42. Navigation systems (PH047IU)

Module designation	*This course introduces the principles of space navigation systems based on inertial sensors and satellite navigation. Students will start with a development history of many global navigation satellite systems (GNSS) such as GPS, GLONASS, EGNOS, Galileo, etc. and then will build upon the modern navigation systems, GPS, with Coordinate Frames, Time Reference, and Orbits to estimate the position, velocity, and times, as well as their errors. Besides, the course also provides the learners with based knowledge of GPS signals and GPS Signal Conditioning and Acquisition utilizing the Fourier transformation and convolution.*
Semester(s) in which the module is taught	1, 2
Person responsible for the module	Dr. Nguyễn Chánh Nghiệm, Dr. Lương Bảo Bình
Language	English
Relation to curriculum	Compulsory
Teaching methods	Lecture, lesson, project, exam.
Workload (incl. contact hours, self-study hours)	(Estimated) Total workload: 127.5 Contact hours (please specify whether lecture, exercise, laboratory session, etc.): lecture: 37.5 Private study including examination preparation, specified in hours: 90
Credit points/ECTS	3 credits/4.62 ECTS
Required and recommended prerequisites for joining the module	None

<table>
<tr><td>Module objectives/intended learning outcomes</td><td>Upon the successful completion of this course students will be able to:
<table>
<tr><th>Competency level</th><th>Course learning outcome (CLO)</th></tr>
<tr><td>Knowledge</td><td>CLO1: Show the understanding of operation of global navigation satellite systems, e.g. GPS.</td></tr>
<tr><td>Skill</td><td>CLO2: Analyze the GPS data for geolocation on the Earth surface from receivers e.g. handheld devices, base stations and RTK rovers.</td></tr>
<tr><td>Attitude</td><td>CLO3: Show the impact of GNSS in society and environments.</td></tr>
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<tr><td>Content</td><td>The description of the contents should clearly indicate the weighting of the content and the level.
Weight: lecture session (3 hours)
Teaching levels: I (Introduce); T (Teach); U (Utilize)
<table>
<tr><th>Topic</th><th>Weight</th><th>Level</th></tr>
<tr><td>Part 1: Fundamentals
Chapter 1: Introduction
Overview of navigation principles
Typical applications, Axis systems and projections</td><td>1</td><td>I, T</td></tr>
<tr><td>Chapter 2: Inertial Navigation Systems
Principles of inertial navigation
Accelerometers, gyroscopes, specific technologies such as Ring Laser Gyros
Axis transformations and mechanization of IN equations,
Errors in inertial navigation</td><td>1</td><td>T</td></tr>
<tr><td>Chapter 3: GPS: An overview
Objectives, Policies, and Status
System Architecture, Signals
Receivers, Measurements, and Performance
Applications</td><td>1</td><td>T</td></tr>
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	Chapter 4: GNSS Development history: GNSS, GPS, GLONASS, EGNOS, Galileo GPS system architecture (ground, space, user segment), Code (CDMA) and carrier techniques	2	T, U
	Chapter 5: GPS Coordinate Frames, Time Reference, and Orbits Global Coordinate Systems Time References and GPS Time GPS Orbits and Satellite Position Determination	2	T, U
	Part 2: Estimation of Position, Velocity, and Time Chapter 6: GPS Measurements and Error Sources Measurement Models Control Segment Errors: Satellite Clock and Ephemeris, Signal Propagation Modeling Errors Measurement Errors	1	U
	Chapter 7: PVT Estimation Position Estimation with Pseudoranges Position and Velocity from Pseudorange Rates Time Transfer	1	T, U
	Part 3: GPS Signals Chapter 8: Signals and Linear Systems Overview, Convolution Transfer Functions and Basis Functions Fourier Series, Fourier Transform Random Signals, Laplace Transform	1	T, U
	Chapter 9: GPS Signals	1	T, U
	Chapter 10: Signal-to-Noise Ratio and Ranging Precision	2	T, U
	Part 4: Receivers Chapter 11: Signal Conditioning and Acquisition Signal Conditioning Signal Acquisition Statistical Analysis of Signal Acquisition	2	T, U
Examination forms	Project/Written examination		

Study and examination requirements	Attendance: A minimum attendance of 80 percent is compulsory for the class sessions. Students will be assessed on the basis of their class participation. Questions and comments are strongly encouraged. Assignments/Examination: Students must have more than 50/100 points overall to pass this course.
Reading list	**Textbooks**: [1] *Global Positioning System, Signals Measurements, and Performance,* 2nd Edition, 2012 by P. Misra and P. Enge, Ganga-Jamuna Press. **References:** [2] *Leick, A. GPS satellite surveying. New York:* Wiley & Sons, 1994. 19 p. ISBN 0-471-30626-6 [3] Elliott Kaplan, Christopher J. Hegarty*, Understanding GPS/GNSS: Principles and Applications,* Third edition.