# *DI101F.EN Real and Complex Analysis*

**1. Study program**

| | |
|---|---|
| 1.1. University | University of Bucharest |
| 1.2. Faculty | Faculty of Physics |
| 1.3. Department | Department of Theoretical physics, Mathematics, Optics, Plasma, and Lasers |
| 1.4. Field of study | Physics |
| 1.5. Course of study | Undergraduate/Bachelor of Science |
| 1.6. Study program | Physics (in English) |
| 1.7. Study mode | Full-time study |

**2. Course unit**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2.1. Course unit title | **Real and Complex Analysis** | | | | | | | |
| 2.2. Teacher | | | | **Prof. dr. Claudia Timofte** | | | | |
| 2.3. Tutorials/Practicals instructor(s) | | | | **Prof. dr. Claudia Timofte** | | | | |
| 2.4. Year of study | 1 | 2.5. Semester | I | 2.6. Type of Evaluation | E | 2.7. Type of course unit | Content[1)] | **DC** |
| | | | | | | | Type[2)] | **DI** |

[1)] fundamental (DF), speciality (DS), complementary (DC); [2)] compulsory (DI), elective (DO), optional (DFac)

**3. Total estimated time** (hours/semester)

| | | | | | |
|---|---|---|---|---|---|
| 3.1. Hours per week in curriculum | **6** | distribution: Lecture | **3** | Practicals/Tutorials | **3** |
| 3.2. Total hours per semester | **84** | distribution: 1-st semester | **84** | 2-nd semester | **0** |

| Distribution of estimated time for study | **hours** |
|---|---|
| 3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography | **30** |
| 3.2.2. Research in library, study of electronic resources, field research | **27** |
| 3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks | **30** |
| 3.2.4. Examination | **4** |
| 3.2.5. Other activities | **0** |

| | |
|---|---|
| 3.3. Total hours of individual study | **87** |
| 3.4. Total hours per semester | **175** |
| 3.5. ECTS | **7** |

**4. Prerequisites** (if necessary)

| | |
|---|---|
| 4.1. curriculum | High school mathematics courses |
| 4.2. competences | Not applicable |

**5. Conditions/Infrastructure** (if necessary)

| | |
|---|---|
| 5.1. for lecture | Multimedia room (with video projector). Lecture notes. Recommended bibliography. |
| 5.2. for practicals/tutorials | Video projector. Computers. |

**6. Specific competences acquired**

| | |
|---|---|
| Professional competences | C1. The identification and the appropriate use of the main physical laws and principles in a given context.<br>C2. The use of suitable software packages for data analysis and processing.<br>C3. Solving physics problems under given conditions using analytical, numerical and statistical methods.<br>C5. The ability to analyse and communicate the didactic, scientific and popularization information of Physics. |
| Transversal competences | CT3 - The efficient use of the information sources and of the communication and professional development resources in Romanian and in a widely used foreign language, as well. |

**7. Course objectives**

| | |
|---|---|
| 7.1. General objective | • Knowledge and understanding: knowledge and appropriate use of the specific notions of mathematical analysis.<br>• Achieving a thorough theoretical knowledge.<br>• Gaining computation skills. |
| 7.2. Specific objectives | • Knowledge and appropriate use of fundamental concepts of mathematical analysis.<br>• Developing the ability to work in a team.<br>• Developing computational skills. |

**8. Contents**

| **8.1. Lecture** [chapters] | Teaching techniques | Observations |
|---|---|---|
| Metric spaces. Normed spaces. Spaces with scalar product. Real and complex Euclidean spaces. | Systematic exposition - lecture. Critical analysis. Examples. | 2 hours |
| Sequences in $R^n$. Convergent and fundamental sequences. Complete spaces. Series in normed spaces. Number series. Convergence tests. | Systematic exposition - lecture. Critical analysis. Examples. | 3 hours |
| Limits of functions. Continuous functions. Continuous functions on compact sets. Uniform continuity. Connected sets. | Systematic exposition - lecture. Critical analysis. Examples. | 3 hours |
| Differentiable functions on $R^n$. Partial derivatives. Jacobi matrix. Differential operators: gradient, divergence, curl. Applications in mechanics. | Systematic exposition - lecture. Critical analysis. Examples. | 6 hours |
| Higher order differentials. Taylor's formula. Local extrema. Implicit functions. | Systematic exposition - lecture. Critical analysis. Examples. | 4 hours |
| Sequences and series of functions. Pointwise and uniform convergence. Power series. Taylor series. Fourier series. Discrete Fourier transform. Applications. | Systematic exposition - lecture. Critical analysis. Examples. | 6 hours |

| | | |
|---|---|---|
| Integrable functions. Improper integrals. Parameter-dependent integrals. Improper integrals depending on parameters. Euler's functions. | Systematic exposition - lecture. Critical analysis. Examples. | 3 hours |
| Line integrals. Paths. Line integrals of the first kind. Integration of differential forms of degree one. | Systematic exposition - lecture. Critical analysis. Examples. | 3 hours |
| Multiple integrals. Change of *v*ariables in multiple integrals. Improper multiple integrals. Applications in quantum mechanics. | Systematic exposition - lecture. Critical analysis. Examples. | 4 hours |
| Area of a smooth surface. Surface integrals. Oriented surfaces. Flux of a field through a surface. | Systematic exposition - lecture. Critical analysis. Examples. | 4 hours |
| Integral formulas: Green-Riemann, Gauss-Ostrogradski, Stokes. Mechanical work. Path-independence of line integrals. Applications in physics. | Systematic exposition - lecture. Critical analysis. Examples. | 4 hours |

Bibliography:


- G. Arfken, H. Weber, "Mathematical Methods for Physicists", Elsevier Academic Press, 2005.
- P. Bamberg, S. Sternberg, "A Course in Mathematics for Students of Physics", Cambridge University Press, 1990.
- N. Cotfas, L. Cotfas, "Elements of Mathematical Analysis" (in Romanian), Editura Universității din București, 2010.
- R. Courant, "Differential and Integral Calculus", Wiley, New York, 1992.
- A. Halanay, V. Olariu, S. Turbatu, "Mathematical Analysis" (in Romanian), E.D. P., 1983.
- E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2011.
- K. F. Riley, M. P. Hobson, S. J. Bence, "Mathematical Methods for Physics and Engineering", 3rd edition, Cambridge University Press, Cambridge, 2006.
- W. Rudin, "Principles of Mathematical Analysis", McGraw-Hill, New York, 1964.
- D. Stefănescu, "Real Analysis" (in Romanian), Editura Universității din București, 1990.
- C. Timofte, ''Differential Calculus'', Editura Universității din București, 2009.


| **8.2. Tutorials** | Teaching and learning techniques | Observations |
|---|---|---|
| The seminar follows the course content. The issues to be discussed are meant to provide the student with a deep understanding of the theoretical concepts presented during the course, to develop computing skills and the appropriate use of the | Exposition. Guided work. | |

| | | |
|---|---|---|
| basic concepts of mathematical analysis. | | |

Bibliography:


- L. Aramă, T. Morozan, "Problems of Differential and Integral Calculus" (in Romanian), Ed.Tehnică, Bucureşti, 1978.
- Armeanu, D. Blideanu, N. Cotfas, I. Popescu, I. Şandru, ''Problems of Complex Analysis'' (in Romanian), Ed.Tehnică, 1995.
- Gh. Bucur, E. Câmpu, S. Găină, "Problems of Differential and Integral Calculus" (in Romanian), vol. I- III, Ed.Tehnică, Bucureşti, 1978.
- Demidovich, B., "Problems in Mathematical Analysis", Mir Publishers, Moscow, 1977.
- N. Donciu, D. Flondor, "Mathematical Analysis. Problems" (in Romanian), Editura ALL, 1998.
- D. Stefănescu, S. Turbatu, ''Analytical Functions. Problems'' (in Romanian), Universitatea din București, 1986.


| **8.3. Practicals** | Teaching and learning techniques | Observations |
|---|---|---|
| | | |
| | | |
| **8.4. Project** | Teaching and learning techniques | Observations |
| | | |

**9. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program)**

This course unit develops some theoretical and practical competences and abilities, which are important for an undergraduate student in the field of modern Physics, corresponding to national and international standards. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union. The contents are in line with the requirements of the main employers of the graduates (industry, research, secondary school teaching).

**10. Assessment**

| Activity type | 10.1. Assessment criteria | 10.2. Assessment methods | 10.3. Weight in final mark |
|---|---|---|---|
| **10.4. Lecture** | - coherence and clarity of exposition;<br>- correct use of mathematical methods and techniques;<br>- ability to analyse specific examples. | Written tests/oral examination | 80% |
| **10.5.1. Tutorials** | - ability to use specific problem solving methods;<br>- ability to analyse the results;<br>- ability to present and discuss the results. | Homeworks/written tests | 20% |

| | | | |
|---|---|---|---|
| **10.5.2. Practicals** | | | |
| **10.5.3. Project** | | | |
| **10.6. Minimal requirements for passing the exam** | | | |
| **Requirements for mark 5 (10 points scale)**<br><br>Fulfillment of at least 50% of each of the criteria that determine the final grade. | | | |

| Date | Teacher's name and signature | Practicals/Tutorials instructor(s) name(s) and signature(s) |
|---|---|---|
| 29.04.2016 | Prof. dr. Claudia Timofte | Prof. dr. Claudia Timofte |

Date of approval

Head of Department

Prof. dr. Virgil Băran