**SYLLABUS:**

**Application of remote sensing and geographic information systems to environmental research**

Course name: Application of remote sensing and geographic information systems to environmental research

Course index: ENVI402

Number of credits: 6 ECTS/3 MCTS

Period: Fall/Spring semester

| Host institution | National University of Mongolia, School of Engineering and Applied Sciences |
| --- | --- |
| Lecturer | Professor Ochir Altansukh |
| Level | Bachelor course |
| Course type | Major compulsory course |
| Course duration | 16 weeks |
| New/Revised | Revised course, previous version was developed in 2015 |
| E-course link | <https://online.num.edu.mn/courses/course-v1:NUM+ENVI402+2022/course/> |
| Language | Available in Mongolian language, only |

### Summary

This course is about fundamental understanding of geographic information system (GIS) and remote sensing (RS) and its application for environmental study. It consists of 16 video lecturers, 16 video laboratory works and supplementary study materials that use in the laboratory classes. The following contents are included in the lecture: introduction to GIS, the real world and representations of it, geographic information and spatial data types, organizing one’s spatial data, the temporal dimension, data processing systems, stages of spatial data handling, database management systems, metadata, determining and mapping position, data quality, spatial referencing, measures of location error on maps, satellite-based positioning. In the laboratory, GIS-RS application, topo map, spatial visualization, spatial data characteristics, metadata, map development and satellite image processing are included.

### Target student audiences

* Bachelor students who are majoring in environmental science, environmental management.
* Open for life-long learners who are interesting GIS and its application at the fundamental level.

### Prerequisites

Pre-required courses:

1. Environmental science ENVI200
2. Environmental monitoring ENVI301

Parallel course (only suggestion):

1. Environmental modeling ENVI404

### Aims and objectives

The course objective is to provide knowledge about the basic concepts of geographic information systems (GIS) and remote sensing (RS) through lectures, and to teach its application in environmental research through laboratory classes. By studying the course, the student will acquire the ability to develop a map using the results of research.

**The authentic tasks**

The authentic tasks are:

* Read the core study book of the course and answer self-testing questions of each section
* Install ArcGIS software for the laboratory class and download the provided dataset
* Independently prepare a visual map using the datasets and snow it at the end of the course

### General learning outcomes:

By the end of the course, successful students will:

| Knowledge | * geographic information and spatial data types * the temporal dimension * data processing systems * database management systems, metadata * data quality * spatial referencing * satellite-based positioning and etc. |
| --- | --- |
| Comprehensive | * self-learning * team working * learning in practice * technology literacy * lifelong learning * practical application |
| Application | * organizing spatial data * determining and mapping position * developing map * satellite image processing |
| Analysis | * spatial data analysis * temporal data analysis * creativity |
| Synthesis | * data gathering and combining * visual map developing |

### Overview of sessions and teaching methods

The course will conduct online form that means students no longer needed to come to the university for the lecture class. For the laboratory work, students can come to the class, if they need. GIS laboratory will be available during the course. Most of the interactive and self-reflective methods of teaching-learning will be applied to the course, where possible, avoid standing lectures and presentations. All video lectures, and laboratory works were prepared and embedded in OpenEDX based online learning platform of the university.

| Learning  methods | * video presentations * group and independent work * project based learning * data analysis |
| --- | --- |
| Course  outline | 1. Introduction to GIS 2. The real world and its representations 3. Geographic phenomena 4. Geographic information representation 5. Spatial scale and resolution, organizing spatial data 6. Stages of spatial data handling 7. Database management systems 8. Determining and mapping position, data quality 9. Spatial referencing, measures of location error on maps 10. Satellite-based positioning 11. Data entry and preparation 12. Interpolation and advanced operation on raster dataset 13. Spatial data analysis 14. Data visualization 15. Cartographic tool and map development |

### Course workload

The table below summarizes course workload distribution:

| Activities | Learning outcomes | Assessment | Workload  (hours) |
| --- | --- | --- | --- |
| **In-class activities – 50 hours** | | | |
| Lectures | Understanding theories, concepts, methodology and tools | Class participation | 36 |
| Moderated in-class  discussions | Understanding various contexts and common problems in GIS/RS application | Class participation and preparedness for discussions | 4 |
| Homework  assignments | Understanding various contexts and common problems in GIS/RS application to environmental study | 3 |
| Watching and discussion  of video guidelines  for laboratory | Understand step-be-step approach to each laboratory work | Class participation, contribution to discussion | 3 |
| Examination | Measure students' knowledge and understanding at the end of a course | Individual assessment | 4 |
| **Independent work – 100 hours** | | | |
| Group work | Ability to collect, create and interpret spatio-temporal data, to analyze datasets, and to apply the theoretical knowledge to the practice | Quality of group work | 4 |
| Assignment | Ability to determine spatial data types and the temporal dimension, to process spatial data, to develop metadata, to check data quality, to determine spatial referencing and etc. | Quality of individual presentations | 20 |
| Map development | Ability to interpret data, to develop and visualize map, to apply different types of spatial data, to apply the theoretical knowledge to the practice | Quality of  printed map | 8 |
| Exam preparation | Measure students' knowledge and understanding at the end of a course | Individual assessment | 4 |
| E-learning | Ability to learn individually | Answers of key questions | 64 |
| **Total** |  |  | **150** |

### Grading

The students’ performance will be based on the following:

| Assessment | * Attendance (20%): based on watching e-learning videos and answer the key questions of each lecture class * Progress assessment (20%): based on the mid-term exam after the 7th lecture class when completing chapters 1-3 of the core study book * Final assessment (30%): based on the final exam after all lecture class when completing chapters 4-7 of the core study book at the end of the semester * Skill test (30%): based on the quality of the individually developed map at the end of the laboratory class | | | | |
| --- | --- | --- | --- | --- | --- |
| Evaluation  EU system | A (8,5 – 10)  B (7,0 – 8,4)  C (5,5 - 6,9)  D (4,0 – 5,4) | Evaluation  MN system | 95-100  90-94  85-89  80-84  75-79  70-74  65-69  60-64  0-59 | A  A-  B  B-  C  C-  D  D-  F | 4.0  3.6  3.1  2.7  2.3  1.9  1.4  1.0  0.0 |

### Course schedule – Lecture

| Week | Class  hours | Topic | Content |
| --- | --- | --- | --- |
| 1 | 2 | Introduction to GIS | Natural phenomena, GIS definition, spatial data and geo-information |
| 2 | 2 | The real world and its representations | Modeling, map, database, spatial database |
| 3 | 2 | Geographic phenomena | Geographic phenomena definition, different types of it, geographic field and object, boundary |
| 4 | 2 | Geographic information representation | Regular and irregular tessellation, vector representation, topology and spatial relationship, representations of geographic field and object |
| 5 | 2 | Spatial scale and resolution, organizing spatial data | Scale and resolution, organizing spatial data, temporal dimension |
| 6 | 2 | Stages of spatial data handling | Spatial data capture, preparation, storage and maintenance, spatial analysis and presentation |
| 7 | 2 | Database management systems | Alternatives for data management, relational data model, querying the database, using GIS and DBMS together |
| 8 | 2 | Determining and mapping position, data quality | Accuracy and precision, attribute and temporal accuracy, spatial referencing system |
| 9 | 2 | Spatial referencing, measures of location error on maps | Spatial referencing system, frame and datum, map projection, location error on map |
| 10 | 2 | Satellite-based positioning | Absolute, relative and network positioning, positioning technology |
| 11 | 2 | Data entry and preparation | Spatial data input, digitizing, data check and repair, combining multiple data sources |
| 12 | 2 | Interpolation and advanced operation on raster dataset | Point data transformation, advanced operation on raster dataset, filtering, computation of slope |
| 13 | 2 | Spatial data analysis – 1 | Retrieval, classification, measurement and overlay functions |
| 14 | 2 | Spatial data analysis – 2 | Neighborhood, proximity, spread, seek computations, network analysis |
| 15 | 2 | Data visualization | GIS and map, visualization process, cartography |
| 16 | 2 | Cartographic tool and map development | Mapping of qualitative and quantitative data, terrain elevation, time series, map cosmetics and dissemination |

### Course schedule – Laboratory

| Week | Class  hours | Topic | Content |
| --- | --- | --- | --- |
| 1 | 2 | Geographic coordinate, topo map | Introduction to geographic coordinate system, topo map interpretation and information on the map |
| 2 | 2 | GIS software | ArcGIS software and its functions |
| 3 | 2 | Geo-referencing of topo map | Topo map geo-referencing using 4 and 9 tie points |
| 4 | 2 | Spatial data analysis | Primary analysis of spatial data, merging, clip, buffer zone |
| 5 | 2 | Shape data | Creating shape data, geodatabase |
| 6 | 2 | Shape data conversion | Converting shape data between ArcGIS and Google Earth |
| 7 | 2 | Attribute data | Nominal, ordinal, interval, ratio data values, tabular dataset |
| 8 | 2 | Attribute data analysis | Statistical analysis of attribute data, convert it into Excel software |
| 9 | 2 | Map development – 1 | Temporal representation, thematic map, visualization process |
| 10 | 2 | Map development – 2 | Visualization types depend on data type, Bertin categories, visual variables |
| 11 | 2 | Map development – 3 | Map cosmetics, title, scale, north arrow, image, legend, projection, bibliographic information |
| 12 | 2 | Map printing and wrap-up | Prepare digital map to print version, convert it into image file |
| 13 | 2 | Digital elevation model | Introduction to DEM, download it, processing, application |
| 14 | 2 | Satellite data | Introduction to satellite data, download it, band combination |
| 15 | 2 | Normalized difference vegetation index | Introduction to NDVI, its process and interpretation |
| 16 | 2 | Normalized difference water index | Introduction to NDWI, its process and interpretation |

### Course assignments/tests

Course assignment consists of three parts, progress, final and skill tests. Questions of the progress and the final tests will come from the core study book, namely “Principles of geographic information system”. The skill test will score on the basis of quality of the individually developed map which students work entire laboratory classes.

### Supplementary materials

The following study materials will be used for the course.

* ArcGIS software
* Topo map
* Satellite image

### Literature

**Compulsory:**

1. Altansukh.O and et al, (2016) “Principles of geographic information system”, editors Bolorchuluun.N and V.Battsengel, 2nd edition of translation of ITC course book, NUM Press, Ulaanbaatar, pages 347, ISBN: 999733220-2, in Mongolian.
2. National agency for geodesy and cartography, (2001) “Legends of 1:25000, 1:50000, 1:100000 scaled topo map”, editors Sanjaajamts.J and Oyunchimeg.B, The color printing, Ulaanbaatar, pages 72, in Mongolian.

**Recommended:**

1. Amarsaikhan.D and et al, (2014) “Application of remote sensing and geographic information systems to natural resource management”, Admon Press, Ulaanbaatar, pages 168, in Mongolian.