STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Microwave Devices and Systems		**1010811161010843181**
Field of study	Profile of study (general academic, practical)	Year /Semester
Electronics and Telecommunications	**general academic**	**3 / 6**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Radio Communications	**Polish**	**elective**
Cycle of study:	Form of study (full-time,part-time)	
First-cycle studies	**full-time**	
No. of hours		No. of credits
Lecture: **1** Classes: **-** Laboratory: **30** Project/seminars: **-**		**3**
Status of the course in the study program (Basic, major, other)	(university-wide, from another field)	
other	**from field**	
Education areas and fields of science and art		ECTS distribution (number and %)
technical sciences		**3 100%**
Technical sciences		**3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	K1_W01 K1_W02
2	**Skills**	K1_U09
3	**Social competencies**	none

Assumptions and objectives of the course:

Understanding the principle of operation, construction, and parameters of microwave components and radio communication systems working in the microwave frequency range; learning the basic skills and principles of microwave and RF measurements.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Has a systematic knowledge, together with necessary mathematical background, of the fundamentals of microwave and RF metrology, which is necessary to measure the signal properties and the parameters of electronic and telecommunication systems components. Has knowledge of microwave and RF measurement methods, measurement equipment and computerized microwave and RF measurement systems. - [K1_W18]
2. Has knowledge of microwave devices and systems exploitation (including radar systems). - [K1_W20]
3. Knows about development trends in electronics and telecommunication. - [K1_W24]

Skills:

1. Is able to extract information from Polish or English language literature, databases and other sources. Is able to synthesize gathered information, draw conclusions, and justify opinions. - [K1_U01]
2. Is capable of studying autonomously. - [K1_U05]
3. Is able to use catalogues, find required information from application notes of semiconductor elements and electronic circuits, select appropriate elements and electronic circuits. - [K1_U12]
4. Is able to measure typical parameters of signals, systems and devices, in particular those used in telecommunication. Is able to choose appropriate methods to measure given electrical quantities and parameters of signals and devices. Is able to plan and perform measurements and analyze the results. - [K1_U17]
5. Can implement the occupational health and safety principles. - [K1_U27]

Social competencies:

1. Is aware of the limitations of his/her current knowledge and skills; is committed to further self-study. - [K1_K01]
2. Demonstrates responsibility for designed electronic and telecommunication systems. Is aware of the hazards they pose for individuals and communities if they are improperly designed or produced. - [K1_K03]

Assessment methods of study outcomes

1. Written final exam (theory and problems)
2. Reports from laboratory exercises
3. Tests during laboratory exercises

Course description

1. Frequencies of microwave range, characteristic properties of microwaves and microwave devices, advantages of microwaves for radio communications and radar technology, application of microwaves - medicine, microwave ovens, radio communitation systems, food industry
2. Decibels, definitions of gain and attenuation, power levels in dBm, dBW, dBmV, dBuV, power levels in a radio communication link.
3. Refreshing the fundamentals of electromagnetic wave theory and TEM transmission line theory, VSWR, return loss RL, input impedance of a transmission line, transmission line as impedance transformer, Smith chart, microstrip line, effective permittivity
4. Impedance matching with lumped elements, single-stub tuning, quater-wave transformer, multisection matching transformers
5. Wave propagation in waveguides, general solution of Maxwell's equations for TEM, TE and TM waves, Laplace equation for TEM waves, solution of Helmholtz equations for TM and TE waves, solution for parallel plate waveguide, TE and TM solutions for rectangular and circular waveguide, waveguide parameters, cavity and dielectric resonators
6. Voltages, currents and impedance in microwave circuits, reciprocal and lossless circuits, definition of scattering matrix, shift in reference planes, general scattering matrix, microwave two-port device parameters
7. Parameters of ferrites, passive microwave components and their applications:oraz ich zastosowania: junctions, circulators, isolators, directional couplers, power dividers, matched loads, phase shifters, attenuators; parameters of dividers and couplers, analysis and design of microstrip power dividers, microstrip microwave filters
8. Noise in microwave circuits, mixers and detectors, semiconductor microwave devices: transistors, diodes, PIN and Gunn diodes, monolithic microwave integrated circuits, parameters and operation principle of clystron, magnetron, travelling wave tube
9. Stability of amplifiers, low-noise amplifiers, design of microwave amplifiers, Barkhausen criteria, design of microwave oscillators, PIN switch and phase shifter
10. Measurement of masic microwave parameters: power, frequency, insertion loss, return loss, VSWR, scattering matrix; modern measurement equipment - signal generators, vector/network analyzers, spectrum analyzers, measurements with network/spectrum analyzer
11. Antenna parameters, microwave antennas for radio communication and radar systems
12. Propagation of microwaves - basic propagation formulas, troposphere as propagation medium, K factor, radio horizon, refraction types, fading, Fresnel zones.
13. Radio communication system - basic elements, review of the most popular radio communication systems: satellite TV, GPS, mobile systems, GPS, microwave links, wireless data transmission (Wi-Fi, WiMAX, Bluetooth, UWB), radio astronomy, meteorology, remote sensing
14. Principles of radar, radar equation, choice of operation frequency, Doppler radar, pulse radar, pulse-Doppler radar, clutter, detection threshold, false alarms, pulse integration, pulse compression, radar cross section, friend-or-foe systems, SAR radars, electronic warfare
15. Safety principles for microwave devices

Basic bibliography:

1. J. Szóstka, Mikrofale. Układy i systemy. Wyd. Komunikacji i Łączności, Warszawa, 2006.

Additional bibliography:

1. J. Szóstka , Fale i anteny (wyd. III), Wyd. Komunikacji i Łączności, Warszawa, 2006.
2. J. Szóstka, Horyzontowe linie radiowe. Wyd. Politechniki Poznańskiej, Poznań, 2011.
3. D. Pozar, Microwave Engineering, Addison-Wesley Publishing Comp., New York 2005.

Result of average student's workload

Activity	Time (working hours)

1. Lecture	30
2. Laboratory exercises	15
3. Preparation for labs	15
4. Preparation of lab reports	15
5. Consulting	2
6. Preparation for the exam and the exam	23

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	90	3
Contact hours	50	2
Practical activities	55	1