts ➢ Waste minimization	25
4.	Environmental ethics and Engineer's responsibilities. ➢ Environment and the engineer, environmental ethics ➢ Elementary understanding of current - local legislation for environmental control, their concepts and implementation agencies ➢ Setting bench marks and standards (Ex: for the products or building industry)	25
5.	Disaster Resilience ➢ Overview of emergency or disaster situations and the consequences in the built environment. ➢ Existing theories and practices in disaster management. ➢ Existing bodies that manage disaster situations. ➢ The principles and process of post disaster reconstruction project management.	30
	Total:	**150**

[14] Please add as many topics as needed
[15] Includes self-learning, on-line conferences and consultations

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LEARNING MATERIALS[16]

Core materials (up to 5 references):

1. Robert, G. W. (2017). **Engineering response to Climate Change.** *https://www.routledge.com/Engineering-Response-to-Climate-Change/Watts/p/book/9781138074118*
2. Lawlor, R., & Morley, H. (2017). **Climate Change and Professional Responsibility:** A Declaration of Helsinki for Engineers. *Science and Engineering Ethics*, *23*(5), 1431–1452. https://doi.org/10.1007/s11948-017-9884-4
3. Liu, Z., & Chen, Y. (2015). **Impacts, risks, and governance of climate engineering.** ***Advances in Climate Change Research***, *6*(3), 197–201. https://doi.org/10.1016/j.accre.2015.10.004
4. Gonzales, V., Krupnick, A., & Dunlap, L. (2020, May 6). Carbon Capture and Storage 101. Resources for the Future. https://www.rff.org/publications/explainers/carbon-capture-and-storage-101/
5. Dutta, A. M., & Sengupta, I. (2014). Engineering and Sustainable Environment. International Journal of Engineering Research and General Science, 2(6), 124–130

Supplementary materials (up to 10 references):

1. Impacts, risks, and governance of climate engineering. https://doi.org/10.1016/j.accre.2015.10.004

2. Climate Change and Resource Sustainability; An Overview for Actuaries. https://www.cia-ica.ca/docs/default-source/2015/215068e.pdf

3. Research for assessment, not deployment, of Climate Engineering. https://doi.org/10.1002/2016EF000446

4. Bridges in a changing climate: a study of the potential impacts of climate change on bridges and their possible adaptations. https://doi.org/10.1080/15732479.2019.1670215

5. An Analysis of Climate Engineering as a Response to Climate Change.

https://www.copenhagenconsensus.com/sites/default/files/ap_climate-engineering_bickel_lane_v.5.0.pdf

6. WSPC,2018. Our Warming Planet. ISBN Number :9789813148772

7. Luís, S., Vauclair, C.M. and Lima, M.L., 2018. Raising awareness of climate change causes? Cross-national evidence for the normalization of societal risk perception of climate change. Environmental Science & Policy, 80, pp.74-81. https://doi.org/10.1016/j.envsci.2017.11.015

[16] Courses should provide high quality materials to enable an independent learner to progress through self-study. Materials should make best use of online affordances (interactivity, communication, collaboration) as well as rich media (video and audio) to engage students with their learning.

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9. U.S. Environmental Protection Agency, Office of Atmospheric Programs (2002) Greenhouse gases and global warming potential values: Excerpt from the inventory of U.S. greenhouse emissions and sinks: 1990-2000
On-line resources[17]: 1. https://www.nasa.gov 2. ps://unfoundation.org/what-we-do/issues/climate-and-energy/?gclid=CjwKCAjwiLGGBhAqEiwAgq3q_uzd8-i_B1QaTMtKsr542TqAAzJUQjhS84jEHEkObCWY4dqGY_CcThoCiUAQAvD_BwE 3. https://sitn.hms.harvard.edu/flash/2016/engineering-earth-fight-climate-change/ 4. https://www.unsdsn.org/climate-and-energy?gclid=CjwKCAjwq7aGBhADEiwA6uGZpxFs944TVwknQyMY1qSoHKK_tvakG8nsdjdPej0PxnVlzIp4QO3xbBoCoaYQAvD_BwE 5. https://youtu.be/dcBXmj1nMTQ 6. https://youtu.be/k1oPVp63eNk 7. https://youtu.be/4zt-SMlaaM8 8. https://youtu.be/H2QxFM9y0tY 9. https://youtu.be/H2QxFM9y0tY 10. https://youtu.be/8NSQYO2es3U
Other materials: Lecture materials available at the BECK Simulated Big Data Interuniversity Networked Affective Educational Centre.

REQUIRED IT RESOURCES[18]

No.	Software, manufacturer
1.	Word, Microsoft
2.	Excel, Microsoft
3.	Power Point, Microsoft
4.	Adobe Acrobat reader
5.	Zoom
6.	Prezi

Date of completion of this version of Module Specification: 19-05-2021

Date of approval by the Faculty : 12-02-2020

[17] Please provide links
[18] Please add as many software as needed for the course

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