

**ERASMUS+**

**HIGHER EDUCATION CAPACITY BUILDING**

**Erasmus+ Project**

**New and Innovative Courses for Precision Agriculture**

**(NICOPA)**

**Erasmus+ 597985-EPP-1-2018-1-KZ-EPPKA2-CBHE-JP**

STUDY PROGRAM DESCRIPTION

**Global Navigation Satellite Systems (NAVSTAR, GLONASS, GALILEO, etc.)**

**National University of Uzbekistan**

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| **Program title**: | Global Navigation Satellite Systems (NAVSTAR, GLONASS, GALILEO, etc.) | **University:** | *National University of Uzbekistan* |
| **Degree**: | **MA** | **Standard period of study:** | 15 weeks |
| **Web link of the university:** | [*https://nuu.uz/*](https://nuu.uz/) | | |
| **Web link of the program:** |  | | |
| **Credit points (ECTS):** | **5** | **Teaching language:** | Uzbek |
| **Contact (email):** | [*azizjon.ruziev@gmail.com*](mailto:azizjon.ruziev@gmail.com) | | |
| **Program Description:**  This course gives an introduction of GNSS by introducing the characteristic of the satellite systems (GPS, NAVSTAR, GLONASS, GALILEO, etc), signal structure and forms the skills for using various GNSS systems, applying modern positioning methods of GNSS systems. The knowledge obtained as a result of mastering the discipline is necessary for solving practical problems in the field of professional activity, designing and developing in Land Surveying and precision agriculture. | | | |
| **Objectives**: The main goal of the subject is for masters of this specialty to teach their students coordinate systems used in satellite geodesy, methods of satellite observations, geodetic satellites, movements of Earth satellites, geometric issues of space geodesy, global navigation satellite systems (GNSS) and the tools and technologies used in it consist of teaching theoretical and practical knowledge. | | | |
| **Prerequisites**:  To know:  Geodesy, Land Surveying, GIS  Possess:  Use application of GIS | | | |

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| **Short Name of the University/Country code Date (Month / Year)** | **NUU-UZ**  **2020** |
| **TITLE OF THE Curricula/Module** | **Code** |
| **Global Navigation Satellite Systems (NAVSTAR, GLONASS, GALILEO, etc.)** |  |

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| **Teacher(s)** | **Department** |
| **Coordinating:**  **Senior teacher Azizjon Ruziev**  **Others:** | Department of Geodesy and Geoinformatics  NUU |

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| **Study cycle** | **Level of the module** | **Type of the module** |
| BA/**MA**/PhD | Master |  |

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| **Form of delivery** | **Duration** | **Language(s)** |
| offline | 15 weeks | Uzbek |

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| **Prerequisites** | |
| **Prerequisites:**  To know:  Geodesy, Land Surveying, GIS  Possess:  Use application of GIS | **Co-requisites (if necessary):** |

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| **ECTS  (Credits of the module)** | **Total student workload hours** | **Contact hours** | **Praxis** | **Individual work hours** |
| 5 | 110 | 32 | 40 | 38 |
|  | **Aim of the module (course unit): competences foreseen by the study programme** | | | |
| This course gives an introduction of GNSS by introducing the characteristic of the satellite systems (GPS, NAVSTAR, GLONASS, GALILEO, etc), signal structure and forms the skills for using various GNSS systems, applying modern positioning methods of GNSS systems. The knowledge obtained as a result of mastering the discipline is necessary for solving practical problems in the field of professional activity, designing and developing in Land Surveying and precision agriculture. | | | | |

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| **Learning outcomes of module (course unit)** | **Teaching/learning methods** | **Assessment methods** |
| To know:  The Major Satellite Navigation Systems how they work  To point:  •Global and regional navigation satellite systems;  To explain:  • What is a satellite navigation system and how do they work?  To numerate:  • Current and Planned Global and regional Navigation Satellite Systems and Satellite-based Augmentations Systems;  To recognize:  • Different forms of GNSS interference;  To give examples of:  • accuracy and precision of GNSS;  To describe:  • The factors that make it difficult for a GNSS receiver to calculate an exact position. Causes of GNSS denial and the methods used to mitigate them;  To formulate:  • The steps involved in using GNSS to determine time and position through to the end user application. | Lectures, presentations, practical lessons, independent study of the material | Participation in discussions,  Course project,  Written test  Verbal exam  Quiz |
| To be able to:   * Working with GPS tracks and Points; * Collection, processing and presentation of GNSS data; * Finding location; * Map your property with high accuracy, quickly and easily; * Find certain points in the field. |  |  |
| Possess:   * to build a map of agricultural fields; * to develop knowledge and understanding on coordinate and time systems; * to evaluate Field Survey using Low-Cost receiver for High-Accuracy positioning. |  |  |

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| **Themes** | **Contact work hours** | | | | | | | **Time and tasks for individual work** | |
| Lectures | Consultations | Seminars | Practiacl work | Laboratory work | Placements | **Total contact work** | **Individual work** | **Tasks** |
| GNSS Overview | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Satellite navigation system and how do they work;  Types of satellite navigation systems;  Review of global and regional satellite systems;  Regional Satellite-based Augmentation Systems;  GNSS architecture. |
| Coordinate and time systems | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Introduction to coordinate system definition and realization concentrating on geometric definitions. |
| Basic GNSS Concepts | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Steps involved in using GNSS to determine time and position through to the end user application – Satellites, Propagation, Reception, Computation, Application. |
| GPS (Global Positioning System, United States) | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Overview of the components of the system: Space segment, Control segment, User segment;  Modernization. |
| GLONASS (Global Navigation Satellite System, Russia) | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Overview of the components of the system: Space segment, Control segment, User segment;  Modernization. |
| Galileo and BeiDou Navigation Satellite System (China) | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Overview of the components of the system: Space segment, Control segment, User segment;  Modernization. |
| IRNSS (Indian Regional Navigation Satellite System, India) and QZSS (Quasi-Zenith Satellite System, India) | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **4** | Overview of the components of the system: Space segment, Control segment, User segment;  Modernization. |
| GNSS Error Sources. Types of errors | 4 | 0 | 0 | 2 | 0 | 0 | **6** | **2** | Techniques used to improve GNSS accuracy – Multi-Constellation and Multi-Frequency;  Satellite Based Augmentation Systems;  Real-Time Kinematic (RTK);  Precise Point positioning (PPP);  GNSS Data Post-Processing. |
| GNSS and other navigation systems | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | GNSS+ Inertial Navigation System (INS);  Odometers;  Vision Aided Navigation;  Sensors Fusion. |
| GNSS Denial | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Courses of GNSS denial and the methods used to mitigate them – Interference;  Anti-Jam Antennas;  Multiple Navigation Sensors;  Spoofing;  Signal Blockage;  Constellation Failure. |
| GNSS Applications and Equipment. Commercial applications. GNSS Equipment | 2 | 0 | 0 | 2 | 0 | 0 | **4** | **2** | Commercial applications;  GNSS Equipment. |
| GNSS in Precision Farming and Agriculture Technology | 4 | 0 | 0 | 4 | 0 | 0 | **8** | **4** | GNSS application in Quality management;  Reduced workload;  Environmental Protection;  Consumer Protection;  Benefits. |
| Application for agricultural – Mobile and computer applications | 4 | 0 | 0 | 14 | 0 | 0 | **18** | **10** | BaseCamp, DNR GPS, ExpertGPS, Locus Map, MachineryGuide, Geo Area –GPS Area Calculator, Field Navigator, AgroPilot, Soil Sampler, Farm Tracks, Tractor Guide, AgriBus-NAVI, Trimble Ag Mobile, Map Pad GPS Land Surveys & Measurements, eFarmer, etc. |
| **Total** | **32** | **0** | **0** | **40** | **0** | **0** | **72** | **38** |  |

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| **Assessment strategy** | **Weight in %** | **Deadlines** | **Assessment criteria** |
| Running control 1 | 15 | 7 week | Test and/or Quiz |
| Running control 2 | 15 | 13 week | Test and/or Quiz |
| Final exam | 70 | 15 week | Course project development |

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| **Compulsory literature/ Author** | **Year of issue** | **Title** | **No of periodical or volume** | **Place of printing. Printing house or internet link** |
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| European GNSS Agency | 2018 | GNSS User Technology Report | Issue 2 | Luxemburg: Publications Office of the European Union, 2018  <https://www.gsa.europa.eu/system/files/reperts/gnss_user_tech_report_2018.pdf>  doi:10.2878/743965 |
| Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, Elmar Wasle | 2008 | GNSS – GPS, GLONASS, Galileo & more |  | Springer-Verlag Wien;  doi: 10.1007/978-3-211-73017-1 |
| J. Sanz Subirana, J.M. Juan Zornoza and M. Hernandez-Pajares | 2013 | GNSS DATA PROCESSING | Volume I: Fundamentals and Algorithms | <https://gssc.eca.int/navipedia/GNSS_Book/ESA_GNSS-Book_TM-23_Vol_I.pdf> |
|  | 2008 | GLOBAL POSITIONING SYSTEM STANDARD POSITIONING SERVICE PERFORMANCE STANDARD | 4th Edition | <https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf> |
| China Satellite Navigation Office | 2019 | BeDou Navigation Satellite system Signal In Space Interface Control Document Open service Signal B1I | Version 3/0 | [http:/en.beidou.gov.cn/SYSTEMS/Officialdocumentt/201902/P020190227601370045731.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf) |
| Whelan, B. and J. Taylor | 2013 | Precision Agriculture for Grrain Production Systems |  |  |
| European Union | 2016 | Galileo – Open Service – Signal In Space Interface Control Document (OS SIS ICD V1.3) | Issue 1 rev. 1 | [https:/www.gsc-europa.eu/system/files/galileo\_documents/Galleo-OS-SDD.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf) |
| European Union | 2016 | Galileo – Open Service – Signal In Space Interface Control Document (OS SIS ICD V1.3) | Issue 1 rev. 3 | [https:/www.gsc-europa.eu/system/files/galileo\_documents/Galleo-OS-SIS-ICD.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf) |
| Indian Space Research Organization | 2017 | Indian Regional Navigation Satellite System  SIGNAL IN SPACE ICD FOR STANDARD POSITIONING SERVICE | Version 1.1 | BANGALORE  [https:/www.isro.gov.in/sites/default/files/irnss\_sps\_icd\_version1/1-2017.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf) |
| Manuel Perez-Ruiz and Shrini K. Upadhyaya | 2012 | GNSS in Precision Agricultural Operations |  | [http:/dx.doi.org/10/5772/50448](http://http:/dx.doi.org/10/5772/50448%20www.isro.gov.in/sites/default/files/irnss_sps_icd_version1/1-2017.pdf) |
| International Civil Aviation Organization | 2005 | Global Navigation Satellite System (GNSS) Manual | First Edition | Canada  [https:/www.icao.int/Meetings/PBN-Symposium/documrnts/9849\_cons\_en%5B1%5D.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf) |
| **Additional literature** | | | | |
| European GNSS Agency | 2017 | GNSS Market Report | Issue 5 | Luxemburg:Publications Office of the European Union  [https:/www.gsa.europa.eu/system/files/report/gnss\_mr\_2017.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf)  doi:10/2878/0426 |
| European GNSS Agency | 2018 | Report on agriculture user needs and requirements | Issue 1 | Luxemburg:Publications Office of the European Union  [https:/www.gsc.europa.eu/system/files/galileo\_documents/Agri-Report-on-User-Needs-and-Requirements-v1.0.pdf](https://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf) |

**ANOTATION /course summery**

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| This course gives an introduction of GNSS by introducing the characteristic of the satellite systems (GPS, NAVSTAR, GLONASS, GALILEO, etc), signal structure and forms the skills for using various GNSS systems, applying modern positioning methods of GNSS systems. The knowledge obtained as a result of mastering the discipline is necessary for solving practical problems in the field of professional activity, designing and developing in Land Surveying, precision agriculture and scientific studies.  The student will learn the basics of navigation using Global Navigation Satellite Systems (GNSS), such as GPS signals, and other navigation technologies.  The student will also get a hands-on training on the GNSS receiver functionalities via a course work assignment. |

List of **themes and short description**

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| **Themes** | **Contact work hours** |
| **GNSS Overview**  History and introduction on the major GNSS systems (GPS, GLONASS, GALILEO, BEIDOU, SBAS);  Physical principles that operate in GNSS; | **4** |
| **Coordinate and time systems**  Introduction to coordinate system definition and realization concentrating on geometric definitions | **4** |
| **Basic GNSS Concepts**  The steps involved in using GNSS to determine time and position through to the end user application.  Introduction on GNSS signal structure and properties;  Introduction on signal processing techniques;  Introduction on GNSS receiver architectures. | **4** |
| **GPS (Global Positioning System, United States)**  Overview of the components of the system – Space segment, Control segment and User segment. Modernization. | **4** |
| **GLONASS (Global Navigation Satellite System, Russia)**  Overview of the components of the system – Space segment, Control segment and User segment. Modernization. | **4** |
| **Galileo and BeiDou Navigation Satellite System (China)**  Overview of the components of the system – Space segment, Control segment and User segment. Modernization. | **4** |
| **IRNSS (Indian Regional Navigation Satellite System, India) and QZSS (Quasi-Zenith Satellite System, India)**  Overview of the components of the system – Space segment, Control segment and User segment. Modernization. | **4** |
| **GNSS Error Sources. Types of errors**  Principles associated with high accuracy differential GNSS positioning. After briefly reviewing the relevant concepts of GNSS positioning, the lecture presents the different measurements and error sources that limit positioning accuracy. The geographical and temporal variability of the errors will be addressed, as appropriate. Once the GNSS errors are understood, focus turns to mitigation of these errors through measurement differencing, linear measurement combinations, and different augmentation approaches (i.e., DGNSS, RTK, NRTK, and PPP). The motivation for these approaches will be explained in the context of trying to mitigate errors and resolve the carrier phase ambiguities. Mathematical formulations for the various augmentation approaches are introduced. Different augmentation message formats are also presented. The lecture will conclude with a discussion of the future prospects for the GNSS augmentation technique. | **4** |
| **GNSS Denial**  Courses of GNSS denial and the methods used to mitigate them – Interference, Anti-Jam Antennas, Multiple Navigation Sensors, Spoofing, Signal Blockage, Constellation Failure. | **4** |
| **GNSS Applications and Equipment. Commercial applications. GNSS Equipment**  Review of some of the incredible GNSS applications and equipment that are now available. | **4** |
| **GNSS in Precision Farming and Agriculture Technology**  GNSS in Precision Farming and Agriculture Technology. GNSS application in Quality management, Reduced workload, Environmental Protection, Consumer Protection, Benefits. | **8** |
| **Application for agricultural – Mobile and computer applications**  How mobile apps and technologies help farmers. | **18** |