SYLLABUS

1. Program information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Bases of Electronics
1.4 Field of study	Electronic engineering, telecommunications and information technologies
1.5 Cycle of study	Bachelor of Science
1.6 Study program / Qualification	Electronic engineering, telecommunications and information technologies/ Engineer
1.7 Form of education	IF – full-time education

2. Course information

2.1 Course title	Microwaves				Course code	24.00
2.2 Course coordinator	*Assist. Prof. Andra PASTRAV, PhD Andra.Pastrav@com.utcluj.ro*					
2.3 Seminar/ laboratory/ project/ practical activity coordinator	*Assist. Prof. Andra PASTRAV, PhD Andra.Pastrav@com.utcluj.ro*					
2.4 Year of study	II	2.5 Semester	2	2.6 Type of assessment		E
2.7 Course status	Formative category					DD
	Optionality					DOB

3. Estimated total time

3.1 Hours per week	4	of which:	3.2 Lecture	2	3.3 Seminar		3.3 Laboratory	2	3.3 Project		3.3 Practical training	
3.4 Hours per semester	56	of which:	3.5 Lecture	28	3.6 Seminar		3.6 Laboratory	28	3.6 Project		3.3 Practical training	

3.7 Time distribution (hours per semester) for individual study and assessment:	
(a) Assessment	6
(b) Study using textbook, course materials, bibliography, and notes	25
(c) Additional documentation in the library, on specialized electronic platforms, and in the field	-
(d) Preparation for seminars/laboratories, assignments, reports, portfolios and essays	10
(e) Tutoring	3
(f) Other activities	-
3.8 Total hours of individual study and assessment (sum of (3.7(a)...3.7(f))	44
3.9 Total hours per semester (3.4+3.8)	100
3.10 Number of credits	4.0

4. Prerequisites (where applicable)

4.1 curriculum	Bases of Electrotechnics I, Bases of Electrotechnics II, Passive Components and Circuits, Differential Equations, Electronics Devices, Fundamental Electronic Circuits, Signals and Systems
4.2 competencies	Know Maxwell's equations and the fundamental principles of electromagnetics. Apply electrical circuit analysis methods. Explain the operation of passive components, resonant circuits, diodes, and transistors. Analyze signals and linear systems in the time and frequency domains.

5. Requirements (where applicable)

5.1. for the development of the lecture	Video-projector, screen, whiteboard / blackboard
5.2. for the development of the seminar/ laboratory/ project	PCs with Internet access

6. Specific competencies acquired

Professional competencies	C1 Use of fundamental elements related to electronic devices, circuits, systems, instrumentation and technology C1.1 Description of the operation of electronic devices and circuits and of the fundamental methods for measuring electrical quantities C1.2 Analysis of low-/medium-complexity electronic circuits and systems for their design and measurement C1.4 Use of electronic instruments and specific methods to characterize and evaluate the performance of electronic circuits and systems C1.5 Design and implementation of low-/medium-complexity electronic circuits using CAD-CAM technologies and standards in the field C2 Application of basic methods for signal acquisition and processing C2.1 Time-domain, spectral and statistical characterization of signals C2.2 Explanation and interpretation of signal acquisition and processing methods C2.3 Use of simulation environments for signal analysis and processing C2.4 Use of specific methods and instruments for signal analysis C5 Application of basic knowledge, concepts and methods from: power electronics, automatic systems, electrical energy management and electromagnetic compatibility C5.1 Definition of the specific elements that characterize electronic devices and circuits in the fields of: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods

Professional competencies	C5.2 Qualitative and quantitative interpretation of the operation of circuits in the fields of: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods; analysis of operation from the standpoint of electromagnetic compatibility C5.4 Evaluation, based on technical quality and environmental impact criteria, of equipment in the fields of applied electronics: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods C5.5 Design, using established principles and methods, of low-complexity subsystems in the fields of applied electronics: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods C6 Solving technological problems in the fields of applied electronics C6.1 Definition of the principles and methods underlying the manufacture, adjustment, testing and troubleshooting of devices and equipment in the fields of applied electronics C6.2 Explanation and interpretation of production processes and maintenance activities for electronic equipment, identifying test points and the electrical quantities to be measured C6.4 Use of criteria and methods for evaluating the quality of production and service activities in the fields of applied electronics
Transversal competencie	

7. Expected learning outcomes

Knowledge	- The student/graduate explains and interprets theoretical and experimental results in mathematics, physics, chemistry, economics, technical drawing and computer science.
Skills	- The student/graduate applies evaluation criteria and methods for identifying, modelling, experimenting, analysing and qualitatively and quantitatively assessing phenomena and processes specific to the fundamental field, including by using digital technologies. - The student/graduate designs solutions, in compliance with relevant standards, for medium-complexity engineering problems that meet specified needs, while observing requirements related to public health, safety, welfare, environment, sustainability and economic factors, as well as other specific constraints.
Responsibility and autonomy	- The student/graduate fluently uses at least one international language in technical communication.

8. Course objectives (based on the grid of specific competencies acquired)

8.1 General objective of the course	Develop the competences required to analyze, design, evaluate, and apply fundamental microwave circuits, components, and systems.

8.2 Specific objectives	1. Explain and analyze electromagnetic wave propagation in transmission lines, stripline and microstrip structures, and rectangular waveguides. 2. Use the Smith Chart to analyze transmission lines, determine impedance transformations, and design impedance matching networks for microwave circuits. 3. Analyze the behavior of microwave networks using multiport network parameters (S-parameters) and evaluate their performance. 4. Analyze, design, and assess the performance of passive microwave components, including resonators, power dividers, hybrid junctions, directional couplers and microwave filters. 5. Explain the operating principles of active devices, including microwave diodes and transistors, and analyze their applications in microwave oscillators, amplifiers, mixers, and switching circuits. 6. Explain the operating principles, characteristics, and applications of microwave vacuum tubes, including klystrons, traveling-wave tubes (TWTs), and magnetrons, and evaluate their suitability for high-power microwave systems. 7. Analyze the operating principles and radiation characteristics of microwave antennas, and select appropriate antenna types based on application requirements, including gain, directivity, polarization, and bandwidth. 8. Perform basic microwave link budget calculations by evaluating propagation losses, antenna gains, other system loss, receiver sensitivity and fade margin to assess the performance of point-to-point microwave communication systems. 9. Perform laboratory measurements on microwave circuits, antennas, and components using specialized instrumentation, and analyze the measured results.

9. Contents

9.1 Lecture	**No. of hours**	**Teaching methods**	**Remarks**
1. Introduction. Microwaves applications. Recap of basic concepts that are needed for the study of Microwaves.	2	Interactive lectures based on presentations, heuristic conversation, and exemplification; problem-	
2. Transmission Line Theory. Field Analysis on Transmission Lines	2		
3. Transmission Lines and Waveguides. General Solutions for TEM, TM and TE Waves	2		
4. Rectangular Waveguides. Coaxial Lines. Stripline. Microstrip	2		
5. The Smith Chart	2		
6. Impedance Matching and Tuning. Singles Stub Tuning, Matching with Lumped Elements (L Network). The Quarter-Wave Transformer	2		

9.1 Lecture	No. of hours	Teaching methods	Remarks
7. The S-matrix, Power Dividers and Directional Couplers	2	solving; analytical and numerical exercises; testing and measurements; discussion of experimental results.	
8. Microwave Resonators	2		
9. Microwave Active Components – Diodes and Transistors	2		
10. Microwave Amplifiers, Oscillators, Detectors and Mixers	2		
11. Microwave Tubes	2		
12. Microwave Antennas	2		
13. Link Budget Analysis	2		
14. Microwave and RF Systems Testing and Measurement	2		

Bibliography

1. Pozar, D. – Microwave Engineering, 4th Edition, John Wiley & Sons, 2012. ISBN: 978-0-470-63155-3.
2. Laverghetta, T. – Microwaves and wireless simplified, Artech House, 2005, ISBN 1-58053-943-2.
3. Palade, T. – Tehnica Microundelor, Genesis, Cluj-Napoca, 1997, ISBN 973-98204-3-3 2.

9.2 Seminar /laboratory /project /practical training	No. of hours	Teaching methods	Remarks
1. Laboratory Work Regulations. Infrastructure Presentation. Software Tool for Wave Propagation Simulation.	2	Interactive presentations, heuristic conversation, and exemplification; problem-solving; analytical and numerical exercises; testing and measurements; laboratory experiments; simulations; discussion of experimental results.	
2. Wave Propagation on TEM Transmission Lines	2		
3. Microwave Propagation in Rectangular Waveguides. Dominant and High-order Propagation Modes.	2		
4. Coaxial Lines. Stripline. Microstrip	2		
5. The Smith Chart	2		
6. Impedance Matching – Single Stub Tuning	2		
7. Impedance Matching – L-section Networks	2		
8. Power and Attenuation Measurements	2		
9. Directional Couplers, Power Dividers and Hybrid Junctions	2		
10. Microwave Amplifiers, Oscillators, Detectors, and Mixers	2		
11. Industrial Applications of the Magnetron. Microwave Oven	2		
12. Microwave Antennas	2		
13. Link Budget Analysis	2		
14. Make-up missed laboratory activities	2		

Bibliography

1. Pozar, D. – Microwave Engineering, 4th Edition, John Wiley & Sons, 2012. ISBN: 978-0-470-63155- 3.
2. Laverghetta, T. – Microwaves and wireless simplified, Artech House, 2005, ISBN 1-58053-943-2.
3. Crisan, N., Cremene, L., Palade, T., Puşchiţa, E., Microunde – Aplicaţii (Microwave – Applications), Vol. 1, U.T. Press, 2008.
4. Palade, T., Moldovan, A., Puschita, E., Vermeşan, I., Colda, R., Microunde – Aplicaţii (Microwave – Applications), Vol.2, U. T. Press, 2009

9.2 Seminar /laboratory /project /practical training	No. of hours	Teaching methods	Remarks
5. A.Pastrav, T.Palade, E.Puschita, P.Dolea, P.V.Dascal- Întrebări și probleme din tehnica microundelor, UTPRESS, Cluj-Napoca, 2017, ISBN 978-606-737-250-2			

10. Alignment of the course contents with the expectations of the epistemic community, professional associations, and representative employers in the field related to the program

The course content and the teaching-learning-assessment methods are aligned with the current requirements of the Electronics, Telecommunications, and Information Technology Engineering field, considering the expectations of the academic and professional community, representative employers, as well as the national quality assurance standards in higher education. The course helps prepare students in line with employer expectations and the quality requirements set for engineering study programs.

11. Assessment

Activity type	11.1 Assessment criteria	11.2 Assessment methods (and type of assessment: continuous/ summative)	11.3 Weight in final grade
11.4 Lecture	The level of acquired theoretical knowledge	Summative evaluation written exam (theory and problems)	50 % (theory accounts for 25%, problem solving accounts for 25%)
11.5 Seminar/ Laboratory/ Project /Practical activity	The level of acquired knowledge and practical skills	Continuous formative evaluation – 3 tests: - one practical lab test - two problem solving tests	50 % (average of the 3 lab tests)

11.6 Minimum performance standard

Qualitative:

- ✓ Basic knowledge of wave propagation on transmission lines, stripline and microstrip structures, as well as rectangular waveguides.
- ✓ Basic knowledge of impedance matching techniques.
- ✓ Basic knowledge regarding the design, role, and working principle of power dividers, directional couplers, passive and active microwave components
- ✓ Basic knowledge regarding microwave antennas and link budget analysis.
- ✓ Main microwave applications.

Quantitative:

- ✓ Complete the tasks for all laboratory activities
- ✓ Minimum 5 points (out of 10) for the laboratory evaluation **(Lab_evaluation),**
- ✓ Minimum 5 points (out of 10) for the theoretical part of the Final Exam **(Exam_Theory),**
- ✓ Minimum 5 points (out of 10) for the problem-solving part of the Final Exam **(Exam_Problems).**
- ✓ The final score is: **0.5*Lab_evaluation + 0.25*Exam_Theory + 0.25*Exam_Problems**

Completion date:	**Course coordinators**	**teaching rank, title First name LAST NAME**	**Signature**
23.06.2026	Lecture	Assist. Prof. Andra PASTRAV, PhD	
	Applications	Assist. Prof. Andra PASTRAV, PhD	

Approval of the Head of the Department coordinating the course, only if this differs from the department organizing the study program	Head of the Communications Department Prof. Virgil DOBROTĂ, Ph.D.

Date of approval by the Council of the Department of Bases of Electronics 26.06.2026	Head of the Bases of Electronics Department Prof. Sorin HINTEA, Ph.D.
Date of approval by the Council of the Faculty of Electronics, Telecommunications and Information Technology 30.06.2026	Dean, Prof. Ovidiu-Aurel POP, Ph.D.