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	Applied Electronics; Telecommunication Technologies and Systems / Engineer
1.7 Form of education	Full time
1.8 Subject code	16.00

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***, PhD. Eng. Math.						
2.4 Teacher in charge with seminar / laboratory / project	Associate Prof. ***Mihaela Cretu***, PhD. Eng.						
2.5 Year of study	II	2.6 Semester	3	2.7 Assessment	E	2.8 Subject category	DID/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	4.0

4. Pre-requisites (where appropriate)

4.1 curriculum	Physics 2, Basics of Electrotechnics 1, 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	Theoretical knowledge (what the student must know):	After completing the discipline, the students will be able to solve real problems regarding: • to handle important practical problems in EMF • to gain physical intuition about nature around themselves • analytically compute the electric and magnetic field for real applications in different coordinate systems • solve real applications 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 The electromagnetics technical specialty prepares future engineers for employment in industry in the areas of: *radar, antennas and wave propagation, fiber optics, electromagnetic interference, high frequency circuits, electromagnetic compatibility and microwave communication system.*
	Acquired skills (what the student will be	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 will be able to handle)	After completing the discipline, the students will be able to: • use the methods for the analysis, modelling and synthesis of electromagnetic fields to implement/design/solve practical problems in electrical and electronic engineering.
	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 competence	N.A.

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

7.1 General objective	Introduce the basic principles of the electromagnetic phenomena in terms of a few relatively simple laws. 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	Recognizing and understanding concepts specific to electromagnetic field theory; Developing skills and abilities necessary to solve electromagnetic compatibility problems. Developing skills and abilities for the analysis, modelling and synthesis of electromagnetic fields

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
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 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.	Didactic proof, didactic exercise, team work. The course will be presented online	Use of PowerPoint presentation, and IPad for online teaching
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		
Lecture 5 **Electric Currents**. Current and Current Density; Conductivity and Resistance; Current Density Boundary Conditions; Ohm's law – Electric conductive law – differential form; Charge conservation law. Continuity of current. Continuity Equation; Energy conservation law in conductors - Joule-Lenz law - differential form; Analogy between the electrostatic field and electrokinetic field.		
Lecture 6+7+8	Did	Us

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		
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)		
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		
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*).		

Bibliography

1. ***Fawwaz T. Ulaby, Fundamentals of Applied Electromagnetics, 6th Edition, 2020***
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, 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
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. The seminar will be onsite	Use of PowerPoint presentation, 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 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.		
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 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 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.		

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.		
Seminar 13 Normalized lads on a lossless transmission line. Smith Chart. Characteristic admittance. Standing wave-probe measurement. Two wire lines. Short circuited stub		
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, 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 organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of electrical and electronic engineering: *radar, antennas and wave propagation, fiber optics, electromagnetic interference, high frequency circuits, electromagnetic compatibility and microwave communication system*), and the expectations of the national organization for quality assurance (ARACIS).

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

Quality Level:
- ✓ 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 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 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.

Quantitative Level:

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

Date of filling in:	Responsible	Title Surname NAME	Signature
10.07.2023	Course	Prof. ***Dan Doru Micu***, PhD. Eng. Math.	
	Applications	Associate Prof. ***Mihaela Cretu***, PhD. Eng.	

Date of approval in the Department of Basics of Electronics

11.07.2023

Head of Department
Prof.dr.ing. Sorin HINTEA

Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology

12.07.2023

Dean
Prof. Pop Ovidiu Aurel, PhD. Eng.