SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University of Cluj-Napoca**
1.2 Faculty	**Environmental Science and Engineering**
1.3 Department	**Environmental Analysis and Assessment**
1.4 Field of study	**Environmental Engineering**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Sustainable Developement and Environmental Management**

2. Information regarding the discipline

2.1 Name of the discipline	LIDAR systems						
2.2 Course coordinator	**Nicolae Ajtai, Lecturer Ph.D.**						
2.3 Seminar coordinator	**CS III dr. Horatiu Stefanie**						
2.4. Year of study	**II**	2.5 Semester	**3**	2.6. Type of evaluation	**C**	2.7 Type of discipline	Optional

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	1	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	42	Of which: 3.5 course	14	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					15
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					15
Tutorship					2
Evaluations					4
Other activities:					

3.7 Total individual study hours	56
3.8 Total hours per semester	98
3.9 Number of ECTS credits	4

4. Prerequisites (if necessary)

4.1. curriculum	Basic knowledge of atmospheric environment
4.2. competencies	Basic computer and technical skills

5. Conditions (if necessary)

5.1. for the course	Video projector
5.2. for the seminar /lab activities	Laboratory with computers;

6. Specific competencies acquired

Professional competencies	• Understanding the concepts, methods and models used in environmental data acquisition and remote sensing • Understanding the composition of the atmosphere and its dynamics • Understanding radiative transfer through the atmosphere • Understanding basic meteorological aspects • Understanding the principles of active and passive remote sensing • Learn to derive microphysical properties of particles from optical ones • Learn to use trajectory models for particle dynamics • Learn the basic operation of LIDAR systems
Transversal competencies	• Apply descriptive methodologies according to the type of study design for answering a particular research question • Learn data processing with specific software • Learn to work in research teams • Learn to integrate environmental data with other socio-economical parameters in order to get a broader perspective on sustainable development

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Acquire expertise regarding concepts, methodologies and techniques used in environmental data acquisition and LIDAR remote sensing
7.2 Specific objective of the discipline	• Acquire a theoretical background regarding data acquisition and remote sensing • To provide hands-on expertise in the use of LIDAR systems and remote sensing instrumentation • Learn to integrate different types of environmental data in order to better characterize environmental factors

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction. Initial Evaluation	• Conversation • Assessment	
2. The atmosphere. Composition and dynamics	• Interactive exposure • Explanation • Oral presentation • Conversation	
3. Radiative transfer through the atmosphere	• Interactive exposure • Explanation • Oral presentation	

	• Conversation	
4. Active and passive remote sensing systems.	• Interactive exposure • Explanation • Oral presentation • Conversation	
5. LIDAR systems. Set-up and operation.	• Interactive exposure • Explanation • Oral presentation • Conversation	
6. LIDAR data acquisition and processing.	• Interactive exposure • Explanation • Oral presentation • Conversation	
7. Final evaluation.	• Explanation • Conversation	
	• Assessment	

Bibliography

Wallace, J.M., Hobbs, P.V., (2006) –*Atmospheric science: an introductory survey* - 2nd edition., ISBN 13: 978-0-12-732951-2

Ştefan, S., Nicolae, D., Caian, M., (2008), *Secretele aerosolului atmosferic in lumina laserului*, Ed. Ars Docendi, Bucuresti

Ştefan, S., (2004), *Fizica Atmosferei, vremea şi clima,* Editura Universităţii, Bucureşti

Ristoiu, D., (2005), *Fizica atmosferei*, Ed. Napoca Star, ISBN: 973-647-268-X, 560 p.

Rayleigh, L., (1964), *On The Light From The Sky, Its Polarization And Colour*, Philos. Mag., vol. 41, 107-120, 274-279, reprinted Sci. Papers, vol. I, no. 8, 1869-1881, Dover, New York

Weitkamp, C., (2005), *Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere*, Springer, 460p.

Lenoble, J., (1993), *Atmospheric radiative transfer,* Publisher Hampton : Deepak, ISBN: 0937194212

Holloway, A., Wayne, R., (2010), *Atmospheric chemistry*, RSC Publishing, ISBN: 978-1-84755-807-7. 260 pp

Hobbs, P.V., (2000), *Introduction to Atmospheric Chemistry*, Camb. Univ. Press, p. 150

Ångström, A., (1929), *On the atmospheric transmission of sun radiation and on dust in the air*, Geogr. Ann., 11, 156–166

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Discussions over initial evaluation. Project assignments.	• Interactive discussions • Brainstorming	
2. Data acquisition procedures and protocols. Safety procedures in the laboratory	• Explanation • Oral presentation	
3. The radiative transfer equation.	• Explanation • Demostration • Hands-on learning	
4. LIDAR technique. Instrumentation.	• Explanation • Demostration • Hands-on learning	
5. LIDAR technique. Operation.	• Explanation • Demostration • Hands-on learning	
6. LIDAR technique. Data acquisition.	• Interactive discussions • Assessment	
7. LIDAR data pre-processing in LabView	• Explanation • Oral presentation	

8. LIDAR data processing in LabView.	• Explanation • Demostration • Hands-on learning	
9. LIDAR data processing in LabView.	• Explanation • Demostration • Hands-on learning	
10. HYSPLIT particle back-trajectory model	• Explanation • Demostration • Hands-on learning	
11. Joint project work.	• Explanation • Demostration • Hands-on learning	
12. Joint project work.	• Explanation • Demostration • Hands-on learning	
13. Joint project work.	• Explanation • Demostration	
14. Final project presentation	• Interactive discussions • Assessment	

Bibliography

Draxler, R.R., Rolph, G.D., (2012), HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://ready.arl.noaa.gov/HYSPLIT.php), NOAA Air Resources Laboratory, Silver Spring, MD

Dubovik, O., et al., (2006), *Application of spheroid models to account for aerosol particle nonsphericity in remonte sensing of desert dust,* J. Geophys. Res., 111, doi:10.1029/2005JD006619.

Dubovik, O., (2004), *Optimization of Numerical Inversion in Photopolarimetric Remote Sensing*, in Photopolarimetry in Remote Sensing (G. Videen, Y. Yatskiv and M. Mishchenko, Eds.), Kluwer Academic Publishers, Dordrecht, Netherlands, 65-106

Dubovik, O., Holben, B.N., Eck, T.F., Smirnov, A., Kaufman, Y.J., King, M.D., Tanre, D., Slutsker, I., (2002), *Variability of absorption and optical properties of key aerosol types observed in worldwide locations*, Journal of Atmospheric Science., 59, 590-608

Dubovik, O., Smirnov, A., Holben, B.N., (2000), *Accuracy assessments of aerosol optical properties retrieved from Aerosol Robotic Network (AERONET) sun and sky radiance measurements*, JGR, 105 (D8), 9791-9806

Dubovik, O., King, M.D., (2000), *A flexible inversion algorithm for retrieval of aerosol optical properties from Sun and sky radiance measurements*, J. Geophys. Res., 105, 20 673-20 696

Nicolae, D., (2006), *Tehnici LIDAR pentru caracterizarea aerosolilor din atmosfera joasă,* Teză de doctorat, Universitatea Politehnica Bucureşti

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

This course will give the opportunity for the students to work with state-of-the-art remote sensing LIDAR equipmets available within the Romanian Atmospheric 3D Research Observatory and get a complete and complex view of the atmospheric environment.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Theoretical and practical skills should	Coloquium	50%

	be demonstrated within a 2 hour colloquim		
10.5 Seminar/lab activities	Project presentation	Public presentation	50%
10.6 Minimum performance standards			
Successful passing of the course is conditioned by the final grade that has to be at least 5, and the two individual composig grades should also be at least 5.			

Date | Signature of course coordinator | Signature of seminar coordinator

15.04.2019

Date of approval | Signature of the head of department