CA5315: CARBON CAPTURE, UTILIZATION, AND STORAGE

Effective Term
Semester A 2026/27

Part I Course Overview

Course Title
Carbon Capture, Utilization, and Storage

Subject Code
CA - Civil and Architectural Engineering

Course Number
5315

Academic Unit
Architecture and Civil Engineering (CA)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Additional Information
Nil

Part II Course Details

Abstract

This course will mainly explore some carbon capture and utilization techniques in green concrete production, which will permanently store CO2 into products, contributing to emission reduction. Additionally, such green concrete products can be exclusively made from waste materials enhancing environmental benefits and promoting circular economy. How the adoption of waste and the combination of carbon capture techniques impact sustainable development will be illustrated by life cycle assessments. Students will evaluate the effectiveness of carbon capture techniques in producing sustainable materials via learning some knowledge about material science while studying resilient concrete mix design guidelines, microstructural analysis, environmental assessment, and cost analysis. Some other carbon capture and utilization techniques may also be included.

Through case studies, competition, and group presentation, the course aims to cultivate future engineers who are responsible for our community and planet and can integrate environmentally friendly concepts into engineering practices, which can make contributions to the development of Zero-waste Cities and the realization of carbon neutralization.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Students will understand the effect of carbon capture and utilization techniques on green concrete products and their impact on concrete properties.	20%	x		
2	Students will analyse carbon capture and utilization case studies to understand their application in the research field and their positive effect on environmental protection.	30%		x	
3	Students will perform resilient concrete mix design strategies in producing concrete materials for sustainable practice.	30%			x
4	Students will propose the best solutions by combining technical aspects, environmental assessment, and cost analysis for low-carbon products.	20%	x		

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Introduction of basic concepts, ideas, and arguments.	1, 2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	In-class exam	1, 2, 3	20	-	No
2	Assignment	2, 3	30	-	Yes
3	Group project	3, 4	50	-	Yes

Continuous Assessment (%)

100

Examination (%)

0

Minimum Continuous Assessment Passing Requirement (%)

40

Assessment Rubrics (AR)

Assessment Task

In-class exam (Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to answer exam questions

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Low

Assessment Task

Assignment (Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to solve problems

Excellent (A+, A, A-)

High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Low

Assessment Task
Group Projects (Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to complete the project and present the work

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Low

Assessment Task
Final exam(Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to answer exam questions

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Low

Assessment Task
In-class exam (Applicable to students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to answer exam questions

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Basic

Failure (F)
Low

Assessment Task
Assignment (Applicable to students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to solve problems

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Basic

Failure (F)
Low

Assessment Task
Group Projects (Applicable to students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to complete the project and present the work

Excellent (A+, A, A-)
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Part III Other Information

Keyword Syllabus

Carbon Capture, Utilization, and Storage, Green Concrete, Environmental Assessment, Cost Analysis, Climate Change, Sustainable Development.

Reading List

Compulsory Readings

	Title
1	Sanna A. and Maroto-Valer M. (2016) CO2 sequestration by Ex-Situ Mineral Carbonation, Heriot-Watt University, UK
2	Soutsos M. and Domone P. (2017) Construction materials: their nature and behaviour, 5th Edition. CRC Press, Taylor & Francis Group

Additional Readings

	Title
1	E. Van Roijen, K. Sethares, A. Kendall, S.A. Miller, The climate benefits from cement carbonation are being overestimated, Nature Communications 15 (2024) 4848. https://doi.org/10.1038/s41467-024-48965-z.
2	S.Ó. Snæbjörnsdóttir, B. Sigfússon, C. Marieni, D. Goldberg, S.R. Gislason, E.H. Oelkers, Carbon dioxide storage through mineral carbonation, Nature Reviews Earth & Environment 1 (2020) 90–102. https://doi.org/10.1038/s43017-019-0011-8.
3	G. Li, Y. Tao, X. Zhu, Y. Gao, P. Shen, B. Yin, R. Dupuis, K. Ioannidou, R.J.-M. Pellenq, C.S. Poon, Optimal CO2 intake in metastable water film in mesoporous materials, Nature Communications 15 (2024) 10790. https://doi.org/10.1038/s41467-024-55125-w.

4	Y. Gao, Y. Tao, G. Li, P. Shen, R.J.-M. Pellenq, C.S. Poon, Moisture-driven carbonation kinetics for ultrafast CO2 mineralization, Proceedings of the National Academy of Sciences 122 (2025) e2418239121. https://doi.org/10.1073/pnas.2418239121.
5	F. Xi, S.J. Davis, P. Ciais, D. Crawford-Brown, D. Guan, C. Pade, T. Shi, M. Syddall, J. Lv, L. Ji, L. Bing, J. Wang, W. Wei, K.-H. Yang, B. Lagerblad, I. Galan, C. Andrade, Y. Zhang, Z. Liu, Substantial global carbon uptake by cement carbonation, Nature Geoscience 9 (2016) 880–883. https://doi.org/10.1038/ngeo2840.
6	G. Churkina, A. Organschi, C.P.O. Reyer, A. Ruff, K. Vinke, Z. Liu, B.K. Reck, T.E. Graedel, H.J. Schellnhuber, Buildings as a global carbon sink, Nature Sustainability 3 (2020) 269–276. https://doi.org/10.1038/s41893-019-0462-4.
7	R.L. Siegelman, E.J. Kim, J.R. Long, Porous materials for carbon dioxide separations, Nature Materials 20 (2021) 1060–1072. https://doi.org/10.1038/s41563-021-01054-8.