Bachelor in Physics
(Academic Year 2024-25)

Physics of the Atmosphere		**Code**	800511	**Year**	3rd	**Sem.**	2nd
Module	Applied Physics	**Topic**	Compulsory for Applied Physics	**Character**	Optional		

	Total	Theory	Pract./Semin.	Lab.
ECTS Credits	6	4.2	1.8	
Semester hours	45	31	8	6

Learning Objectives (according to the Degree's Verification Document)

- *To acquire knowledge on the main physical characteristics and processes regulating the atmosphere's behavior.*
- *To identify the physical laws (radiation, thermodynamics, dynamics) regulating the main atmospheric processes.*
- *To acknowledge the atmosphere's role as one of the main components of the climate system, and to identify the basic aspects of the Physics of climate change.*
- *To apply the acquired knowledge to practical cases through problem solving and practical training*

Brief description of contents

Atmospheric composition; solar and terrestrial radiation; energy balance; water vapor and cloud formation; air motion equation; weather analysis and prediction; climate changes.

Prerequisites

Coordinator	Carlos Yagüe Anguís		**Dept.**	FTA
	Office	04.110.0	**e-mail**	carlos@ucm.es

Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	10	Mo We	17:00 – 18:30 16:30 – 18:00	Blanca Ayarzagüena Porras	Full term	37,5	T/E	FTA

T: Theory, E: Exercises

Group	Computer Lab	Day - hours	Professor	Hours	Dept.
LB1	AI(A1)	26 March, y 9th, , 23rd and 30th April,	Blanca Ayarzagüena Porras	6	FTA
	Teaching laboratory of Meteorology and Geophysics (4th floor)	7th May		1,5	

Office hours				
Group	**Professor**	**Schedule**	**E-mail**	**Location**
B	Blanca Ayarzagüena Porras	L: 10.30h-12.00h V: 11.30h-13.00h Resto on-line	bayarzag@ucm.es	04.233.0

Syllabus

Theory

1. Introduction. Physics of the atmosphere. Air composition. Origin of Earth's atmosphere. Vertical distribution of atmospheric mass. Vertical distribution of temperature.
2. Fundamental thermodynamic processes in the atmosphere. Equation of state for air. Virtual temperature. Hydrostatic equation. Adiabatic processes. Potential temperature.
3. Water vapor in air. Phases of water in the atmosphere. Saturation. Moisture parameters. Formation of fog and clouds.
4. Atmospheric stability and cloud formation. Ascent of air parcels: temperature variation. Dry adiabatic and saturated adiabatic lapse rates. Adiabatic and pseudoadiabatic ascent. Static stability. Convection and cloud formation. Thermodynamic diagrams.
5. Energy balance. Heat transfer in the atmosphere. Solar and terrestrial radiation. Fundamental radiation laws. Absorption, emission and equilibrium. Greenhouse effect. Total energy balance. Implications for climate change studies. Latitudinal variations of energy balance.
6. Temperature. Hemispheric seasonal variations in temperature: causes and effects. Local seasonal variations in temperature. Daily temperature variations. Measuring air temperature.
7. Air pressure and winds. Atmospheric pressure. Variation with height. Forces that influence the winds. The geostrophic wind. The gradient wind. Effect of surface friction.
8. Weather analysis and prediction. Global observing system. Meteorological maps. Weather forecasting methods using meteorological maps. Current weather forecasting. Numerical models. Weather predictability.

Practical sessions

Five practical sessions will be held (four in the computer classroom and one in the Teaching Laboratory of Meteorology and Geophysics on the 4th floor)

Bibliography

BASIC

- C.D. Ahrens and R. Henson (2019). Meteorology Today, 12th edition. Cengage. Also online resource from the library: https://ucm.on.worldcat.org/oclc/1227788986
- J.M. Wallace and P.V. Hobbs (1977, 1st edition; 2006, 2nd edition). Atmospheric Science: An Introductory Survey. Academic Press. Elsevier

COMPLEMENTARY

- R.B. Stull (2000). Meteorology for Scientists and Engineers, 2nd ed. Brooks/Cole Thomson Learning.
- Sendiña Nadal and V. Pérez Muñuziri (2006). Fundamentos de Meteorología. Academic Press. Universidad de Santiago de Compostela (Servicio Publicaciones).
- M. Ledesma Jimeno (2011). Principios de Meteorología y Climatología. Ediciones Paraninfo S.A.
- Zúñiga López, Ignacio; Crespo del Arco, Emilia; Fernández Sánchez, Julio; Santos Burguete,Carlos (2016). Problemas de meteorología y climatología. UNED.

Online Resources

Virtual campus

Meteorology and Climate virtual laboratory: http://meteolab.fis.ucm.es/

Methodology
The following training activities will be conducted: ● Theory lessons where the main concepts of Physics of the Atmosphere will be explained, including examples and applications. ● Problem solving classes will be combined with theory lessons to provide an adequate complement. ● Questionnaires and/or practical exercises will be proposed through the use of Virtual Campus. ● Four practical sessions will be held in the Computer Classroom and one in the Teaching Laboratory of Meteorology and Geophysics on the 4th floor (lecture experiments supported by the Meteolab tool). All of them will be 90 minutes each and will serve to reinforce the knowledge acquired in theory lessons. For the theory lessons, projected computer presentations and explanations with the blackboard will be used. Occasionally, the lessons can be complemented with real cases of particular meteorological situations. The computer presentations and proposed exercises will be provided to the students through the virtual campus in advance. As part of the continuous evaluation, students will have to hand in the proposed exercises and practice reports in due time, as specified.

Evaluation Criteria		
Exams	**Weight:**	70%
A Final Exam will be performed, which can consist of multiple-choice questions, short questions with theoretical and/or practical argumentation and/or problem solving. No reference material will be allowed. The Final Exam (Nexam) will be marked over 10.		
Other Activities	**Weight:**	30%
Throughout the course, as part of the continuous evaluation, students will hand in the proposed exercises in due time, as specified. A partial test can be proposed in class time. It can include multiple-choice questions and/or exercises. The test will be announced in advance in class and through the Virtual Campus. Lab practices, to which attendance is compulsory, will be held as programmed. Students will hand in a report for each of them. The overall mark for Other Activities (NOtherActiv) will be provided over 10.		
Final Mark		
The final mark will be the result of the following equation: CFinal = 0.7 x NExam + 0.3 x NOtherActiv, where NOther is the mark for Other Activities and NExam the one obtained in the Final Exam. The mark for the June-July resit will be obtained following the same evaluation procedure.		