

## 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                    | Communications                                                          |
| 1.4 Field of study                | Electronic engineering, telecommunications and information technologies |
| 1.5 Cycle of study                | Bachelor of Science                                                     |
| 1.6 Study program / Qualification | Telecommunications technologies and systems / Engineer                  |
| 1.7 Form of education             | IF – full-time education                                                |

### 2. Course information

|                                                                  |                                                                                                                                                                                                                                    |              |       |
|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|
| 2.1 Course title                                                 | Optoelectronics                                                                                                                                                                                                                    | Course code  | 32.00 |
| 2.2 Course coordinator                                           | Conf.dr.ing. Szolga Lorant Andras, – <a href="mailto:lorant.szolga@bel.utcluj.ro">lorant.szolga@bel.utcluj.ro</a>                                                                                                                  |              |       |
| 2.3 Seminar/ laboratory/ project/ practical activity coordinator | Conf.dr.ing. Szolga Lorant Andras, – <a href="mailto:lorant.szolga@bel.utcluj.ro">lorant.szolga@bel.utcluj.ro</a><br>Prof.dr.ing. Galatus Ramona, - <a href="mailto:ramona.galatus@bel.utcluj.ro">ramona.galatus@bel.utcluj.ro</a> |              |       |
| 2.4 Year of study                                                | III                                                                                                                                                                                                                                | 2.5 Semester | 1     |
| 2.6 Type of assessment                                           | E                                                                                                                                                                                                                                  |              |       |
| 2.7 Course status                                                | Formative category                                                                                                                                                                                                                 |              | DF    |
|                                                                  | Optionality                                                                                                                                                                                                                        |              | DOB   |

### 3. Estimated total time

|                                                                                                    |    |           |             |    |             |   |                |    |             |     |                        |   |
|----------------------------------------------------------------------------------------------------|----|-----------|-------------|----|-------------|---|----------------|----|-------------|-----|------------------------|---|
| 3.1 Hours per week                                                                                 | 4  | of which: | 3.2 Lecture | 2  | 3.3 Seminar | 0 | 3.3 Laboratory | 2  | 3.3 Project | 0   | 3.3 Practical training | 0 |
| 3.4 Hours per semester                                                                             | 56 | of which: | 3.5 Lecture | 28 | 3.6 Seminar | 0 | 3.6 Laboratory | 28 | 3.6 Project | 0   | 3.3 Practical training | 0 |
| 3.7 Time distribution (hours per semester) for individual study and assessment:                    |    |           |             |    |             |   |                |    |             |     |                        |   |
| (a) Assessment                                                                                     |    |           |             |    |             |   |                |    |             |     |                        |   |
| (b) Study using textbook, course materials, bibliography, and notes                                |    |           |             |    |             |   |                |    |             |     |                        |   |
| (c) Additional documentation in the library, on specialized electronic platforms, and in the field |    |           |             |    |             |   |                |    |             |     |                        |   |
| (d) Preparation for seminars/laboratories, assignments, reports, portfolios and essays             |    |           |             |    |             |   |                |    |             |     |                        |   |
| (e) Tutoring                                                                                       |    |           |             |    |             |   |                |    |             |     |                        |   |
| (f) Other activities                                                                               |    |           |             |    |             |   |                |    |             |     |                        |   |
| 3.8 Total hours of individual study and assessment (sum of (3.7(a))...3.7(f))                      |    |           |             |    |             |   |                |    |             | 69  |                        |   |
| 3.9 Total hours per semester (3.4+3.8)                                                             |    |           |             |    |             |   |                |    |             | 125 |                        |   |
| 3.10 Number of credits                                                                             |    |           |             |    |             |   |                |    |             | 5.0 |                        |   |

#### 4. Prerequisites (where applicable)

|                  |                                                         |
|------------------|---------------------------------------------------------|
| 4.1 curriculum   | Analog Integrated Circuits, Digital Integrated Circuits |
| 4.2 competencies |                                                         |

#### 5. Requirements (where applicable)

|                                                              |  |
|--------------------------------------------------------------|--|
| 5.1. for the development of the lecture                      |  |
| 5.2. for the development of the seminar/ laboratory/ project |  |

#### 6. Specific competencies acquired

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Professional competencies | <p>C1 Use of the fundamentals relating to devices, circuits, systems, instrumentation and electronic technology</p> <p>C1.1 Description of the operation of electronic devices and circuits and of the fundamental methods of measuring electrical quantities</p> <p>C1.2 Analysis of circuits and electronic systems of low/medium complexity, for the purpose of design and measurement</p> <p>C1.4 Use of electronic instruments and specific methods to characterize and evaluate the performance of electronic circuits and systems</p> <p>C1.5 Design and implementation of electronic circuits of low / medium complexity using CAD-CAM technologies and Industry standards</p> <p>C4 Design, implementation and operation of data, voice, video, multimedia services, based on the understanding and application of the fundamental notions in the field of communications and information transmission</p> <p>C4.1 Identification of fundamental concepts related to information transmission and analogue and digital communications</p> <p>C4.3 Explanation and interpretation of the main requirements and specific approach techniques for data, voice, video, multimedia transmissions</p> <p>C4.5 Development of simple communication services</p> |
| Transversal competence    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

#### 7. Expected learning outcomes

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Knowledge | <ol style="list-style-type: none"> <li>1. Define and explain the photometric and radiometric quantities used for the characterization of optoelectronic sources, detectors and systems.</li> <li>2. Describe the physical principles of optical radiation generation, propagation, modulation, and detection.</li> <li>3. Explain the structure, principle of operation, and characteristics of the main optoelectronic sources: electroluminescent diodes, laser diodes, and other semiconductor sources.</li> <li>4. Explain the structure and operation of the main photodetectors: photoresistors, PN</li> </ol> |
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|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             | <p>photodiodes, PIN and avalanche, phototransistors and image sensors.</p> <p>5. Identify the characteristic parameters of optoelectronic components, such as wavelength, radiant power, efficiency, sensitivity, responsiveness, noise, response time and frequency band.</p> <p>6. Describe the phenomena of propagation of optical radiation through transparent media, waveguides and optical fibers.</p> <p>7. Explain the operating principles of optocouplers, displays, transducers and optoelectronic measurement and communication systems.</p> <p>8. Explains the influence of temperature, electrical polarization, noise, and environmental conditions on the performance of optoelectronic devices.</p> <p>9. Recognises the basic requirements for the safety of the use of optical sources, lasers and electronic laboratory equipment.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Skills                      | <p>1. Correctly use radiometric, photometric and electro-optical relationships to solve problems specific to optoelectronic devices.</p> <p>2. Calculate the operating parameters of the sources and photodetectors based on the electrical and optical characteristics provided.</p> <p>3. Select an optical source, photodetector, or optical coupler according to the requirements of an application.</p> <p>4. Interprets the spectral characteristics, current-voltage, power-current, sensitivity, and frequency response of optoelectronic components.</p> <p>5. Design and size elementary circuits for power and control of electroluminescent diodes and laser diodes.</p> <p>6. Design and size elementary polarization, conversion and amplification circuits for photodiodes and phototransistors.</p> <p>7. Performs and experimentally tests optoelectronic assemblies using power supplies, signal generators, oscilloscopes, multimeters and optical measuring instruments.</p> <p>8. Measures the electrical and optical parameters of optoelectronic components and systems and estimates the errors associated with the measurement.</p> <p>9. Processes, graphs and interprets the experimental data obtained in the laboratory.</p> <p>10. Compare the measured results with the theoretical values and specifications in the technical documentation of the components.</p> <p>11. Identify possible sources of error or malfunction of an optoelectronic setup and propose remedial measures.</p> <p>12. Uses technical documentation, manufacturers' catalogues and bibliographic resources for the selection and evaluation of optoelectronic components.</p> <p>13. Presents, synthetically, orally and in writing, the working method, the experimental results and the conclusions of an optoelectronics application.</p> |
| Responsibility and autonomy | <p>1. Organizes and carries out individual or team experimental activities, respecting the requirements of the theme and the sequence of laboratory operations.</p> <p>2. Responsibly uses the apparatus, optoelectronic components and laboratory equipment, in compliance with the electrical and optical safety norms.</p> <p>3. Follow the instructions on the safe use of laser sources and avoid direct or indirect exposure to potentially hazardous optical radiation.</p> <p>4. Assumes responsibility for the correctness of the assemblies made, the measurements made, the calculations and the reported results.</p> <p>5. Independently verifies the coherence of the experimental results and argues any differences between the theoretical and measured values.</p> <p>6. Selects, with an appropriate degree of autonomy, the methods, components and tools necessary to solve an optoelectronic problem of low or medium complexity.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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|  | <p>7. Collaborates effectively within the team, performs assigned tasks and communicates results in an appropriate technical form.</p> <p>8. Respects the principles of academic ethics, data traceability and correct indication of the bibliographic and technical sources used.</p> <p>9. Critically evaluates its own results, identifies the limits of the solution adopted and formulates proposals for improvement.</p> <p>10. Expresses concern for the continuous updating of knowledge, given the rapid evolution of optoelectronic devices, sensors and systems.</p> |
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#### 8. Course objectives (based on the grid of specific competencies acquired)

|                                     |                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8.1 General objective of the course | Familiarizing students with optoelectronic components and systems frequently encountered in practice.                                                                                                                                                                                                                  |
| 8.2 Specific objectives             | <p>1. Training students to simulate optoelectronic circuits. Students must be able to specify/choose optoelectronic devices adapted to the applications, to be able to design.</p> <p>2. Training students to the level where they can build simple optoelectronic equipment, measure/test optoelectronic systems.</p> |

#### 9. Contents

| 9.1 Lecture                                                                                                                                                             | No. of hours | Teaching methods                                                                 | Remarks |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------|---------|
| 1. Introduction. Elementary notions of optics.                                                                                                                          | 2            | Presentation, discussions, For online teaching, the graphic tablet will be used. |         |
| 2. Mirrors.                                                                                                                                                             | 2            |                                                                                  |         |
| 3. Lenses.                                                                                                                                                              | 2            |                                                                                  |         |
| 4. Lens systems.                                                                                                                                                        | 2            |                                                                                  |         |
| 5. Interference, diffraction                                                                                                                                            | 2            |                                                                                  |         |
| 6. Photometry, radiometry and colorimetry.                                                                                                                              | 2            |                                                                                  |         |
| 7. Electroluminiscent diodes (LED).                                                                                                                                     | 2            |                                                                                  |         |
| 8. Laseri. Diode laser cu semiconductor (LD).                                                                                                                           | 2            |                                                                                  |         |
| 9. Optical guides. Fiber optics.                                                                                                                                        | 2            |                                                                                  |         |
| 10. Optical detectors: photocells.                                                                                                                                      | 2            |                                                                                  |         |
| 11. Optical detectors: photodiodes and phototransistors.                                                                                                                | 2            |                                                                                  |         |
| 12. Solar cells                                                                                                                                                         | 2            |                                                                                  |         |
| 13. Circuits with optoelectronic devices.                                                                                                                               | 2            |                                                                                  |         |
| 14. Optoelectronic sensors                                                                                                                                              | 2            |                                                                                  |         |
| Bibliography                                                                                                                                                            |              |                                                                                  |         |
| 1. Edited by Robert G . W . Brown and John P Dakin - Handbook of Optoelectronics - Taylor & Francis, 2006, Print ISBN: 978-0-7503-0646-1, eBook ISBN: 978-1-4822-6066-3 |              |                                                                                  |         |
| 2. Emil Voiculescu, Tiberiu Marița - "Optoelectronics", Microinformatica Publishing House (Blue), 2001, ISBN 973-9443-96-6.                                             |              |                                                                                  |         |
| 3. Safa O Kasap - Optoelectronics Devices and Photonics: Principles and Practices. Prentice Hall ISBN 0-201-61087-6, Kasap Book Images.                                 |              |                                                                                  |         |
| 4. Raymond Serway, John Jewett : Physics for Scientists and Engineers, 2003, ISBN-10: 0534408427                                                                        |              |                                                                                  |         |

| 9.1 Lecture                                                                                                                                                                                                                                                                                                                                                                                                  | No. of hours | Teaching methods | Remarks |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------|---------|
| 5. Stefan Nilsson-Gistvik – Optical Fiber Theory for Communication Networks, EN/LZT 199210/R1, Ericsson 2002.<br>6. Harry J R Dutton - Understanding Optical Communications<br>7. Catalog Thorlabs<br><br><b>Virtual teaching materials</b><br>1. Szolga Lorant – files with presentations in PPT format, for the course.<br>2. Szolga Lorant – pdf files, containing book chapters or specialized articles. |              |                  |         |

| 9.2 Seminar /laboratory /project /practical training                                                                                                                                                                           | No. of hours | Teaching methods         | Remarks |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------|---------|
| 1. Introduction – labor protection rules, presentation of laboratory instrumentation.                                                                                                                                          | 2            | Exposure,<br>Experiments |         |
| 2. Light reflection and refraction: transmission on POF.                                                                                                                                                                       | 2            |                          |         |
| 3. Lenses and telescopes.                                                                                                                                                                                                      | 2            |                          |         |
| 4. Light polarization.                                                                                                                                                                                                         | 2            |                          |         |
| 5. Light as a wave: interference.                                                                                                                                                                                              | 2            |                          |         |
| 6. Light as a wave: diffraction.                                                                                                                                                                                               | 2            |                          |         |
| 7. Light as a wave: the colors of white light.                                                                                                                                                                                 | 2            |                          |         |
| 8. Electroluminescent diode.                                                                                                                                                                                                   | 2            |                          |         |
| 9. The voltage and current response of the photodiode and phototransistor to different IR illuminations.                                                                                                                       | 2            |                          |         |
| 10. Photoresist response at different wavelengths.                                                                                                                                                                             | 2            |                          |         |
| 11. Determination of the directivity characteristic of photosensitive devices.                                                                                                                                                 | 2            |                          |         |
| 12. Fiber optics. Application: fiber optic welding.                                                                                                                                                                            | 2            |                          |         |
| 13. Linear and switching LED drivers for strobing displays. Bargraph displays.                                                                                                                                                 | 2            |                          |         |
| 14. Material lab overview and evaluation.                                                                                                                                                                                      | 2            |                          |         |
| Bibliography                                                                                                                                                                                                                   |              |                          |         |
| <p>*Note: In the case of online laboratories, they involve the implementation and simulation of circuits involving optoelectronic devices. The following will be used as simulation environments: Proteus and Arduino IDE.</p> |              |                          |         |
| Bibliography                                                                                                                                                                                                                   |              |                          |         |
| Lorant Szolga, Ramona Gălătuș, Emil Voiculescu - <i>Optoelectronics – Laboratory Tutor</i> , UTPRESS, Cluj-Napoca, Romania, 2013, ISBN 978-973-662-858-0, p.113                                                                |              |                          |         |

**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 acquired skills will be used in the following occupations according to the COR (Classification of Occupations in Romania): Emission Engineer; Electronics, transport, telecommunications engineer; Image Engineer; Sound engineer; Electronic engineer designer; Systems and Computer Engineer Designer; Chief Car Engineer; Chief Emission Change Engineer; Communications Design Engineer; Security Systems Engineer; Sales Support Engineer; Multimedia application developer; Network Operations Engineer; Communication Systems Testing Engineer; Project Manager; Traffic Engineer; Consultant for communication systems.

## 11. Assessment

| Activity type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 11.1 Assessment criteria                                                                                                             | 11.2 Assessment methods<br>(and type of assessment:<br>continuous/ summative) | 11.3 Weight<br>in final grade |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------|
| 11.4 Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | The exam consists of the verification of knowledge by solving problems and a theory part (questions) in writing (maximum 1.5 hours). | Written exam in the classroom/online (Teams platform)                         | 90%                           |
| 11.5 Seminar/<br>Laboratory/ Project<br>/Practical activity                                                                                                                                                                                                                                                                                                                                                                                                                                      | Verification of the skills and abilities acquired within each laboratory activity.                                                   | Check-in along the way                                                        | 10%                           |
| <b>11.6 Minimum performance standard</b> <ol style="list-style-type: none"> <li>In order to take the final exam, it is mandatory to be present at all laboratories, to carry out all practical work within the laboratories and to obtain a minimum grade of 4.5 in laboratory activities.<br/>The marking of the laboratories is made from 1 to 10.</li> <li>Passing the discipline implies obtaining a grade of at least 4.5 in the written exam and a final grade of at least 4.5.</li> </ol> |                                                                                                                                      |                                                                               |                               |

| Completion date: | Course coordinators | teaching rank, title First name<br>LAST NAME | Signature                                                                             |
|------------------|---------------------|----------------------------------------------|---------------------------------------------------------------------------------------|
| 23.06.2026       | Lecture             | Conf.dr.ing. Lorant Andras SZOLGA            |  |
|                  | Applications        | Conf.dr.ing. Lorant Andras SZOLGA            |  |
|                  |                     | Prof.dr.ing. Ramona GALATUS                  |                                                                                       |
|                  |                     |                                              |                                                                                       |

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| Approval of the Head of the Department coordinating the course, only if this differs from the department organizing the study program | Head of the Bases of Electronics Department<br>Prof. Sorin HINTEA, Ph.D. |
| Date of approval by the Council of the Department of Communications<br><br>26.06.2026                                                 | Head of the Communications Department<br>Prof. Virgil DOBROTĂ, Ph.D.     |
| Date of approval by the Council of the Faculty of Electronics, Telecommunications and Information Technology<br><br>30.06.2026        | Dean,<br>Prof. Ovidiu-Aurel POP, Ph.D.                                   |