COURSE OUTLINE

(1) GENERAL

SCHOOL	POLYTECHNIC		
ACADEMIC UNIT	ARCHITECTURE		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	ARC_301	SEMESTER	7th
COURSE TITLE	SUSTAINABLE DESIGN		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	WEEKLY TEACHING HOURS	CREDITS
	4	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	specialised general knowledge
PREREQUISITE COURSES:	Architectural Design 1-4, Building Technology 1-2
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/ARCH585/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

On successful completion of the course, students will be able to:

- Demonstrate a critical understanding of the term sustainability and the different ways with which sustainability is defined in relation to design and the environment.
- Demonstrate a global understanding the main approaches to sustainable design.
- Demonstrate a practical understanding of systems thinking and how it can be applied to frame and tackle questions of sustainability
- Demonstrate a practical understanding of various methods modeling and simulation of complex systems in relation to sustainability.
- Demonstrate a practical understanding of conducting causal loop analysis to analyze complex sociotechnical systems
- Demonstrate problem solving skills
- Demonstrate a broad understanding of contemporary trends in intelligent mobility on demand systems and a critical understanding of their costs and benefits.
- Develop the ability for independent thinking and in parallel for teamwork through the combination of different teaching methods used in the course.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*

- Search for, analysis and synthesis of data and information with the use of the necessary technology
- Adapting to new situations
- Decision-making
- Working independently
- Team work
- Working in an interdisciplinary environment
- Production of new research ideas
- Project planning and management
- Respect for the natural environment
- Criticism and self-criticism
- Production of free, creative and inductive thinking
- Communication skills
- Capacity for critical thinking

(3) SYLLABUS

From smart buildings and mobility systems to automated construction methods and circular approaches to reuse of resources, information technologies and systems thinking are changing our perspective to sustainable design. A more holistic approach that considers the entire lifecycle of urban, building and mobility systems as well as their interactions with humans is complementing traditional strategies of bioclimatic design. Such approach requires understanding sustainability as a performative attribute of systems that depends on the interactions of their components and a familiarity with theories, tools and methods to define, analyze, model and simulate such interactions.

The course approaches the subject of sustainable design of building, urban and mobility systems through systems theory and systems science. It introduces bioclimatic design principles and insights into the analysis, modelling, and simulation of complex systems as well as how these techniques can be applied to understand, frame, and approach important sustainability questions in architectural or urban design. Students will learn how to considers benefits, costs and performance limitations of systems, how to formulate meaningful research questions, and how to use diagrammatic methods, interactive simulations, and data visualizations to qualitatively explore scenarios to address them. Emphasis is placed on participatory or collaborative systems, on resource sharing, and on circular economies with applications in shared mobility systems and their interactions with shared living and working spaces.

The course combines lectures, class discussions, demos, a design lab project, student presentations and occasionally guest speakers. The course is organized into two thematic areas, taught interchangeably. The first area focuses on bioclimatic design of building envelopes through a practical approach. The second area focuses on urban and mobility systems and cyclical approaches to design through a system thinking approach. The design lab project synthesizes these two thematic areas. Collectively, the topics, techniques and technologies in the two thematic areas cover concepts of passive, active, and behavioral strategies to sustainable design. Due to the breadth of topics covered, there is no single dedicated textbook for the course. A list of suggested readings is provided in combination with lecture notes.

Weekly topics (topics subject to change)

1. Introduction: Sustainability, Carbon footprint, Circularity, Lifecycle Design
2. Bioclimatic Design

3. Design and analysis 1: the building envelope
4. Mobility on Demand (MoD) systems
5. System Dynamics and causal loop analysis
6. Design and analysis 2: Physics
7. Working session
8. Interim Reviews
9. Guest lecture on Circularity / System dynamics and stock-flow modeling
10. Working session
11. Working session
12. Cities and mobility: Land uses, building program, and sustainability of MoD systems / Guest lecture on computational urban sustainability
13. Final Reviews

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in teaching and communication with students. Support of learning through the e-learning platform e-class. Demonstration of use of software for system dynamics modeling and simulation.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	See table below
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Language of evaluation: Greek, English. Methods of evaluation: Laboratory work (30%), public presentations during mid-term and final reviews (30%), and individual or team discussions with the instructors (30%) constitute 90% of the grade. Participation and engagement in the lectures constitute 10%. The laboratory work consists of a group project that expands throughout most of the semester. The evaluation procedure and criteria are presented to students in the first lecture and in the assignment descriptions that are being distributed. Any changes are announced in advance and are included in the course website and in the assignment descriptions.

Activity	*Semester workload*
Lectures	40
Seminars - Educational visits	10
Presentations - Discussions	40
Independent study - Bibliographical research - Project	60
Course total (25 hours = 1ECTS)	***150***

(4) ATTACHED BIBLIOGRAPHY

Suggested Bibliography:

- *Mitchell, Frederico Casalegno Willliam J. Connected Sustainable Cities. MIT Mobile Experience Lab, 2008.*
- *Mitchell, William J., Chris E. Borroni-Bird, and Lawrence D. Burns. Reinventing the Automobile: Personal Urban Mobility for the 21st Century. New edition. Cambridge, MA: The MIT Press, 2010.*
- *Mostafavi, Mohsen, Gareth Doherty, and Harvard University Graduate School of Design, eds. Ecological Urbanism. Revised edition. Zürich: Lars Muller, 2016.*

- *Pollalis, Spiro, Andreas Georgoulias, Stephen Ramos, and Daniel Schodek, eds. Infrastructure Sustainability and Design. 1st edition. New York, NY: Routledge, 2012.*
- *Papanikolaou, Dimitris. "Intelligent Infrastructures." In Infrastructure Sustainability and Design, edited by Spiro N. Pollalis, Andreas Georgoulias, Stephen J. Ramos, and Daniel Schodek, 1 edition., 266–75. New York, NY: Routledge, 2012.*
- *Papanikolaou, Dimitris. "The Cost of Sharing Bikes and Docks: Quantifying Rent and Work Requirements between Four Bike Sharing Systems in North America." Travel Behaviour and Society 25 (October 1, 2021): 193–208. https://doi.org/10.1016/j.tbs.2021.05.009.*
- *Papanikolaou, Dimitris. "To Share or Not? A Critical View on Personal Mobility." Architecture and Culture 7, no. 3 (September 2, 2019): 399–417. https://doi.org/10.1080/20507828.2019.1653030.*
- *Papanikolaou, Dimitris. "Data-Driven State Space Reconstruction of Mobility on Demand Systems for Sizing-Rebalancing Analysis." In Proceedings of the Symposium on Simulation for Architecture and Urban Design, 1–8. SIMAUD '18. San Diego, CA, USA: Society for Computer Simulation International, 2018.*
- *Papanikolaou, Dimitris. "Computing and Visualizing Taxi Cab Dynamics as Proxies for Autonomous Mobility on Demand Systems." In Computer-Aided Architectural Design. "Hello, Culture," edited by Ji-Hyun Lee, 183–97. Communications in Computer and Information Science. Springer Singapore, 2019.*
- *Meadows, Donella H., Jorgen Randers, and Dennis L. Meadows. Limits to Growth: The 30-Year Update. 3rd ed. Chelsea Green, 2004.*
- *Forrester, Jay Wright. Urban Dynamics. Book, Whole. Cambridge, Mass.: M.I.T. Press, 1969.*
- *Forrester, Jay Wright. World Dynamics. 2d ed. Book, Whole. Cambridge, Mass.: Wright-Allen Press, 1973.*
- *Forrester, J. W. "Systems Analysis as a Tool for Urban Planning." IEEE Spectrum 8, no. 1 (January 1971): 48–58. https://doi.org/10.1109/MSPEC.1971.6501063.*
- *"Lifecycle Construction Resource Guide." EPA Region 4. 61 Forsyth Street SW Atlanta, GA 30303: United States Environmental Protection Agency. Pollution Prevention Program Office Office of Policy and Managemen, February 2008. www.epa.gov/region4/p2.*
- *Rios, Fernanda Cruz, Wai K. Chong, and David Grau. "Design for Disassembly and Deconstruction - Challenges and Opportunities." Procedia Engineering, Defining the future of sustainability and resilience in design, engineering and construction, 118 (January 1, 2015): 1296–1304. https://doi.org/10.1016/j.proeng.2015.08.485.*
- *Sterman, John, and John D. Sterman. Business Dynamics: Systems Thinking and Modeling for a Complex World with CD-ROM. McGraw-Hill/Irwin, 2000.*
- Ενέργεια στην αρχιτεκτονική: Το Ευρωπαϊκό Εγχειρίδιο για τα παθητικά ηλιακά κτήρια, 1996, Μαλλιάρης-Παιδεία.
- Ανδρεαδάκη-Χρονάκη, Ε. Βιοκλιματικός Σχεδιασμός – Περιβάλλον και Βιωσιμότητα», 2006, University Studio Press, Θεσσαλονίκη.
- Άγις Μ. Παπαδόπουλος. Θερμική Άνεση στα Κτήρια. Νέα Πρότυπα και Βελτίωση Θερμικής Άνεσης στα Κτήρια, 2006, Θεσσαλονίκη,.
- Αναλυτικές Εθνικές Προδιαγραφές Παραμέτρων για τον υπολογισμό της Ενεργειακής Απόδοσης Κτηρίων και την Έκδοση του Πιστοποιητικού Ενεργειακής απόδοσης: Τεχνική Οδηγία Τεχνικού Επιμελητηρίου Ελλάδος, Τ.Ο.Τ.Ε.Ε. 20701-1/2017, Υ.Π.ΕΝ.
- GAUZIN - MULLER DOMINIQUE. Sustainable Architecture and Urbanism: Concepts, Technologies, Examples, 2002, Birkhauser.
- *Baker, Nick, and Koen Steemers. Energy and Environment in Architecture: A Technical Design Guide. 1st edition. New York: Taylor & Francis, 1999.*