COURSE OUTLINE

1. GENERAL

SCHOOL	TECHNOLOGICAL APPLICATIONS		
DEPARTMENT	ENVIRONMENTAL ENGINEERING		
LEVEL OF STUDY	*Undergraduate*		
COURSE UNIT CODE	TA57B0	**SEMESTER OF STUDY**	7th
COURSE TITLE	CO_2 CAPTURE AND STORAGE TECHNOLOGIES		

COURSEWORK BREAKDOWN *σε περίπτωση που οι πιστωτικές μονάδες απονέμονται σε διακριτά μέρη του μαθήματος π.χ. Διαλέξεις, Εργαστηριακές Ασκήσεις κ.λπ. Αν οι πιστωτικές μονάδες απονέμονται ενιαία για το σύνολο του μαθήματος αναγράψτε τις εβδομαδιαίες ώρες διδασκαλίας και το σύνολο των πιστωτικών μονάδων*	**TEACHING WEEKLY HOURS**	**ECTS Credits**
Theory	2	3
Προσθέστε σειρές αν χρειαστεί. Η οργάνωση διδασκαλίας και οι διδακτικές μέθοδοι που χρησιμοποιούνται περιγράφονται αναλυτικά στο 4.		

COURSE UNIT TYPE *Υποβάθρου , Γενικών Γνώσεων, Επιστημονικής Περιοχής, Ανάπτυξης Δεξιοτήτων*	Scientific Area
PREREQUISITES :	
LANGUAGE OF INSTRUCTION/EXAMS:	GREEK
COURSE DELIVERED TO ERASMUS STUDENTS	YES (ENGLISH, FRENCH)
MODULE WEB PAGE (URL)	http://eclass.teikoz.gr

2. LEARNING OUTCOMES

Learning Outcomes

Περιγράφονται τα μαθησιακά αποτελέσματα του μαθήματος οι συγκεκριμένες γνώσεις, δεξιότητες και ικανότητες καταλλήλου επιπέδου που θα αποκτήσουν οι φοιτητές μετά την επιτυχή ολοκλήρωση του μαθήματος.

Συμβουλευτείτε το Παράρτημα Α

- *Περιγραφή του Επιπέδου των Μαθησιακών Αποτελεσμάτων για κάθε ένα κύκλο σπουδών σύμφωνα με Πλαίσιο Προσόντων του Ευρωπαϊκού Χώρου Ανώτατης Εκπαίδευσης*
- *Περιγραφικοί Δείκτες Επιπέδων 6, 7 & 8 του Ευρωπαϊκού Πλαισίου Προσόντων Διά Βίου Μάθησης*

και Παράρτημα Β

- *Περιληπτικός Οδηγός συγγραφής Μαθησιακών Αποτελεσμάτων*

This course introduces to "Carbon dioxide (CO_2) Capture and Storage (CCS) technologies", which are aimed at reducing greenhouse gas emissions from burning fossil fuels during industrial and energy-related processes (such as for power generation, accounting for about 40% of total anthropogenic CO2 emissions, cement manufacturing etc.), this being an increasingly urgent priority nowadays.

CCS technologies are practically the only methods currently available to contribute to reducing CO_2 emissions, while offering important possibilities to allow a further use of fossil fuels more compatible with climate change mitigation policies.

Already, several academic institutions and research institutes as well as major energy industrial companies are working together and closely with government organizations, mainly in the EU and the USA, in various projects, in order to advance the science, economics and engineering applications that will underpin the deployment of industrial-scale CCS.

Upon successful completion of the course, the student will be prepared to face the scientific and professional reality and practice as to the CCS technologies. Indeed, need for specialists, engineers/technologists, is expected to be fast growing in the near future, both for CO_2 capture (which has received most attention in CCS research so far) and for starting to find out access to suitable storage locations and how storage should be implemented in a safe and stable manner. Moreover, need for experts is also foreseen for full environmental monitoring that must accompany all pilot sequestration projects so that industrial scale data sets can be established quickly to guide decision making.

General Skills

Λαμβάνοντας υπόψη τις γενικές ικανότητες που πρέπει να έχει αποκτήσει ο πτυχιούχος (όπως αυτές αναγράφονται στο Παράρτημα Διπλώματος και παρατίθενται ακολούθως) σε ποια / ποιες από αυτές αποσκοπεί το μάθημα;.

Αναζήτηση, ανάλυση και σύνθεση δεδομένων και πληροφοριών, με τη χρήση και των απαραίτητων τεχνολογιών
Προσαρμογή σε νέες καταστάσεις
Λήψη αποφάσεων
Αυτόνομη εργασία
Ομαδική εργασία
Εργασία σε διεθνές περιβάλλον
Εργασία σε διεπιστημονικό περιβάλλον
Παράγωγή νέων ερευνητικών ιδεών
Σχεδιασμός και διαχείριση έργων
Σεβασμός στη διαφορετικότητα και στην πολυπολιτισμικότητα
Σεβασμός στο φυσικό περιβάλλον
Επίδειξη κοινωνικής, επαγγελματικής και ηθικής υπευθυνότητας και ευαισθησίας σε θέματα φύλου
Άσκηση κριτικής και αυτοκριτικής
Προαγωγή της ελεύθερης, δημιουργικής και επαγωγικής σκέψης

- Autonomous work
- Teamwork
- Project planning and management
- Work in an interdisciplinary environment
- Respect for the natural environment

3. COURSE CONTENTS

In the beginning, basic introductory scientific issues will be discussed, and then emphasis will be placed to major scientific/research achievements regarding the development of new processes, technologies and applications for CCS, in a multidisciplinary approach. In particular:

<u>CO_2 Capture Technologies</u>:

a) By using photosynthetic organisms to fix carbon, thus providing a biomass energy source. Especially, CO_2 bio-mitigation using microalgae, being currently in the limelight, will be explained.

b) By direct capture from the air. Applications comprise valorization of industrial wastes (including coal fly ashes and steel slags) as sorbents by their accelerated carbonation or conversion into zeolites for mineral sequestration of CO_2, development of biomass-derived biochars, various chemical absorption processes, membrane-based technologies etc.

Upon CO_2 capture, possible synergistic effects of other co-emitted pollutants (such as SO_2, NO_X and dust) should also be outlined.

Moreover, cost issues for CO_2 capture will be discussed, as they still remain significant for several large industrial activities, although the experience already earned from operating the first capture units worldwide and possible synergy effects of a common infrastructure are expected to make a significant contribution for further advancement of the application of these technologies.

<u>CO_2 Storage Technologies</u>:

Beyond natural absorption of CO_2 in oceans, forests and soil, potential options under examination for gas storage include pumping into deep ocean water, a huge potential reservoir for dissolved CO_2, or even in a subsurface deposit area into the earth's crust in various types of porous rock that should co-exist with dense cap rock possessing a necessary holding capacity to prevent leaks.

Reference should be made to leakage rates of CO_2 back to the atmosphere from potential ocean and geological and ocean sequestration, as it appears that both storage technologies can at least lessen the net flow of the gas into the atmosphere adequately to prevent catastrophic climate change.

In addition to technologies already getting well known for in CO_2 storage, alternative methods for adding value to gas disposal, thus potentially providing offsetting economic applications for sequestration, will also be mentioned, e.g. recently reported use of CO_2 intended for oceanic disposal to carry out seawater desalination through the formation of CO_2 hydrate.

Furthermore, novel research in the field of CO_2 utilization as a feedstock in the chemical, energy and materials sectors, which is underway to help minimize environmental impact, will also be mentioned.

4. TEACHING METHODS - ASSESSMENT

MODE OF DELIVERY *Πρόσωπο με πρόσωπο, Εξ αποστάσεως εκπαίδευση κ.λπ.*	• In the classroom • Face to face
USE OF INFORMATION AND COMMUNICATION TECHNOLOGY *Χρήση Τ.Π.Ε. στη Διδασκαλία, στην Εργαστηριακή Εκπαίδευση, στην Επικοινωνία με τους φοιτητές*	• Extensive use of electronic literature databases (including Scopus, ScienceDirect, Springerlink) in teaching (lectures and individual/group work) • Support of learning process through the e-class platform • Continuous communication and cooperation responsible professor - student via e-mail

TEACHING METHODS

Περιγράφονται αναλυτικά ο τρόπος και μέθοδοι διδασκαλίας.
Διαλέξεις, Σεμινάρια, Εργαστηριακή Άσκηση, Άσκηση Πεδίου, Μελέτη & ανάλυση βιβλιογραφίας, Φροντιστήριο, Πρακτική (Τοποθέτηση), Κλινική Άσκηση, Καλλιτεχνικό Εργαστήριο, Διαδραστική διδασκαλία, Εκπαιδευτικές επισκέψεις, Εκπόνηση μελέτης (project), Συγγραφή εργασίας / εργασιών, Καλλιτεχνική δημιουργία, κ.λπ.

Αναγράφονται οι ώρες μελέτης του φοιτητή για κάθε μαθησιακή δραστηριότητα καθώς και οι ώρες μη καθοδηγούμενης μελέτης ώστε ο συνολικός φόρτος εργασίας σε επίπεδο εξαμήνου να αντιστοιχεί στα standards του ECTS

Method description	***Semester Workload***
A) Lectures B) Study & Presentation of scientific/research literature review (in constant cooperation with the responsible professor during the semester, for the introduction of students to recent scientific progress and research results and the development of critical thinking, via: i) the integration into educational procedure of continuously renewed theoretical and/or research material from publications in peer-reviewed international scientific journals and congresses/conferences proceedings, using Internet search engines and scientific literature databases) ii) feedback from undergraduate students carrying out their Research Thesis in the Laboratory)	26
Oral Presentation of students Studies	2
Self-study	47

	Course Total (25 hours of work load /credit unit)	***75***
ASSESSMENT METHODS *Περιγραφή της διαδικασίας αξιολόγησης* *Γλώσσα Αξιολόγησης, Μέθοδοι αξιολόγησης, Διαμορφωτική ή Συμπερασματική, Δοκιμασία Πολλαπλής Επιλογής, Ερωτήσεις Σύντομης Απάντησης, Ερωτήσεις Ανάπτυξης Δοκιμίων, Επίλυση Προβλημάτων, Γραπτή Εργασία, Έκθεση / Αναφορά, Προφορική Εξέταση, Δημόσια Παρουσίαση, Εργαστηριακή Εργασία, Κλινική Εξέταση Ασθενούς, Καλλιτεχνική Ερμηνεία, Άλλη / Άλλες* *Αναφέρονται ρητά προσδιορισμένα κριτήρια αξιολόγησης και εάν και που είναι προσβάσιμα από τους φοιτητές.*	Two examination methods are provided, for, as far as possible, comprehensive assessment of the response, performance and capabilities of students: a) the final Written Examination (A or B examination period), with 10 short-answer questions throughout the course content. b) the assessment of the (optional) Study and Presentation of relevant scientific research literature. This grade is the outcome of i) the student's response for preparation of the Study in continuous cooperation with the responsible professor during the semester and ii) the evaluation of both the final text of the Study and of its presentation using PowerPoint in front of all students of the course at the end of the semester.	

5. RESOURCES

- Recommended Book Resources:
- Recommended Article/Paper Resources:

Proposed sources for the introduction to the basic knowledge of the subject, as well as to deepen into more specific topics, are:

BOOKS

- "Carbon Capture and Storage in Industrial Applications", OECD/International Energy Agency and United Nations/Industrial Development Organization, 2011.
- R.E. Hester, R.M. Harrison (eds.), "Carbon Capture: Sequestration and Storage", Royal Society of Chemistry, RSC Publishing, 2010.
- S. Rackley, "Carbon Capture and Storage", Gulf Professional Publishing, 2009.

PUBLICATIONS IN PEER-REVIEWED INTERNATIONAL SCIENTIFIC JOURNALS

- www.scopus.com
- www.sciencedirect.com
- www.springerlink.com