COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Urban Climate	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Assoc. Prof. Justas Kažys **Other(s):**	Faculty of Chemistry and Geosciences, Institute of Chemistry Naugardukas str. 24, LT-03225 Vilnius

Study cycle	Type of the course unit (module)
First cycle	Optional

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face to face	Autumn	English

Requirements for students	
Prerequisites: fundamental of meteorology and atmospheric chemistry	**Additional requirements (if any): fundamental of meteorology**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	133	48	85

Purpose of the course unit (module): programme competences to be developed		
The main objectives of this course are to know fundamentals of urban climatology, to explore research methods of urban climate and to present differences of meteorological elements in urban environments.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
1. will be able to understand man features of urban climate and to describe processes of formation	Lectures, self-study	Final exam
2. will be able to detect changes in vertical and horizontal structures of radiation, air temperature, humidity, water fields in urban environment	Lectures, self-study, discussion	Presentation in the seminar, final exam
3. will be able to understand main urban air pollutants, their origin, development and measuring methods	Lectures, self-study	Final exam
4. will be able to understand urban effects on human ecology and climate change challenges in the cities	Lectures, self-study, discussion	Presentation in the seminar, final exam

Content: breakdown of the topics	Contact hours	nt ac	ud y	Self-study work: time and assignments

	Lectures	Seminars	Exercises	Laboratory work	Internship/work placement			Assignments
1. **Basics of urban climate (UC).** Environmental quality control. Urban climatology as independent science. Research history. Main objectives and goals. Growing of cities and future perspectives.	2					**2**		Reading and analysis of textbooks.
2. **Solar radiation and energy balance.** Changing in intensity. Urban albedo. Differences between components of energy balance. Anthropogenic heat emission and sources. Heat in city canyons.	2					**2**	**5**	Reading and analysis of textbooks.
3. **Thermal balance in the city.** Temperature changes during day and year. Heat island and its formation. Vertical structure of thermal fields. Thermal gradients. Inversions. Differences in temperature between rural and urban environments. Modelling of urban temperature.	3					**3**	**10**	Reading and analysis of textbooks. Preparation for seminar.
4. **Atmospheric humidity in the city.** Changing in humidity. Humidity changes during day and year. Cloudiness, precipitation, snow cover and atmospheric phenomena in urban environment.	1	4				**5**	**5**	Reading and analysis of textbooks. Discussion in seminar.
5. **Wind characteristics in the city.** Wind in boundary layer. Roughness. Changing in speed and direction. Modelling of wind fields.	2	4				**6**	**5**	Reading and analysis of textbooks. Discussion in seminar.
6. **Urban hydrology.** Run-off in the urban environment. Hydrographical systems. Evaporation from artificial surfaces.	1					**1**		Reading and analysis of textbooks.
7. **Atmosphere composition.** Air composition in the city. Pollution classification, sources and types. The main pollutants and their impact on health. Aerosols. Pollution monitoring and measuring. Maximus concentration levels. Modelling of pollutants spread.	3					**3**	**10**	Reading and analysis of textbooks. Preparation for seminar.
8. **Atmosphere composition (2).** Dynamics of pollutants. Smog in the city. London and Los Angeles types. Ozone concentration. Toxic compounds formation and distribution. Air conditions impact on pollution. Acid rains formation.	3	4				**7**	**5**	Reading and analysis of textbooks. Discussion in seminar.
9. Indoor pollution. Main pollutants and their impact on human health. Volatile	2	4				**6**	**5**	Reading and analysis of textbooks. Discussion in seminar.

organic compound (VOCs). Specific indoor pollutants. Sick Building Syndrome.								
10. **Urban noise.** Main sources of noise. Classification and levels. Measuring units. Mitigation and adaptation actions. EU perspective.	1					**1**	**10**	Preparation for seminar.
11. **Cities and humans.** Human thermal balance. Urban impact on thermal comfort and stress. Heat waves. Local thermal factors.	2	4				**6**	**5**	Reading and analysis of textbooks. Discussion in seminar.
12. **Cities and environment.** Green and blue zones in urban environment. Green roofs. Ecological planning of urban territories. Climate change impact and urban adaptation.	2	4				**6**	**5**	Discussion in seminar.
13. **Preparation to final exam**. Consultation before the exam. Individual preparation for the exam.							**20**	Reading and analysis of textbooks.
Total	**24**	**24**				**48**	**85**	

Assessment strategy	Weight,%	Deadline	Assessment criteria
2 oral presentation for every student and open discussion during seminars	40	During the semester	Maximum for seminars 40% (2 seminars x 20%) of final mark. Attendance no less than 75% of all seminars.
Final exam (written form) with 6 open (short) questions	60	During the session	Maximum for final exam 60% (6 questions x 10%). Exam only then seminars are passed. Positive mark only then 30% are aggregated during final exam.

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
Erell E., Pearlmutter D., Williamson T.	2011	Urban Microclimate Designing the Spaces Between Buildings, p: 1-140; 165-230		London: Earthscan
ESPERE net	2006	ESPERE Climate Encyclopaedia: Climate in Cities, 85 p		http://klimat.czn.uj.edu.pl/enid/Climate_in_Cities/basics_3op.html
Jacobson M. Z.	2002	Atmospheric pollution: history, science and regulation, p: 81-178; 241-272		New York: Cambridge University Press
Oke T.	1990	Boundary layer climates, p: 229-239; 242-261; 264-338		London: Routledge
Marzluff, J. ir kt. (red.)	2008	Urban Ecology: An International Perspective on the Interaction Between Humans and Nature, p: 161-280; 519-536		Berlin: Springer
Purkis S., Klemas V.	2011	Remote sensing and global environment change, p: 91-121		Chichester: Wiley-Blackwell
Optional reading				
Arya S. P. I.	2001	Introduction to		New York: Academic

		micrometeorology		Press
Brown R. P., Gillespie T. J.	1995	Microclimatic Landscape Design		New York: John Wiley & Sons
Burinskienė M. ir kt.	2000	Miestotvarka		Vilnius: Technika
Griciūtė A., Kavaliauskas B., Tomkus J.	1979	Lietuvos antropoklimatas		Vilnius: Mokslas
Fezer F.	1995	Das Klima der Städte		Gotha: Justus Perthes verlag
Foken T.	2003	Angewandte Meteorologie - Mikrometeorologische Methoden		Heidelberg: Springer-Verlag
Kaušyla K. A., Šver C. A. (red.)	1983	Klimat Vilniusa i Kaunasa	Klimat goroda	Leningrad: Gidrometeoizdat
Landsberg H. E.	1981	The urban climate	Int Geophys Ser 28	New York: Academic Press
Movčan V. N.	2006	Ekologija čeloveka		Sankt-Peterburg: Izdatelstvo S.-Peterburgskogo Universiteta
Rosenzweig, Cynthia; Hammer, Stephen A.; Solecki, William D.; Mehrotra, Shagun (eds.)	2011	Climate change and cities: First assessment report of the urban climate change research network (ARC3)		http://uccrn.org/resources/publications/arc3/
Rutkovienė V. M., Sabienė N.	2008	Aplinkos tarša		http://dspace.lzuu.lt/bitstream/1/548/1/Aplinkos%20tarsa.%20Rutkoviene%2C%20Sabiene_1.pdf
Werquin A. C., Duhem B., Lindholm G., Oppermann B., Pauleit S., Tjallingii S. (eds.)	2005	Green Structure and Urban Planning	COST C11	http://www.greenstructureplanning.eu/COSTC11-book/pdfs/a-Intro.pdf
Tiwary A., Colls J.	2010	Air Pollution Measurement, modelling and mitigation		New York: Routledge