

SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electrical Engineering
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	Professor Dan Doru Micu, PhD. Eng. Math. Dan.Micu@ethm.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Assistant Professor Andrei Ceclan, PhD. Eng., Andrei.Ceclan@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	Physics 2, Analysis 1, Algebra 1
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 electric, magnetic fields and electromagnetic waves in a structured manner, in order to understand the working principles of electric and electronic devices.
7.2 Specific objectives	<ol style="list-style-type: none"> 1. Recognizing and understanding concepts specific to electromagnetic field theory 2. Developing skills and abilities necessary to solve electromagnetic compatibility problems 3. Developing skills and abilities for the analysis, modelling and synthesis of electromagnetic fields

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
<p>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</p>	Didactic proof, didactic exercise, team work. The course will be presented online	Use of PowerPoint presentation, and iPad for online teaching
<p>Lecture 3 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; Boundary-value problems</p>		

<p>in different coordinates; Refraction of Electric Field at Dielectric Boundary; Electrostatic Energy.</p>		
<p>Lecture 4+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. Mathematical differential model for an electrostatic application. Example of the solution of Poisson equation: The p-n junction capacitance</p>		
<p>Lecture 6 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.</p>		
<p>Lecture 7 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</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Didactic proof, didactic exercise, team work. The course will be presented online</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Use of PowerPoint presentation, and iPad for online teaching</p>
<p>Lecture 8+9 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.</p>		
<p>Lecture 10+11 Transmission Lines. The Transmission Line equations; Lossless Propagation of sinusoidal waves; Low-Loss propagation; Power transmission; Wave Reflection at discontinuities; Voltage standing wave ratio; Transmission lines of finite length; Transmission line examples; The Smith Chart; Transient analysis.</p>		
<p>Lecture 12+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; Skin effect; Power Flow and Poynting Vector; Uniform Wave Polarization. Plane wave reflection and dispersion; Incident and Reflected Waves at normal incidence; Standing Wave ratio; Wave reflection from multiple interfaces; Plane wave propagation in general directions; Total reflection</p>		

<p>and transmission of oblique incidence waves; Wave propagation in dispersive media; Pulse broadening media; Basics of Antennas. Working Principles of Antennas; Potential Functions for Antennas; Hertzian Dipole; Antenna Gain and Directivity; Long Dipole Antennas.</p>		
<p>Bibliography</p> <ol style="list-style-type: none"> 1. W. Hayt, J. Buck, Engineering Electromagnetics, 8th Edition, 2011 2. Fawwaz T. Ulaby, Fundamentals of Applied Electromagnetics, 6th Edition, 2016 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. <p>On-line references</p> <ol style="list-style-type: none"> 1. Dan D. Micu, Electromagnetic Field Theory - Lecture Notes, Technical University of Cluj-Napoca, Electrical Engineering Department https://lcmn.utcluj.ro/dan-doru-micu/ 2. http://ocw.mit.edu/resources/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/textbook-contents/ 3. http://nptel.ac.in/courses/117103065/ 		
8.2 Seminar	Teaching methods	Notes
<p>Seminar 1+2</p> <p>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)</p>	Didactic proof, didactic exercise, team work. The seminar will be onsite	Use of PowerPoint presentation, blackboard
<p>Seminar 3+4+5</p> <p>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.</p>		
<p>Seminar 6+7</p> <p>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.</p>		
<p>Seminar 8+9</p>		

<p>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. Magnetic equivalent circuits.</p>	
<p>Seminar 10+11 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.</p>	
<p>Seminar 12 Normalized loads on a lossless transmission line. Smith Chart. Characteristic admittance. Standing wave-probe measurement. Two wire lines. Short circuited stub</p>	
<p>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.</p>	
<p>Seminar 14 Brief review before final exam</p>	
<p>Bibliography</p> <ol style="list-style-type: none"> 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. 	

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	<ul style="list-style-type: none"> ▪ Evaluation - online exam (theory) – 1.5 h 	50%
10.5 Seminar/ Laboratory	The level of acquired knowledge and abilities	<ul style="list-style-type: none"> ▪ Evaluation - online exam (problems) – 1.5 h ▪ Continuous formative evaluation 	50%
10.6 Minimum standard of performance			
<p>Quality Level:</p> <ul style="list-style-type: none"> ✓ Lamme Parameters-System of coordinates. Gradient. Divergence theorem. Curl. 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 filled 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 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. Magnetically coupled system of conductors. ✓ Electromagnetic waves. Linear antenna in front of a conducting plane. <p>Quantitative Level:</p> <ul style="list-style-type: none"> ✓ Grade "5" at the online exam (theory + problems). 			

Date of filling in:	Responsible	Title First Name SURNAME	Signature
27.09.2021	Course	Professor Dan Doru Micu, PhD. Eng. Math.	
	Applications	Assist. Prof. Andrei Ceclan, PhD. Eng.	

Date of approval in the Department of Communications 27.09.2021	Head of Communications Department Prof. Virgil DOBROTA, Ph.D.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology 27.09.2021	Dean Prof. Gabriel OLTEAN, Ph.D.