COURSE OUTLINE

(1) GENERAL

SCHOOL	FACULTY OF SCIENCES		
ACADEMIC UNIT	PHYSICS DEPARTMENT		
LEVEL OF STUDIES	POSTGRADUATED		
COURSE CODE	**M212**	**SEMESTER**	**1**
COURSE TITLE	CLIMATOLOGY		

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	7
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*	general background, specialised general knowledge,
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	

(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*

The course is offered to Master students of Atmospheric Sciences having either limited or zero knowledge about the Earth's Climate. It aims to provide 1st-year MSc students with an integrated and advanced knowledge on the Earth's climate as well as its changes. Specific emphasis is given to the acquisition of a deep understanding of physical climate processes and principles and laws that govern climate. More specifically, upon successful completion of the course, the students are expected to:

- learn the exact definition and characteristics of climate as well as the differences and similarities of Climate science with other Atmospheric sciences, with emphasis to the definition and priorities of contemporary Climatology and climate
- be up to date about the recent state of the Earth's climate and the means and methods of its observation and monitoring, emphasizing the nature and patterns of the changes that climate has undergone after the industrial revolution.

- own sufficient knowledge of the basic physical processes, either natural or anthropogenic, that determine climate. In particular, to know the ways that external factors, like the Sun and solar changes, for example the Milankovitch cycles, affect the terrestrial climate, and also how this is influenced by internal factors, namely the greenhouse effect.
- dispose a deep understanding of the main causes/parameters/processes that drive climate, with specific emphasis to its main determinant, namely the Earth's energy budget, which is the contemporary framework of study and understanding of climate at scales ranging from planetary to local scales.
- learn how the Earth's energy budget, and in particular the radiation budgets of solar and infrared (terrestrial) radiation, are determined. Moreover, to know how the solar and terrestrial radiation fluxes are transferred within the Earth-atmosphere system and how they interact with atmospheric constituents and surface. Finally, to be up to date about the distribution and budgets of solar and terrestrial radiation for the Earth-atmosphere system.
- have a good knowledge of the Earth's energy budget at the Earth's surface and within its atmosphere as well as their changes in space and time. Also, to have a comprehensive understanding and basic knowledge of the hydrological cycle and budget and its components.
- have a good knowledge of the atmospheric general circulation, the relevant theories and its main patterns, as well as its role and link with the Earth's planetary climate.
- know what are the main patterns of the various types of Earth's climates and the main climate classification schemes.
- be up to date about the sensitivity of the Earth's climate and its various feedback mechanisms.
- be informed on the main patterns of climate changes, with emphasis to the recent ones, and their natural and anthropogenic drivers.

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
Respect for the natural environment
Adapting to new situations
Working independently
Team work
Working in an international environment
Criticism and self-criticism
Production of free, creative and inductive thinking

(3) SYLLABUS

Introduction to the climatic Earth-atmosphere system. The science of Climatology and its historical evolution. The various climatic parameters. Climatological space and time scales. The Earth's energy budget. The current Earth's climate and its changes with respect to the pre-industrial revolution conditions. The electromagnetic radiation. Theory and laws of black body radiation. Interaction of radiation spectra with the terrestrial atmosphere. The solar radiation, its production, transfer and distribution within the Earth-atmosphere system. Changes of solar radiation (Milankovitch cycles, solar activity) and their relationships with the Earth's climate and its changes. The terrestrial radiation, its production, transfer and distribution within the Earth-atmosphere system. The natural greenhouse effect, its role for the Earth's climate and the anthropogenic effect on climate (anthropogenic greenhouse effect). Monitoring of the radiation balance from space. The Earth's surface, atmosphere and top-of-atmosphere energy budgets. The hydrological cycle, its components (precipitation, evapotranspiration, run-off and storage) and the water budget. The general circulation of the atmosphere. The atmospheric energy budget, the movement of atmospheric air and the meridional energy transport. Regional climates of the Earth. Main climate classifications (Köppen, Thornthwaite). Climatic feedback mechanisms (ice-albedo, clouds). Natural forcings of climate change (external, e.g. related to the Sun, and internals, e.g. related to the Earth's atmosphere and surface). Anthropogenic forcings of climate change (aerosols, atmospheric gases). The El Nino Southern Oscillation (ENSO).

Climate database management and real-time temperature monitoring for the city of Ioannina.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face learning
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	
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*	
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 examinations at the end of semester, in greek (or in English in case of foreign students), which include open-ended questions as well as problem solving.

Activity	***Semester workload***
Lectures	52
Tutorials	16
Study of bibliography	80
Project	17
Climate monitoring for Ioannina	7
Examinations	3
Course total	***175***

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.*	Additionally, two or three projects requiring data acquisition/processing/analysis as well as reporting computed results are assigned to the students. The marks of these projects contribute to the final grade provided that the final examination grade is promotable. In addition written work and essay/report is assigned to the students during the course, requiring bibliographic update, internet search, acquisition and analysis of data. The results are also presented orally before the final written examination. This has a small bonus contribution to the students' final passing mark.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:
- Related academic journals:

- Physical Climatology (in greek), H. S. Sahsamanoglou and A. A. Bloutsos, Zitis Publications, Thessaloniki, Greece (1998).
- Meteorology and Climatology courses (in greek), A. Flocas, Zitis Publications, Thessaloniki, Greece (1997).
- Electronic notes, N. Hatzianastassiou (yearly updated).
- Global Physical Climatology, D. L. Hartmann, Academic Press, San Diego, California, USA (1994).
- Contemporary Climatology, A. Henderson-Sellers and P. J. Robinson, Longman Scientific & Technical, United Kingdom (1986).
- Radiation and climate, I. M. Vardavas and F. W. Taylor, Oxford Science Publications, United Kingdom (2011).