SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electrical Engineering
1.3	Department	Electrotechnics and Measurements
1.4	Field of study	Electronics and Telecommunications Engineering
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					
2.2	Subject area										
2.3	Course responsible/lecturer					Prof. Dan Doru Micu, PhD eng. Math					
2.4	Teachers in charge of applications					Prof. Dan Doru Micu, PhD eng. math.					
2.5	Year of study	II	2.6	Semester	1	2.7	Assessment	Exam	2.8	Subject category	DD/DI

3. Estimated total time

Year / Sem.	Subject name	No. of weeks	Course	Applications			Course	Applications			Indiv. study	TOTAL	Credits
			[hours/week]				[hours/sem.]						
				S	L	P		S	L	P			
II / 1	Basics of Electrotechnics	14	2	2			28	28			44	100	4

3.1	Number of hours per week	4	3.2	of which, course	2	3.3	applications	2
3.4	Total hours in the curriculum	56	3.5	of which, course	28	3.6	applications	28

Individual study	Hours
Manual, lecture material and notes, bibliography	11
Supplementary study in the library, online and in the field	15
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	12
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 applications	Classrooms, Cluj-Napoca

6. Specific competences

Professional competences	Theoretical knowledge (what the student must know):	After completing the discipline, the students will be able to solve real problems regarding: electrostatic field computation, implementation of Poisson's and Laplace's equations,. Induced currents computation, magnetic and time-varying field computation, wave propagation problems.
	Acquired skills (what the student is able to do):	After completing the discipline, the students will be able to: • analytically compute the electric and magnetic field for real applications in different coordinate systems • solve real problems regarding static and time-varying magnetic fields • compute the solutions of a wave equation in different fields and frequency domains • solve problems regarding electric and magnetic couplings
	Acquired abilities: (what type of equipment the student is able to handle)	After completing the discipline, the students will be able to • use the methods for the analysis and synthesis of electromagnetic fields to implement/design/solve practical problems regarding inductive, conductive and capacitive couplings
	In accordance with Grila1 and Grila2 RNCIS	C1. To use the fundamental elements regarding electronic devices, circuits, systems, instrumentation and technology C6. To solve wide-band telecommunications networks' specific problems: propagation in various transmission media, high frequency circuits and equipment (microwaves and optical).
Cross competences (Grila1 and Grila2 RNCIS)		N.A.

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

7.1	General objectives	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	• Recognizing and understanding basic concepts specific to electromagnetic field theory • Developing skills and abilities necessary to solve electromagnetic interference problems • Developing skills and abilities for the analysis and synthesis of electromagnetic fields

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
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	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation	Use of .ppt presentation, projector, blackboard
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		
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		
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		
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		
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.		
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.		
8.2. Applications (lab)		Teaching methods	Notes
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 .ppt presentation, projector, blackboard
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.		
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.		
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.		
11+12	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.		
13	Electromagnetic waves. Transient waves. Coaxial cable with inhomogeneous dielectric. Linear antenna in front of a conducting plane. Hertzian dipole along the x-axis.		
14	Brief review before final exam		

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, Springer, 2014.
3. M. Zahn, Electromagnetic Field Theory: A Problem Solving Approach, Krieger Publishing, 2003.
4. F. Tomescu, Fundamentals of electrical engineering. Electromagnetic field, MatrixRom, 2012.
5. M Sadiku, Numerical techniques in electromagnetics with Matlab, CRC Press, 2013.
6. R. Stanislaw, Fundamental numerical methods for electrical engineering, Springer, 2012.

7. Thomas Senior, Mathematical methods in electrical engineering, Central London Press, 2008.
8. Paul Lorrain, Electromagnetic Fields and Waves, W.H Freeman, New York, 2004.
9. Edward Rothwell, Electromagnetics, CRC Press, California, 2001.
10. G. Mrozynski, Electromagnetic field theory. A collection of problems, Springer, 2014.
11. Dan D. Micu, Metode numerice în studiul interferenţelor electromagnetice, Ed. Mediamira, 2004.
12. Dan D. Micu, G. 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", InTech, 2012.
13. Shang-Xu, Hu, Applied Numerical Computation Methods, Ed. ZJU, MIT – USA, 2011.
14. Joseph Edminister, Schaum's easy outline of electromagnetics, McGraw, 2010.

On-line references

1. Dan D. Micu, Fundamentals of electrotechnics (course slides, problem examples, exam subjects), http://www.ethm.utcluj.ro/dmicu
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/

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

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. Evaluations

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
Course	The level of acquired theoretical knowledge	- Evaluation - written exam (theory) – 2 hours	C=60%
Applications	The level of acquired abilities	- Continuous formative evaluation -- Evaluation - written exam (problems) – 1 hour	A=40%
10.4 Minimum standard of performance			
$C \geq 5$ and $A \geq 5$			

Date of filling in	Course responsible	Teachers in charge of applications
1.10.2018	Prof. Dan Doru Micu, PhD eng. math.	Prof. Dan Doru Micu, PhD eng. math.