Course Title (in English) | Introduction to Remote Sensing
Course Title (in Russian) | Современные проблемы дистанционного зондирования Земли из космоса
Lead Instructor(s) | Ivanov, Anton
                        Nikolaev, Evgeny

Is this syllabus complete, or do you plan to edit it again before sending it to the Education Office? | The syllabus is a work in progress (draft)
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1. Annotation

Course Description

This course introduces students to the first principles and methods of the observation of Earth surface, monitoring of Earth atmosphere and detection of different kind of radiation coming from Space. The course will cover wide range of the satellites-, aircraft-, rockets- and balloon- based techniques designed for environmental monitoring, meteorology, map making etc. Goals of the course include: a comprehensive knowledge of the principles and approaches to the creation and operation of remote sensing systems; acquisition of analysis skills of modern ERS programs; practical application of acquired knowledge and skills for SWOT-analysis of complex information systems.

Course will also include a module on geomatics, i.e, platforms, sensors and methodologies related to the collection, processing, analysis and interpretation of (2D/3D) data related to Earth’s surface. This includes platforms like satellite or drones, sensors like LiDAR or airborne cameras and techniques like photogrammetry, laser scanning, geodesy, topography, etc.

Major learning outcomes include operational principles and design of different sensors used in remote sensing of the Earth, practical skills to design an experiment in remote sensing with applications to a practical business need.

Course Prerequisites / Recommendations | Master level math and physics
                                            (optional) Fundamentals of Systems Engineering
                                            (optional) Spacecraft Mission Analysis and Design
2. Structure and Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Summary of Topic</th>
<th>Lectures (# of hours)</th>
<th>Seminars (# of hours)</th>
<th>Labs (# of hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celestial mechanics</td>
<td>Orbits, constellations</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Physical optics</td>
<td>Diffraction limits, principles of instrument building, characteristics of antennae and cameras</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Electromagnetic wave propagation</td>
<td>Radiation transfer; radiation, diffraction, reflection of electromagnetic waves; wave propagation in media; atmospheric phenomena; reflection of radio waves by common surfaces on Earth;</td>
<td>3</td>
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<td>3</td>
</tr>
<tr>
<td>System modeling</td>
<td>Analysis of objects; phenomena for observations; selection of spacecraft constellations for optimal observation;</td>
<td>3</td>
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</tr>
<tr>
<td>Geoinformatics</td>
<td>Image taking, compression, transmission, analysis of images from georeferencing to neural networks</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Geomatics</td>
<td>Introduction to Geomatics, 3D surveying and 3D modelling; Basics of topography and GNSS;</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>Basic of photogrammetry; history, sensors, principle, platforms, processing pipeline, applications, example; object / terrain / surface model generation; orthophoto production, building modelling</td>
<td>3</td>
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<td>3</td>
</tr>
<tr>
<td>Geographic Information Systems (GIS) and land classification (LULC)</td>
<td>raster and vector data, geographic information, QGIS; GIS, machine learning, LULC</td>
<td>3</td>
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</tr>
</tbody>
</table>

3. Assignments

4. Grading

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Activity weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects</td>
<td>25</td>
</tr>
<tr>
<td>Final Project</td>
<td>51</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>26</td>
</tr>
</tbody>
</table>
Grading Scale

A: 86
B: 76
C: 66
D: 56
E: 46
F: 0

Attendance Requirements
Mandatory with Exceptions

5. Basic Information

Maximum Number of Students

<table>
<thead>
<tr>
<th></th>
<th>Maximum Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall:</td>
<td>20</td>
</tr>
<tr>
<td>Per Group (for seminars and labs):</td>
<td></td>
</tr>
</tbody>
</table>

Course Stream
Science, Technology and Engineering (STE)

Course Term (in context of Academic Year)
Term 4

Course Delivery Frequency
Every year

Students of Which Programs do You Recommend to Consider this Course as an Elective?

<table>
<thead>
<tr>
<th>Masters Programs</th>
<th>PhD Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space and Engineering Systems</td>
<td>Engineering Systems</td>
</tr>
</tbody>
</table>

Course Tags
Math
Physics
Engineering

6. Textbooks and Internet Resources
### Required Textbooks

| Physical Principles of Remote Sensing | 9780521181167 |

### Recommended Textbooks


### Web-resources (links)

<table>
<thead>
<tr>
<th>Web-resources (links)</th>
<th>Description</th>
</tr>
</thead>
</table>

### 7. Facilities

#### Software

- Matlab
- QGIS

#### Labs for Education

- Engineering Design Laboratory (TPOC3: 450)

### 8. Learning Outcomes

#### Knowledge

- Basic principles of creation and construction of remote sensing systems
- Modern problems of signal transmission, the principles of grouping with a view to solving specific problems
- The problems of thematic information processing
- Prospects for the development of the industry, innovative approaches, options for creating hybrid information systems
**Skill**

Use your knowledge to solve the problems of analysis of applicability types of data for those or other branches of science and technology.

Draw conclusions about the efficiency and applicability of various technological, organizational, financial approaches to implementation in the remote sensing systems of various algorithms, designs and solutions.

To construct modern applied algorithms of communication with spacecraft, receiving, distribution and processing of DDMS.

Apply the received system knowledge to other questions of construction and complex information systems.

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**Experience**

The application of the analysis of throughput and quality of lines land-to-ground communications.

Skills calculations of energy efficiency of communication channels, optimization complex information systems architecture.

A culture of analysis and evaluation of the prospects of projects and systems, including space and ground segments.

Methods of SWOT analysis of projects, presentation of results self-analysis and research.

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### 9. Assessment Criteria

- Input or Upload Example(s) of Assignment 1:
- Input or Upload Example(s) of Assignment 2:
- Input or Upload Example(s) of Assignment 3:
- Input or Upload Example(s) of Assignment 4:
- Input or Upload Example(s) of Assignment 5:

### 10. Additional Notes