

## SYLLABUS

### 1. Data about the program of study

|                                      |                                                                                    |
|--------------------------------------|------------------------------------------------------------------------------------|
| 1.1 Institution                      | Technical University of Cluj-Napoca                                                |
| 1.2 Faculty                          | Faculty of Electronics, Telecommunications and information Technology              |
| 1.3 Department                       | Communications                                                                     |
| 1.4 Field of study                   | Electronic Engineering, Telecommunications and Information Technologies            |
| 1.5 Cycle of study                   | Bachelor of Science                                                                |
| 1.6 Program of study / Qualification | Telecommunications Technologies and Systems/ Engineer Applied Electronics/Engineer |
| 1.7 Form of education                | Full time                                                                          |
| 1.8 Subject code                     | TST-E40.00/EA-E109.00                                                              |

### 2. Data about the subject

|                                                           |                                                                                                                  |              |   |                |      |                      |       |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------|---|----------------|------|----------------------|-------|
| 2.1 Subject name                                          | Radiocommunications                                                                                              |              |   |                |      |                      |       |
| 2.2 Subject area                                          | Electronics and Telecommunications Engineering                                                                   |              |   |                |      |                      |       |
| 2.3 Course responsible                                    | Professor Tudor PALADE, Ph.D, <a href="mailto:Tudor.Palade@com.utcluj.ro">Tudor.Palade@com.utcluj.ro</a>         |              |   |                |      |                      |       |
| 2.4 Teacher in charge with seminar / laboratory / project | Assist.Prof. Cristian CODAU, PhD, <a href="mailto:Cristian.Codau@com.utcluj.ro">Cristian.Codau@com.utcluj.ro</a> |              |   |                |      |                      |       |
| 2.5 Year of study                                         | 3                                                                                                                | 2.6 Semester | 6 | 2.7 Assessment | Exam | 2.8 Subject category | DS/DI |

### 3. Estimated total time

|                                                                                   |     |                      |    |                          |       |
|-----------------------------------------------------------------------------------|-----|----------------------|----|--------------------------|-------|
| 3.1 Number of hours per week                                                      | 5   | of which: 3.2 course | 2  | 3.3 laboratory + project | 3     |
| 3.4 To Total hours in the curriculum                                              | 30  | of which: 3.5 course | 28 | 3.6 laboratory + project | 42    |
| Distribution of time                                                              |     |                      |    |                          | hours |
| Manual, lecture material and notes, bibliography                                  |     |                      |    |                          | 14    |
| Supplementary study in the library, online specialized platforms and in the field |     |                      |    |                          | -     |
| Preparation for seminars / laboratories, homework, reports, portfolios and essays |     |                      |    |                          | 10    |
| Tutoring                                                                          |     |                      |    |                          | 3     |
| Exams and tests                                                                   |     |                      |    |                          | 3     |
| Other activities: .....                                                           |     |                      |    |                          |       |
| 3.7 Total hours of individual study                                               | 30  |                      |    |                          |       |
| 3.8 Total hours per semester                                                      | 100 |                      |    |                          |       |
| 3.9 Number of credit points                                                       | 4   |                      |    |                          |       |

### 4. Pre-requisites (where appropriate)

|                |                                                                                                                                                                                                                                                                                                                                         |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1 curriculum | Passive components, Electric Devices and Circuits, Integrated Circuits, Signals Circuits and Systems, Microwaves                                                                                                                                                                                                                        |
| 4.2 competence | Relations and theorems for electric circuits, frequency response representation; operating principles for electronic devices: diode, operational amplifier, MOSFET and BJT transistors; use of electronic devices in electronic circuits; analysis methods for electronic circuits; voltage transfer characteristics; transfer function |

## 5. Requirements (where appropriate)

|                                                 |                                                |
|-------------------------------------------------|------------------------------------------------|
| 5.1. for the course                             | Video-projector, screen, whiteboard/blackboard |
| 5.2. for the seminars / laboratories / projects | Whiteboard, PCs with connection to Internet    |

## 6. Specific competences

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Professional competences | <p>C4. To design, implement and operate data, voice, video and multimedia services, based on the understanding and application of fundamental concepts from the field of communications and information transmission.</p> <p>C5. To select, install, configure and exploit fixed and mobile telecommunications equipment. To equip a site with common telecommunications networks.</p> <p>C6. To solve wide-band telecommunications networks' specific problems: propagation in various transmission media, high frequency circuits and equipment (microwaves and optical).</p> |
| Cross competences        | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## 7. Discipline objectives (as results from the key competences gained)

|                         |                                                                                                                                                                                                                                                                                          |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.1 General objective   | Developing skills in the design, simulation and measurement of circuits and radio systems                                                                                                                                                                                                |
| 7.2 Specific objectives | <p>1. Assimilation of theoretical knowledge for the design and simulation of radio circuits using advanced simulation programs (Microwave Office, Matlab, ADS, LabView etc.)</p> <p>2. Obtaining skills and abilities necessary for measuring and testing circuits and radio systems</p> |

## 8. Contents

| 8.1 Lecture (syllabus)                                                                    | Teaching methods                                                                                                                 | Notes                                           |
|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| 1. The fundamentals of electronic communication                                           | Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation | Use of .ppt presentation, projector, blackboard |
| 2. Wave propagation                                                                       |                                                                                                                                  |                                                 |
| 3. Antennas and transmission lines.                                                       |                                                                                                                                  |                                                 |
| 4. Amplitude modulation fundamentals                                                      |                                                                                                                                  |                                                 |
| 5. Amplitude modulator and demodulator circuits.                                          |                                                                                                                                  |                                                 |
| 6. Fundamentals of frequency modulation.                                                  |                                                                                                                                  |                                                 |
| 7. Frequency modulation circuits.                                                         |                                                                                                                                  |                                                 |
| 8. Digital communication techniques.                                                      |                                                                                                                                  |                                                 |
| 9. Multiplexing and demultiplexing, transmission of binary data in communication systems. |                                                                                                                                  |                                                 |
| 10. Radio transmitters                                                                    |                                                                                                                                  |                                                 |
| 11. Communication receivers.                                                              |                                                                                                                                  |                                                 |
| 12. Satellite communication                                                               |                                                                                                                                  |                                                 |

|                                                                                                                                                 |                                                               |                                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------|
| 13. Wireless technologies                                                                                                                       |                                                               |                                                                    |
| 14. Communication tests and measurements                                                                                                        |                                                               |                                                                    |
| Bibliography                                                                                                                                    |                                                               |                                                                    |
| 1. Palade, T, s.a – Radiocomunicatii laborator, Ed. Mediamira, 1999, Cluj, ISBN 973-97791-2-3                                                   |                                                               |                                                                    |
| 2. Palade, T., s.a. – Radiocomunicatii probleme, Ed. Mediamira, 1999, Cluj, ISBN 973-97790-9-3.                                                 |                                                               |                                                                    |
| 3. Walke, B.H. – Mobile radio networks – Wiley&Sons, 2002, ISBN 0-471-97595-8.                                                                  |                                                               |                                                                    |
| 4. Young, P.H.–Electronic Communication Techniques, Prentice Hall, 2003, ISBN 0-02-431201-0.                                                    |                                                               |                                                                    |
| 5. Karlson, B., s.a. - Wireless Foresight, Wiley&Sons, 2003, ISBN 0-471-85815-X.                                                                |                                                               |                                                                    |
| 6. Haykin, S. – Communication Systems, Wiley&Sons, 4th Edition, 2004, ISBN 0-471-17869-1.                                                       |                                                               |                                                                    |
| 7. Coleman, C.– An introduction to radio frequency engineering, Cambridge Univ. Press, 2005, ISBN 0-521-83481-3.                                |                                                               |                                                                    |
| 8. Hagen, J.B. - Radio-Frequency Electronics, Circuits and Applications, Cambridge University Press, 2009, ISBN 978-0-521-88974-2.              |                                                               |                                                                    |
| 9. Ziemer, R.E., Tranter, W.H. – Principles of Communications – Systems, Modulation and Noise, John Wiley & Sons, 2010, ISBN 978-0-470-39878-4. |                                                               |                                                                    |
| 10. Palade, T., s.a. – Radiocomunicatii – Indrumator de laborator Vol I, U.T.Press, Cluj-Napoca 2012, ISBN 978-973-662-684-5.                   |                                                               |                                                                    |
| 11. Frenzel L. E. – Principles of Electronic Communication Systems – Mc Graw Hill , Fourth Edition 2016, ISBN 978-0-07-337385-0.                |                                                               |                                                                    |
| 8.2 Laboratory                                                                                                                                  | Teaching methods                                              | Notes                                                              |
| 1. Safety measures. Introduction. Link budget analysis                                                                                          | Didactic and experimental proof, didactic exercise, team work | Use of laboratory instrumentation, experimental boards, computers. |
| 2. The transmitter                                                                                                                              |                                                               |                                                                    |
| 3. The receiver                                                                                                                                 |                                                               |                                                                    |
| 4. The PLL circuit                                                                                                                              |                                                               |                                                                    |
| 5. Automatic gain control                                                                                                                       |                                                               |                                                                    |
| 6. Amplitude Modulation                                                                                                                         |                                                               |                                                                    |
| 7. Demodulation of amplitude modulated signals                                                                                                  |                                                               |                                                                    |
| 8. Amplitude modulation: DSB and SSB                                                                                                            |                                                               |                                                                    |
| 9. Demodulation: MA, DSB                                                                                                                        |                                                               |                                                                    |
| 10. Demodulation SSB                                                                                                                            |                                                               |                                                                    |
| 11. Frequency modulation                                                                                                                        |                                                               |                                                                    |
| 12. Demodulation of frequency modulated signals                                                                                                 |                                                               |                                                                    |
| 13. Encoder remote control                                                                                                                      |                                                               |                                                                    |
| 14. Make-up the missed laboratory activities                                                                                                    |                                                               |                                                                    |
| Bibliography                                                                                                                                    |                                                               |                                                                    |
| 1. Palade, T, s.a – Radiocomunicatii laborator, Ed. Mediamira, 1999, Cluj, ISBN 973-97791-2-3                                                   |                                                               |                                                                    |
| 2. Palade, T., s.a. – Radiocomunicatii probleme, Ed. Mediamira, 1999, Cluj, ISBN 973-97790-9-3.                                                 |                                                               |                                                                    |
| 3. Palade, T., s.a. – Radiocomunicatii – Indrumator de laborator Vol I, U.T.Press, Cluj-Napoca 2012, ISBN 978-973-662-684-5.                    |                                                               |                                                                    |
| 8.3 Project                                                                                                                                     | Teaching methods                                              | Notes                                                              |
| 1. Introduction. Presentation of project activity. Topic selection                                                                              | Didactic and experimental proof, teamwork                     | Use of laboratory instrumentation, computers, software simulators  |
| P1 - physical models for MIMO channel                                                                                                           |                                                               |                                                                    |
| P2 - channel models based on stochastic geometry                                                                                                |                                                               |                                                                    |
| P3 - analytical models based on the propagation channel                                                                                         |                                                               |                                                                    |
| P4 - channel models based on correlations                                                                                                       |                                                               |                                                                    |
| P5 – broadcasting radio channel modeling                                                                                                        |                                                               |                                                                    |
| P6 - modeling wideband MIMO channel                                                                                                             |                                                               |                                                                    |
| P7 - capacity of MU-MIMO and MIMO channel                                                                                                       |                                                               |                                                                    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| P8 - MIMO transmission algorithms - STBC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |  |
| P9 - MIMO transmission algorithms - V, H, D BLAST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  |
| P10 - diversity techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |  |
| P11 – space diversity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |  |
| P12 - techniques for radiation lobe synthesis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |  |
| P13 - estimation techniques for angles of arrival - DoA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
| P14 - channel state estimation methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |  |
| 2. Paper Structure. Bibliographical study on the selected topic.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |  |
| 3. Content selection and outline of paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |  |
| 4. First draft of the paper.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |  |
| 5. Review of the first draft of the paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |  |
| 6. Draw conclusions. Write the Abstract. Finish the paper.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |  |
| 7. Evaluation: presentation of final projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |  |
| <b>Bibliography</b><br>3. Walke, B.H. – Mobile radio networks – Wiley&Sons, 2002, ISBN 0-471-97595-8.<br>4. Young, P.H.–Electronic Communication Techniques, Prentice Hall, 2003, ISBN 0-02-431201-0.<br>5. Karlson, B., s.a. - Wireless Foresight, Wiley&Sons, 2003, ISBN 0-471-85815-X.<br>6. Haykin, S. – Communication Systems, Wiley&Sons, 4th Edition, 2004, ISBN 0-471-17869-1.<br>7. Coleman, C.– An introduction to radio frequency engineering, Cambridge Univ. Press, 2005, ISBN 0-521-83481-3.<br>8. Hagen, J.B. - Radio-Frequency Electronics, Circuits and Applications, Cambridge University Press, 2009, ISBN 978-0-521-88974-2.<br>9. Ziemer, R.E., Tranter, W.H. – Principles of Communications – Systems, Modulation and Noise, John Wiley & Sons, 2010, ISBN 978-0-470-39878-4. |  |  |

### 9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of <i>Electronics Engineering, Telecommunications Engineering; Electronics Design Engineering; System and Computer Design Engineering; Communications Design Engineering</i> )), and the expectations of the national organization for quality assurance (ARACIS). |
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### 10. Evaluation

| Activity type                                                                                                                                                                                                                                                                                                                                                                                 | 10.1 Assessment criteria                                         | 10.2 Assessment methods                                       | 10.3 Weight in the final grade |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------|
| 10.4 Course                                                                                                                                                                                                                                                                                                                                                                                   | The level of acquired theoretical knowledge and practical skills | <i>Exam</i>                                                   | 50%                            |
| 10.5 Seminar/<br>Laboratory                                                                                                                                                                                                                                                                                                                                                                   | The level of acquired knowledge and abilities                    | Continuous formative evaluation and practical laboratory test | 50%                            |
| 10.6 Minimum standard of performance                                                                                                                                                                                                                                                                                                                                                          |                                                                  |                                                               |                                |
| <b>Qualitative:</b><br><b>Knowledge:</b> <ul style="list-style-type: none"> <li>✓ <i>Fundamentals of wave propagation and wireless communications</i></li> <li>✓ <i>Basic transmitter and receiver block diagrams and working principle.</i></li> <li>✓ <i>Fundamental modulation techniques</i></li> <li>✓ <i>Features of main radiocommunication systems</i></li> </ul> <b>Competences:</b> |                                                                  |                                                               |                                |

- ✓ To solve link budget analyses
- ✓ To describe the working principles of radio transmitters and receivers
- ✓ To solve specific modulation/demodulation problems

**Quantitative:**

- ✓ Complete the tasks in all laboratory activities
- ✓ Present a final paper for the project evaluation
- ✓ Minimum 5 points (out of 10) for the lab activity evaluation, minimum 5 points (out of 10) for the project evaluation, and minimum 5 points (out of 10) for the final Exam.
- ✓ Final score:  $0.5 * \text{Final\_Exam} + 0.3 * \text{Lab\_evaluation} + 0.2 * \text{Project\_evaluation}$

| Date of filling in: | Responsible  | Title First name SURNAME         | Signature |
|---------------------|--------------|----------------------------------|-----------|
| 16.06.2025          | Course       | Prof. Tudor PALADE, Ph.D.        |           |
|                     | Applications | Assist.Prof. Cristian CODAU, PhD |           |

|                                                                                                                            |                                                                  |
|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Date of approval in the Council of the Communications Department<br>18.06.2025                                             | Head of Communications Department<br>Prof. Virgil DOBROTA, Ph.D. |
| Date of approval in the Council of the Faculty of Electronics, Telecommunications and Information Technology<br>25.06.2025 | Dean<br>Prof. Ovidiu POP, Ph.D.                                  |