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	Electrotechnics and Measurements
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-E16.00/EA-E16.00

2. Data about the subject

2.1 Subject name	Basics of Electrotechnics II						
2.2 Subject area	Theoretical area						
2.3 Course responsible	Prof. Dan Doru MICU, Ph.D, dan.micu@ethm.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Assist.Prof. Levente Czumbil, Ph.D, levente.czumbil@ethm.utcluj.ro						
2.5 Year of study	II	2.6 Semester	3	2.7 Assessment	E	2.8 Subject category	DD/DI

3. Estimated total time

3.1 Number of hours per week	4	of which: 3.2 course	2	3.3 seminar / laboratory	2
3.4 To Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar / laboratory	28

Distribution of time	hours
Manual, lecture material and notes, bibliography	14
Supplementary study in the library, online specialized platforms and in the field	10
Preparation for seminars / laboratories, homework, reports, portfolios and essays	14
Tutoring	3
Exams and tests	3
Other activities:	0

3.7 Total hours of individual study	44
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	N/A
4.2 competence	Recognizing and understanding basic concepts specific to basics of electrotechnics; Developing skills and abilities for the analysis and synthesis of electromagnetic fields; Implementing relations and theorems for electromagnetic field computation

5. Requirements (where appropriate)

5.1. for the course	Amphitheatre, Cluj-Napoca
5.2. for the seminars / laboratories / projects	Classrooms, Cluj-Napoca

6. Specific competences

Professional competences	C1. Use of the fundamental elements related to devices, circuits, systems, instrumentation and electronic technology C6. Solving specific problems of the broadband communications networks: propagation in different environment, circuits and equipment for high frequencies (microwaves and optical).
Transversal competences	N/A

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

7.1 General objective	The objective is to provide fundamental knowledge of electromagnetic fields and waves in a structured manner. A comprehensive fundamental knowledge of electric and magnetic fields is required to understand the working principles of electric and electronic devices.
7.2 Specific objectives	1. Recognizing and understanding basic concepts specific to electromagnetic field theory 2. Developing skills and abilities necessary to solve electromagnetic interference problems 3. Developing skills and abilities for the analysis and synthesis of electromagnetic fields

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
Lecture 1+2 **Basics of Electrotechnics**. Introduction; Field Parameters and SI Units; Electric Flux Density and Field Intensity; Magnetic Flux Density and Field Intensity; Current Density; **Vector Analysis and Coordinate Systems in Electromagnetics**. Vectors and Scalars; Vector Components; Unit Vectors; Orthogonal Coordinate Systems; Cartesian Coordinate System; Circular Cylindrical Coordinate System; Spherical Coordinate System; Potential Gradient and Gradient of a Scalar Field; Divergence of a Vector Field; Curl of a Vector Field; Stokes Theorem	Didactic proof, didactic exercise, team work	**U**se of PowerPoint presentation, projector, blackboard
Lecture 3+4 **Electrostatic Field**. Coulomb's Law; Electric Field Intensity; Gauss' Law; Electric Field of Continuous Charge Distribution; Electric Field Due to an Infinite Sheet Charge; Electric Potential; Derivation of Electric Field; Line Integral of Irrotational Field; Potential Due to a Point Charge;		

Electric Dipole; Materials for Static Electric Field; Dielectric Polarization; Dielectric Material Characteristics; Dielectric Boundary Conditions; Refraction of Electric Field at Dielectric Boundary; Electrostatic Energy.		
Lecture 5 **Poisson's and Laplace's Equations**. Derivation of Poisson's and Laplace's Equations; Uniqueness Theorem; Solutions of Laplace's Equation; One-Dimension Solution; Two-Dimension Solution; Solution of Laplace's Equation in Cylindrical Coordinates; Solutions of Poisson's Equation; Numerical Solution of Laplace's Equation.		
Lecture 6+7 **Electric Currents**. Current and Current Density; Conductivity and Resistance; Power and Joule's Law; Continuity Equation; Current Density Boundary Conditions; Capacitance; Parallel Plate Capacitor; Determination of Resistance; Coaxial Capacitor. Spherical Capacitor; Parallel Plate Capacitor with Two Dielectric Slabs		
Lecture 8+9 **Static Magnetic Field.** Magnetic Flux Density; Biot–Savart's Law; Magnetic Field of a Long Straight Conductor; Ampere's Circuital Law; Ampere's Circuital Law in a Long Straight Conductor; Infinite Sheet of Current; Curl of a Magnetic Field; Scalar and Vector Magnetic Potential; Magnetization; Magnetic Field Boundary Conditions; Magnetic Field of Two Media; Magnetic Circuit; Series Magnetic Circuit; Parallel Magnetic Circuit; Magnetic Circuit with Air Gap; Hysteresis Curve; Inductance and Mutual Inductance	Didactic proof, didactic exercise, team work	Use of PowerPoint presentation, projector, blackboard
Lecture 10+11+12 **Time-Varying Fields**. Faraday's Law; Motional Voltage; Maxwell's Equations; Conduction and Displacement Currents; Maxwell's Equation from Ampere's Law; Transformer; Time-Varying Potentials; Field of a Series Circuit; Time-Harmonic Fields; Fields created by a source distribution: retarded potential Electromagnetic potentials; Lorentz gauge; Solution of the inhomogeneous wave equation for potential; Electromagnetic; Fields from a bounded source distribution; Maxwell's symmetric equations; Theorem of uniqueness; Numerical differential model of electromagnetic fields.		
Lecture 13+14 ***Uniform Plane Waves***. Time-Domain Maxwell's Equations; Wave Equation in Time-Harmonic Fields; Solution of a Wave Equation in the Frequency Domain; Solution of a Wave Equation in the Time Domain; Wave Propagation in Lossy Medium; Wave Propagation in Good Conductors; Power Flow and Poynting Vector; Incident and Reflected Waves; Uniform Wave Polarization		

Basics of Antennas. Working Principles of Antennas; Potential Functions for Antennas; Hertzian Dipole; Antenna Gain and Directivity; Long Dipole Antennas.		

Bibliography

1. J.M. Jin, *Theory and Computation of Electromagnetic Fields*, Ed. Wiley, IEEE Press, 2010.
2. M.A. Salam, *Electromagnetic Field Theories for Engineering*, ed. Springer, 2014.
3. P. Lorrain, *Electromagnetic Fields and Waves*, ed. W.H Freeman, New York, 2004.
4. F.T. Ulaby, U. Ravaioli, *Fundamentals of Applied Electromagnetics*, 7th Edition, ed. Pearson Education Limited, Harlow, UK, 2015.
5. F. Tomescu, *Fundamentals of Electrical Engineering. Electromagnetic field*, ed. Matrix Rom, 2012.
6. E. Rothwell, *Electromagnetics*, CRC Press, California, 2001.
7. D.D. Micu, G.C. Christoforidis, L. Czumbil, Book Chapter: "Artificial Intelligence Techniques applied in Electromagnetic Interference problems between HV Power Lines and Metallic Pipelines", in *Recurrent Neural Networks and Soft Computing*, ed. InTech, 2012.
8. J. Edminister, *Schaum's easy outline of Electromagnetics*, ed. McGraw, 2010.
9. W.H. Hayt, J.A. Buck, E*ngineering Electromagnetics*, 6th edition, ed. McGraw-Hill Education, 2001.
10. D.K. Cheng. *Field and Wave Electromagnetics*, ed. Tsinghua University Press, 2006.
11. S.M. Wentworth, *Applied Electromagnetics. Early Transmission Lines Approach*, ed. Wiley, 2007.

On-line references

12. L. Czumbil, Fundamentals of Electrotechnics (course slides, problem examples, exam subjects), htttp://users.utcluj.ro/~czumbil
13. http://ocw.mit.edu/resources/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/textbook-contents/
14. http://nptel.ac.in/courses/117103065/

8.2 Seminar / laboratory / project	Teaching methods	Notes
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)	Didactic proof, didactic exercise, team work	Use of PowerPoint presentation, projector, blackboard
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 its 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.		

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.		
Seminar 8+9+10 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 plane conductor loops. Inductive coupling between conductor loops.		
Seminar 11+12 Quasi stationary fields-Eddy Currents. Current distribution in a layered 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.		
Seminar 13 Electromagnetic waves. Transient waves. Coaxial cable with inhomogeneous dielectric. Linear antenna in front of a conducting plane. Hertzian dipole along the x-axis.		
Seminar 14 Brief review before final exam		

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*, 7th Edition, ed. Pearson Education Limited, Harlow, UK, 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. S.T. Wentworth, *Fundamentals of Electromagnetics with Engineering Applications*, ed. Wiley, 2006.
8. U.S. Inan, A. Inan, R. Said, *Engineering Electromagnetics and Waves*, 2nd Edition, ed. Pearson, 2014.

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

The discipline content and the acquired skills are in agreement with the expectations of the professional Competences acquired will be used in the following COR occupations (Electronics Engineer; Telecommunications Engineer; Electronics Design Engineer; System and Computer Design Engineer; Communications Design Engineer) or in the new occupations proposed to be included in COR (Sale Support Engineer; Multimedia Applications Developer; Network Engineer; Communications Systems Test Engineer; Project Manager; Traffic Engineer; Communications Systems Consultant).

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	▪ Evaluation - written exam (theory) – 1.5 h	*50%*
10.5 Seminar/ Laboratory	The level of acquired knowledge and abilities	▪ Evaluation - written exam (problems) – 1.5 h ▪ Continuous formative evaluation	*50%*
10.6 Minimum standard of performance			

Quality Level:

✓ Lamme parameters. Del operator. Gradient of a scalar. Divergence of a vector and Divergence theorem. Curl of a vector and Stokes theorem.

✓ 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. 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. Sphere with given potential. Boundary field of a parallel plate capacitor.

✓ Stationary current distributions. Current radially impressed in a conducting cylinder. Current distribution inside a circular cylinder. Current distribution around a conducting sphere.

✓ 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 plane conductor loops. Inductive coupling between conductor loops.

✓ 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. Magnetically coupled system of conductors.

✓ Electromagnetic waves. Transient waves. Linear antenna in front of a conducting plane.

Quantitative Level:

✓ *Grade "5" at the written exam (theory + problems).*

Date of filling in:	Responsible	Title First name SURNAME	Signature
16.06.2025	Course	Prof. Dan Doru MICU, Ph.D	
	Applications	Assist. Prof. Levente CZUMBIL, Ph.D	

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