Geomatics and Modelling

**Spring semester, 2021/2022**

***The course is proposed for students in the academic year 2020-2021 as an optional one.***

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| Coordinator | **Andrii Achasov**  **Anatolii Polevoy** |
| Credits | 3 ECTS, 24 in-class hours |
| Lecturers | **Andrii Achasov** (Karazin Institute of Environmental Sciences, V.N. Karazin Kharkiv National University, Ukraine)  **Anatolii Polevoy** (Odessa State Environmental University, Ukraine) |
| Level | PhD students |
| Host institution | Karazin Institute of Environmental Sciences, V.N. Karazin Kharkiv National University, Ukraine |
| Course duration | February - May |

**Summary**

The course "Geomatics and Modeling" is designed for PhD graduate students, conducting research on "environmental protection". The course is designed to increase the level of knowledge and skills of graduate students in the application of geomatics and modeling in research. The course involves active independent and classroom work with specialized computer software.

**Target student audiences**

PhD students in natural and environmental sciences.

**Prerequisites**

Required courses (or equivalents):

* Informatics and systemology
* GIS
* Modeling and forecasting of the state of the environment
* GIS in ecology
* System analysis of environmental quality

**Aims and objectives**

The course aims to teach PhD students in the methods of geomatics and modeling in the implementation of their specific scientific research as part of the preparation of a doctoral dissertation (PhD).

The brevity of the course "Geomatics and Modeling" presupposes the accelerated integration of knowledge and skills acquired during training at the first or second educational levels. Geomatics and modeling are now used in almost all branches of science and technology. These scientific areas include a huge variety of methods and technologies for solving specific scientific and practical problems. In the course of preliminary training, graduate students already have a basic knowledge base in these disciplines.

The objectives of the course are:

* updating the basic knowledge of postgraduate students in geomatics and modeling
* detailed acquaintance with the basic methods of geomatics and modeling
* familiarization of students with the capabilities of existing software, hardware, and information support
* in-depth study of the free software geoinformation product QGIS
* analysis of scientific works carried out by graduate students (PhD) to determine the possibilities of using the methods of geomatics and modeling in them
* choice of one \ several methods of geomatics by a graduate student for solving a specific scientific task

**General learning outcomes:**

After completing the course, graduate students must acquire new knowledge and develop existing competencies:

* basic knowledge of the functionality available in the GIS
* experience with free QGIS software
* knowledge of free sources for obtaining geodata, in particular, space images
* basic knowledge of spatial data analysis
* in-depth knowledge of certain types of spatial data analysis (depending on the chosen topic of scientific work)

**Overview of sessions and teaching methods**

The course assumes the following types of educational activities: lectures, practical works, independent work of graduate students.

The main emphasis in the study of the material will be placed on the unification of all these types of work based on individual scientific directions chosen by each graduate student.

In the first (basic) classes, graduate students update their theoretical knowledge in geomatics and modeling, receive information about new emerging methods, hardware, and software.

Postgraduate students are given an assignment for independent work - to analyze their scientific research, to determine the possibilities of using the methods of geomatics and modeling in them. In subsequent classes, collective discussions are held on each of the scientific topics of graduate students. As a result, a list of the most promising methods for use in scientific research is formed. Further classes are conducted according to an individual scheme, taking into account the results obtained in the previous step.

Graduate students choose topics for independent work. In the course of its implementation, they form a methodology for applying one or another direction of geomatics to solve their problems. During classroom lessons, this methodology is checked by the professor and tested.

The course involves intensive interactive scientific cooperation of graduate students with the lecturer at all stages. All practical exercises are conducted in computer labs. Depending on the topic of scientific research of graduate students, it is possible to conduct separate classes in the field.

**Course workload**

The table below summarizes course workload distribution:

|  |  |  |  |
| --- | --- | --- | --- |
| **Activities** | **Learning outcomes** | **Assessment** | **Estimated workload (hours)** |
| **In-class activities** | | | |
| Lectures | Understanding theories, concepts, methodology and tools | Class participation, discussion activity. | 12 |
| In-class assignments | Experience with software. Experience in solving specific problems using geomatics methods | Class participation, quality of completed assignments,  discussion activity. | 12 |
| **Independent work** | | | |
| Reading, completing individual assignments received | The ability to critically analyze the material read. Ability to report on the essence of the work performed. Ability to participate in brainstorming | Quality of completed assignments | 66 |
| ***Total*** |  |  | ***90*** |

**Grading**

Evaluation of PhD students will be based on the following:

* quality of practical work performed (50%)
* the level of readiness to participate in seminars, dialogues and discussions in the classroom (25%)
* the quality of the preparation of assignments received for independent completion (25%)

**Structure of the Course**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title of the topic** | **Total hours** | **In-class activities, hours** | | |
| **lecture** | **practical works and workshop** | **independent work** |
| Section 1. Geomatics in ecology |  |  |  |  |
| Topic 1.1. Spatial data analysis | 20 | 2 | 4 | 14 |
| Topic 1.2. Digital Elevation Model analysis | 25 | 4 | 2 | 19 |
| ***Total*** | **45** | **6** | **6** | **33** |
| Section 2. Modeling |  |  |  |  |
| Topic 2.1Modeling the water-thermal regime of vegetation | 15 | 2 | 2 | 11 |
| Topic 2.2Harvest Modeling | 15 | 2 | 2 | 11 |
| Topic 2.3 Climate Resource Assessment Model | 15 | 2 | 2 | 11 |
| ***Total*** | **45** | **6** | **6** | **33** |
| ***Total of course*** | **90** | **12** | **12** | **66** |

At the end of the course the student will have an exam. Grading system is presented below:

|  |  |
| --- | --- |
| **Scores** | **Mark** |
| 90 – 100 | Excellent |
| 70-89 | Good |
| 50-69 | Satisfactory |
| 1-49 | Not passed |

**Course schedule**

*Dates and time will be provided later.*

The overall schedule is provided below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Day** | **Time** | **Topic** | **Lecturer** |
| Day 1 | 2 hours | Lecture 1 | Andrii Achasov |
| Day 2 | 2 hours | Practical work 1 | Andrii Achasov |
| Day 3 | 2 hours | Lecture 2 | Andrii Achasov |
| Day 4 | 2 hours | Practical work 2 | Andrii Achasov |
| Day 5 | 2 hours | Lecture 3 | Andrii Achasov |
| Day 6 | 2 hours | Workshop 1 | Andrii Achasov |
| Day 7 | 2 hours | Lecture 4 | Anatolii Polevoy |
| Day 8 | 2 hours | Practical work 3 | Anatolii Polevoy |
| Day 9 | 2 hours | Lecture 5 | Anatolii Polevoy |
| Day 10 | 2 hours | Practical work 4 | Anatolii Polevoy |
| Day 11 | 2 hours | Lecture 6 | Anatolii Polevoy |
| Day 12 | 2 hours | Workshop 2 | Anatolii Polevoy |
| Day 13 | 2 hours | Final test - Exam | Andrii Achasov, Anatolii Polevoy |

**Course assignments**

The course involves two assignments:

Assignment #1. Building and analyzing a model of a specific area using the ArcGIS, QGIS, or GRASS software platform. It is assumed that the model will include the following landscape elements: relief, hydrography, forest plantations, main buildings, roads, etc. The model will be presented in both 2D and 3D (2.5D) form. By default, the following types of analysis of the constructed model are assumed: 1) construction of maps of steepness and aspect of the surface, 2) assessment of surface insolation, 3) allocation of ecological and technological zones of lands for planning the placement of agricultural cultures, 4) identification of drainage areas in the study area, 5) forecast of water erosion of soil using the WEPP model. Options for assignments will be selected (or offered) by graduate students following the topic of their research.

Assignment #2. 1. Model of the water-thermal regime of the vegetation cover. The model includes a description of the radiation regime (calculation of total radiation, plant cover albedo, effective radiation, photosynthetically active radiation), calculation of evaporation and volatility, assessment of the moisture demand of plants and their moisture supply.

2. Modeling the formation of crops. The model describes the influence of environmental factors on the main processes of plant life (photosynthesis, respiration, growth, development) and the relationship between the processes themselves.

3. The model for assessing the agro-climatic resources of territories includes a quantitative description of the formation of potential productivity, determined by the biological characteristics of the plant and the arrival of photosynthetically active radiation, meteorologically possible productivity, taking into account the influence of the water-thermal regime of crops, really possible productivity, which takes into account the influence of soil fertility and productivity in production, determined by the level of agricultural technology for growing crops. Several complex indicators are given: the favorableness of agroclimatic conditions, the efficiency of the use of agroclimatic resources.

It is assumed that graduate students will choose a topic close to their research. Practical work is supposed to be carried out for each section.

**Literature**

1. Nekos A.N., Achasov A.B., Kochanov A.B. (2017). Metody vymiryuvannya parametriv navkolyshnʹoho seredovyshcha: dystantsiyni metody. [Methods of measurement of environmental parameters: remote methods]. Textbook V.N. Karazin KhNU, 244 [In Ukrainian].
2. Svitlychny O.O., Plotnytsky S.V. (2006). Fundamentals of geoinformatics: a textbook. Sumy: University book, 295 p. (Світличний О. О. Основи геоінформатики: навчальний посібник / О. О. Світличний, С. В. Плотницький. – Суми : Університетська книга, 2006. – 295 с.) [In Ukrainian]
3. Kostrikov S.V., Segida K.Yu. (2016). Geographic information systems: a textbook for classroom and independent work of students majoring in "Geography", "Economic and social geography". Kharkiv, 82 p. (Костріков С. В., Сегіда К. Ю. Географічні інформаційні системи: навчально-методичний посібник для аудиторної та самостійної роботи студентів за спеціальностями «Географія», «Економічна та соціальна географія». – Харків, 2016 – 82 с.) [In Ukrainian]
4. Polevoy A.M. (2012) Agricultural meteorology. Odessa, 629 p. (Польовий А.М. Сільськогосподарська метеорологія. Одеса: ТЕС. 2012. 629 с.) [In Ukrainian]
5. Polevoy A.M. (2013) Modeling of hydrometeorological regime and productivity of agroecosystems. Odessa:Ecology, 430 p. (Польовий А.М. Моделювання гідрометеорологічного режиму та продуктивності агроекосистем. – Одеса: Екологія. 2013. 430 с.) [In Ukrainian]