SYLLABUS

1. Program information

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

2. Course information

2.1 Course title	Basics of Electrotechnics II			Course code	16.00
2.2 Course coordinator	Associate Prof. Mihaela Cretu, PhD. Eng., Mihaela.Cretu@ethm.utcluj.ro				
2.3 Seminar/ laboratory/ project/ practical activity coordinator	Associate Prof. Mihaela Cretu, PhD. Eng., Mihaela.Cretu@ethm.utcluj.ro				
2.4 Year of study	II	2.5 Semester	1	2.6 Type of assessment	E
2.7 Course status	Formative category				DD
	Optionality				DOB

3. Estimated total time

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

3.7 Time distribution (hours per semester) for individual study and assessment:	
(a) Assessment	4
(b) Study using textbook, course materials, bibliography, and notes	14
(c) Additional documentation in the library, on specialized electronic platforms, and in the field	10
(d) Preparation for seminars/laboratories, assignments, reports, portfolios and essays	14
(e) Tutoring	2
(f) Other activities	

3.8 Total hours of individual study and assessment (sum of (3.7(a)...3.7(f))	44
3.9 Total hours per semester (3.4+3.8)	100
3.10 Number of credits	4.0

4. Prerequisites (where applicable)

4.1 curriculum	Physics 2, Basics of Electrotechnics 1, Analysis 1, Algebra 1
4.2 competencies	

5. Requirements (where applicable)

5.1. for the development of the lecture	Amphitheatre, TUCN
5.2. for the development of the seminar/ laboratory/ project	Classrooms, TUCN

6. Specific competencies acquired

Professional competencies	C1 Use of fundamental elements related to electronic devices, circuits, systems, instrumentation and technology C1.1 Description of the operation of electronic devices and circuits and of the fundamental methods for measuring electrical quantities C1.2 Analysis of low-/medium-complexity electronic circuits and systems for their design and measurement C5 Application of basic knowledge, concepts and methods from: power electronics, automatic systems, electrical energy management and electromagnetic compatibility C5.1 Definition of the specific elements that characterize electronic devices and circuits in the fields of: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods C5.2 Qualitative and quantitative interpretation of the operation of circuits in the fields of: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods; analysis of operation from the standpoint of electromagnetic compatibility C5.3 Preparation of technical specifications, installation and operation of equipment in the fields of applied electronics: power electronics, automatic systems, electrical energy management, medical electronics, automotive electronics and consumer goods
Transversal competencie	

7. Expected learning outcomes

Knowledge	- The student/graduate describes, identifies and summarizes elementary concepts and methods related to electronic devices, circuits and instrumentation, as well as their application in concrete problems.

Skills	- The student/graduate uses fundamental methods for measuring electrical quantities and assesses electronic devices and circuits, as well as linear and digital integrated circuits of low/medium complexity. - The student/graduate designs, measures, evaluates performance, diagnoses and troubleshoots functional blocks composed of low/medium-complexity electronic devices and/or circuits.
Responsibility and autonomy	- The student/graduate carries out project management processes in electronics, telecommunications and information technologies, taking on different team roles and clearly and concisely describing the results, both orally and in writing.

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

8.1 General objective of the course	Acquiring the theoretical and applied fundamentals of classical electrodynamics through the rigorous study of the laws and operating regimes of the electromagnetic field. The course aims to develop the capacity for structured analysis of electric and magnetic fields, as well as wave propagation phenomena, providing the conceptual framework necessary for understanding the operating and design principles of electrical, electronic, and telecommunication devices.
8.2 Specific objectives	Upon successful completion of this course, students will be able to: Differentiate and analyze the fundamental equations of electromagnetism based on the operating regime (static, stationary, quasi-stationary, and rapidly time-varying). Apply specific shielding techniques and mitigation technologies to ensure electromagnetic compatibility (EMC) requirements. Utilize analytical and numerical simulation tools for the modeling, interpretation, and optimization (synthesis) of electromagnetic field configurations in electrical devices.

9. Contents

9.1 Lecture	**No. of hours**	**Teaching methods**	**Remarks**
Lecture 1+2 **Review of Vector Analysis. *Mathematical preliminaries for electromagnetic fields.*** Introduction; Vector Analysis and Coordinate Systems in Electromagnetics; Vectors and Scalars; Vector Components; Unit Vectors; Cartesian Coordinate System; Cylindrical Coordinate System; Spherical Coordinate System; Gradient of a Scalar Field; Divergence of a Vector Field; Curl of a Vector Field; Divergence Theorem; Stokes	4	The course is delivered using multimedia facilities, supplemented by blackboard demonstrations/support, providing students with the necessary details to	

9.1 Lecture	**No. of hours**	**Teaching methods**	**Remarks**
Theorem; Useful mathematical formulas used in electromagnetic field computation; Field Parameters and SI Units; Electric Flux Density and Field Intensity; Magnetic Flux Density and Field Intensity; Current Density.		understand the presented topics.	
Lecture 3+4 **Electrostatics.** Introduction *(Basic Concepts; Electrostatic Applications);* Electric Charge Distribution *(Volume, Surface, Line Charge Densities);* Coulomb's Law (*The electric field of a single point charge and multiple point charges; Electric field arising from a continuous volume charge distribution)*; Electric Scalar Potential (*Electric Potential as a Function of Electric Field; Electric Potential Due to Point Charges; Electric Potential Due to Continuous Distributions; Electric Field as a Function of Electric Potential; Poisson's and Laplace's Equations; Equipotential surfaces and lines; Differential equation of the field lines);* Electric Flux; Gauss Law; Alternative techniques for evaluating Electric Fields induced by Symmetrical Charge Distributions. Boundary conditions for electrostatic fields. Poisson's and Laplace's Equations. Electrostatic Potential Energy and Forces	4		
Lecture 6+7+8 **Magnetostatics.** Introduction *(Basic Concepts; Magnetostatics Applications)*; Biot-Savart's Law (*Magnetic field intensity produced by a differential current element; Magnetic Field Due to Surface and Volume Current Distributions*); Maxwell equations for Static-Electric fields and Steady-Magnetic fields (Gauss law for magnetism - *integral and differential form*; Ampere's Law - *integral and differential form*); Applications of Biot-Savart and Ampere's Law (*Magnetic Field of a Linear Conductor; Magnetic Field of a Long Wire; Magnetic Field of a current loop; Magnetic Field inside a Solenoid*); Magnetic Scalar Potential; Magnetic Vector Potential; Poisson and Laplace equations. Applications; Magnetic forces and torque (*Magnetic Force on a Current-Carrying Conductor; Magnetic Force Between Two Parallel Conductors; Magnetic Torque on a current carrying loop);* Magnetic boundary conditions; Inductance (*Magnetic field in a solenoid; Self Inductance; Mutual Inductance; Self and mutual inductance computation*) Magnetic energy	6		

9.1 Lecture	No. of hours	Teaching methods	Remarks
Lecture 9+10 **Time-Varying Fields**. Introduction; Faraday's Law *(Stationary Loop in a Time-Varying magnetic field; The ideal transformer; Moving conductor in a static magnetic field; The Electromagnetic generator Moving Conductor in a Time-Varying magnetic field; Faraday's Law in Integral and Differential Form; Practical Applications);* Ampere circuital Law for time-varying fields; Displacement current; Maxwell Equations in integral form and differential (point) form; Electromagnetic Potentials (Time-Varying Potentials or Retarded Potentials)	4		
Lecture 11+12 ***Plane Waves Propagation***. Maxwell's equations. Wave equation. Diffusion equations. Time-Harmonic Fields; Plane Wave propagation in Lossy Dielectrics; Plane Wave propagation in Lossless Medium (perfect dielectrics); Plane Wave propagation in Free Space; Plane Wave propagation in Good Conductors (perfect conductors); Poynting's theorem and Electromagnetic Wave Power; Plane wave reflection and dispersion; Basics of Antennas	4		
Lecture 13-14 **Transmission Lines.** Introduction (*propagation modes*); Lumped element model; Transmission line equations; Wave propagation on Transmission Lines; The Lossless Transmission Line; Wave impedance of lossless line; Lossless Microstrip line; Special cases of the lossless line; Power flow on a lossless TL; Impedance matching; Transients on Transmission lines (*Transient response; Lattice (bounce) diagram*).	4		

Bibliography

1. *Fawwaz T. Ulaby, Fundamentals of Applied Electromagnetics, 8th Edition, 2022*
2. *W. Hayt, J. Buck, Engineering Electromagnetics, 8th Edition, 2011*
3. *M. Sadiku, Elements of Electromagnetics, 7th Edition, 2018*
4. *J. Edminister, Schaum's easy outline of electromagnetics, McGraw, 2016*
5. *J.M. Jin, Theory and Computation of Electromagnetic Fields, Ed. Wiley, IEEE Press, 2010.*
6. *M.A. Salam, Electromagnetic Field Theories for Engineering, ed. Springer, 2014.*

On-line references

1. *Dan D. Micu, Electromagnetic Field Theory - Lecture Notes, 2023, Beijing Jiaotong University, China*
2. *Dan D. Micu, Electromagnetic Field Theory - Lecture Notes, 2022, University of Florida, USA*
3. http://ocw.mit.edu/resources/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/textbook-contents/
4. http://nptel.ac.in/courses/117103065/

9.2 Seminar /laboratory /project /practical training	No. of hours	Teaching methods	Remarks
Seminar 1+2 Applications of vector analysis in electromagnetics. Vector algebra applications. Coordinate systems and transformations. Lamme parameters. Del operator. Gradient of a scalar. Divergence of a vector and Divergence theorem. Curl of a vector and Stokes theorem. Laplacian of a scalar. Grad, Div, Curl in different coordinate systems (cartesian, circular cylindrical, spherical)	4	Blackboard support, PPT presentations, and solving topic-specific applications with the active involvement of students	
Seminar 3+4+5 Electrostatic fields applications. Mutual capacitances of a screened parallel-wire line. Charge density on a conducting cylinder in front of a conducting plane. Potential of concentric spheres. Potential of a charge with radially dependent density. Concentric cylinders with given potential. Method of images for conducting spheres. Rectangular cylinder with given potential. Energy and force inside a partially filed parallel plate capacitor. 2D problem with homogeneous boundary conditions on different Cartesian coordinates. Method of images for dielectric half-spaces. Force on a ring charge inside a conducting cylinder. Dielectric Cylinder with variable charge on it's surface. Potential and field of dipole layers. Sphere with given potential. Plane with given potential in Free space. Charge on a plane between two dielectrics. Force on a point charge by the field of a ring charge in front of a conducting sphere. Boundary field of a parallel plate capacitor. Electrostatic boundary-value problems. Solutions of Laplace's and Poisson's Equation in cartesian, cylindrical and spherical coordinates system; The p-n junction capacitance; Image Method.	6		
Seminar 6+7 Stationary current distributions. Current radially impressed in a conducting cylinder. Current distribution around a hollow sphere. Current distribution inside a rectangular cylinder. Current distribution inside a circular cylinder. Current distribution around a conducting sphere.	4		
Seminar 8+9 Magnetic field of a stationary currents. Magnetic field of a line conductors. Magnetic field of a current sheet. Energy and inductance of conductors with circular symmetry. Shielding of the magnetic field of a parallel wire line. Mutual inductance of	4		

9.2 Seminar /laboratory /project /practical training	No. of hours	Teaching methods	Remarks
plane conductor loops. Inductive coupling between conductor loops. Magnetic Circuits and applications			
Seminar 10+11 Quasi stationary fields-Eddy Currents. Current distribution in a layerd cylinder. Rotating conductor loop. Impedance of a coaxial cable. Induced current distribution in the conducting half space. Induced current distribution by a moving conductor. Conducting cylinder exposed to a rotating magnetic field. Induced current distribution in a conducting cylinder. Electric circuit with massive conductors. Magnetically coupled system of conductors. Induced current distribution in a conducting slab. Power loss and energy balance inside a conducting sphere exposed to a transient field of a conductor loop.	4		
Seminar 12 Electromagnetic waves. Transient waves. Coaxial cable with inhomogeneous dielectric. Linear antenna in front of a conducting plane. Hertzian dipole along the x-axis.	2		
Seminar 13 Normalized lads on a lossless transmission line. Smith Chart. Characteristic admittance. Standing wave-probe measurement. Two wire lines. Short circuited stub	2		
Seminar 14 Brief review before final exam	2		

Bibliography
1. *M. Zahn, Electromagnetic Field Theory: A Problem Solving Approach, Krieger Publishing, 2003.*
2. *G. Mrozynski, Electromagnetic Field Theory. A Collection of Problems, Springer, 2014.*
3. *F.T. Ulaby, U. Ravaioli, Fundamentals of Applied Electromagnetics, 5th Edition, 2015.*
4. *M Sadiku, Numerical Techniques in Electromagnetics with Matlab, CRC Press, 2013.*
5. *P. Lorrain, Electromagnetic Fields and Waves, ed. W.H Freeman, New York, 2004.*
6. *S.T. Wentworth, Fundamentals of Electromagnetics with Engineering Applications, ed. Wiley, 2006.*
7. *U.S. Inan, A. Inan, R. Said, Engineering Electromagnetics and Waves, 2nd Edition, ed. Pearson, 2014.*

On-line references
1. *Dan D. Micu, Electromagnetic Field Theory - Lecture Notes, 2023, Beijing Jiaotong University, China*
2. *Dan D. Micu, Electromagnetic Field Theory - Lecture Notes, 2022, University of Florida, USA*
3. http://ocw.mit.edu/resources/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/textbook-contents/
4. http://nptel.ac.in/courses/117103065/

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

The course content and the teaching-learning-assessment methods are aligned with the current requirements of the Electronics, Telecommunications, and Information Technology Engineering field, considering the expectations of the academic and professional community, representative employers, as

well as the national quality assurance standards in higher education. The course helps prepare students in line with employer expectations and the quality requirements set for engineering study programs.

11. Assessment

Activity type	**11.1 Assessment criteria**	**11.2 Assessment methods** (and type of assessment: continuous/ summative)	**11.3 Weight in final grade**
11.4 Lecture	Conceptual rigor: The correct use of technical language, physical quantities, and the fundamental laws of electrodynamics in defining the operating regimes of the electromagnetic field. Capacity for analysis and synthesis: The ability to derive, correlate, and interpret Maxwell's equations based on boundary conditions and the operating regime (static, quasi-stationary, time-varying). Logical consistency: The coherence of scientific reasoning in deducing mathematical models for electromagnetic phenomena.	Written exam	40%
11.5 Seminar/ Laboratory/ Project /Practical activity	Problem-solving ability: The capacity to apply structured theorems and laws to the numerical or analytical resolution of specific problems (calculation of fluxes, inductances, capacitances, shielding). Modeling and simulation competencies: The correct utilization of computational methods for the analysis of field configurations and the interpretation of the obtained results. Engineering problem approach – case studies	Written Exam	60%
11.6 Minimum performance standard Grade “5” at the online exam (theory + problems). Students must attend at least 50% of the lectures and 70% of the seminars.			

Completion date:	Course coordinators	teaching rank, title First name LAST NAME	Signature
23.06.2026	Lecture	Associate Prof. *Mihaela Cretu*, PhD. Eng.	
	Applications	Associate Prof. *Mihaela Cretu*, PhD. Eng.	

Approval of the Head of the Department coordinating the course, only if this differs from the department organizing the study program	Head of the Electrotechnics and Measurements Department Prof. Dan D. MICU, PhD

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