Course description

Department/Unit /	KE / DTMRS			**Academic Year**	2023/2024
Title	Theory of Modern Radar Systems			**Type of completion**	Examination
Accredited/Credits	Yes, 20 Cred.			**Type of completion**	Combined
Number of hours					
Occ/max	Status A	Status B	Status C	**Course credit prior to**	NO
Summer semester	0 / -	0 / -	0 / -	**Counted into average**	NO
Winter semester	0 / -	0 / -	0 / -	**Min. (B+C) students**	not determined
Timetable	Yes			**Repeated registration**	NO
Language of instruction	Czech, English			**Semester taught**	Winter, Summer
Optional course	Yes			**Internship duration**	0
Evaluation scale	S|N				
No. of hours of on-premise	0				
Auto acc. of credit	No				
Periodicity	K				
Substituted course	None				
Preclusive courses	N/A				
Prerequisite courses	N/A				
Informally recommended courses	N/A				
Courses depending on this Course	N/A				

Course objectives:

The aim of the course is to be familiar with different types of radar systems, from the point of view of both hardware and signal processing in the complete signal path

Requirements on student

The student completes at least 5 consultations during the semester concerning the theoretical content of the course. The student will pass at least 3 consultations concerning the assigned practical work.

As part of the practical work, the student will work on the topic of modern radar systems, especially in the field of detection, association and classification of targets in various radar systems. The specific topic will be determined with regard to the topic of dissertation.

Content

The course will also discuss issues of flight instrumentation, methods and means for landing under difficult meteorological conditions and specific NDB, VOR, ILS, MLS and DME systems. Furthermore, the subject will include principles of modern radars with a synthetic aperture using sophisticated radar data processing to create a narrow effective anténna beam. An experimental verification of the properties of radar signals dealing with the demonstration of individual steps of the signal processing will be included using modern instrumentation in combination with the existing infrastructure aassistance of the subject. Attention will be paid to the use of radars in meteorology including experimental - research activities.

Content:
*Principles of radar systems: primary radars, secondary radars, passive radars, bistatic, multistatic ones + MIMO.
*Measurement of distance, position angle and speed by means of electromagnetic waves. Resolution, unambiguity and accuracy.
*Radars with synthetic aperture (SAR, ISAR)
*Electromagnetic wave difraction on objects: object classification, scattering and difraction description, statistical properties of scattering and consequences for object detection.
*Influence of atmospheric and ionospheric electromagnetic wave propagation and also in the presence of obstacles and terrain on

the properties of radar systems.
*Radar equations: basic equation, noise (veil) -limited range equation, coverage shielding equation and search equation-derivation, consequences.
*Primary coherent and non-coherent radars (HPRF, LPRF, LPI): types of modulation (pulse, LFM, NLFM, FMCW, FMiCW, P1-P4,Frank code, noisy)
*Primary processing by coherent radars (pulse compression, Doppler filtration, integration, detection, extraction), secondary processing (monitoring, Kalman filtration) and tertiary processing (sensor fusion, data association).
*Special types of primary radars: surveillance, approach and tracking, aviation, meteorological radars, FMCW sensors
*Secondary ATC radars: Basic modes of operation, derived ADS-B and ACAS systems
*Coherent and non-coherent bistatic and multistatic radars (TOA, TDOA, DOA, Doppler, PCL): position ans speed derivation, system errors, data association in the primary system, target tracking - particulate filters, coherent systems: adaptive clutter filtration, uncertainty function.

Prerequisites - other information about course preconditions

Competences acquired

Fields of study

Guarantors and lecturers

- **Guarantors:** prof. Ing. Pavel Bezoušek, CSc., doc. Ing. Jan Pidanič, Ph.D.

Literature

- **Basic:** RICHARDS, M. A., SCHEER, J. A., HOLM, W. A. *Principles of Modern Radar- Advanced Techniques*. 2013. ISBN 978-1-891121-53-1.
- **Basic:** RICHARDS, M. A., SCHEER, J. A., HOLM, W. A. *Principles of Modern Radar- Basic Principles*. 2010. ISBN 978-1-891121-52-4.
- **Basic:** BEZOUŠEK, P., ŠEDIVÝ, P.:. *Radarová technika*. ČVUT Praha, 2. vyd., 2007. ISBN 978-80-01-03036-3.
- **Recommended:** Willis, Nicholas J. *Advances in bistatic radar*. Raleigh: SciTech, 2007. ISBN 978-1-891121-48-7.
- **Recommended:** Barton, David K. *Radar Equations for Modern Radar*. 2013. ISBN 978-1-60807-521-8.

Teaching methods

Monologic (reading, lecture, briefing)
Methods of individual activities
Laboratory work

Assessment methods

Oral examination
Written examination
Home assignment evaluation

Course is included in study programmes:

Study Programme	Type of	Form of	Branch	Stage	St. plan v.	Year	Block	Status	R.year	R.
Electrical Engineering and Informatics	Doctoral	Full-time	Electrical Engineering and Informatics	1	2019	2023	Povinně volitelné předměty profilujícího základu	B	2	

Study Programme	Type of	Form of	Branch	Stage	St. plan v.	Year	Block	Status	R.year	R.
Electrical Engineering and Informatics	Doctoral	Part-time	Electrical Engineering and Informatics	1	2019	2023	Povinně volitelné předměty profilujícího základu	B	2	
Electrical Engineering and Informatics	Doctoral	Full-time	Electrical Engineering and Informatics	1	2019	2023	Povinně volitelné předměty profilujícího základu	B	2	
Electrical Engineering and Informatics	Doctoral	Part-time	Electrical Engineering and Informatics	1	2019	2023	Povinně volitelné předměty profilujícího základu	B	2	