SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Materials and Environment Engineering
1.3 Department	Physics and Chemistry
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-E10.00/EA-E10.00

2. Data about the subject

2.1 Subject name	Physics II						
2.2 Subject area	Theoretical area Methodological area Analytic area						
2.3 Course responsible	Prof. Coriolan TIUSAN, Ph.D - coriolan.tiusan@phys.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Prof. Coriolan TIUSAN, Ph.D - coriolan.tiusan@phys.utcluj.ro Fiz. Roxana ONE, Ph.D -						
2.5 Year of study	1	2.6 Semester	2	2.7 Assessment	E	2.8 Subject category	DF/DI

3. Estimated total time

3.1 Number of hours per week	3	of which: 3.2 course	2	3.3 seminar / laboratory	1
3.4 To Total hours in the curriculum	42	of which: 3.5 course	28	3.6 seminar / laboratory	14

Distribution of time	Hours
Manual, lecture material and notes, bibliography	24
Supplementary study in the library, online specialized platforms and in the field	10
Preparation for seminars / laboratories, homework, reports, portfolios and essays	18
Tutoring	3
Exams and tests	3
Other activities:	0

3.7 Total hours of individual study	58
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	Basic background in Physics from High school
4.2 competence	Basic knowledge of Math from High school

5. Requirements (where appropriate)

5.1. for the course	Amphitheatre, Cluj-Napoca
5.2. for the seminars / laboratories / projects	The presence at the seminaries is compulsory.

6. Specific competences

Professional competences	C1. Use of the fundamental elements related to devices, circuits, systems, instrumentation and electronic technology C2. Applying the basic methods for the acquisition and processing of signals C4. Design, implementation and operation of data, voice, video and multimedia services. This is based on the understanding and the application of fundamental concepts in telecommunications and transmission of information C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications networks 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	Developing the competences and knowledge related to Advanced Physics useful for Electronics and Applied Electronics, underlying physics of some modern devices (sensors, data storage elements, micro and nano-technologies, LASER, microscopes with extreme/atomic resolution).
7.2 Specific objectives	1. Understanding and manipulation of basic concepts in Physics, combined with Math. 2. Developing skills and abilities necessary for solving simple and complex problems of Physics. 3. Developing skills and abilities for the analysis of fundamental phenomena in nature and technics which are transposed as problems in the Engineering domain. 4. Acquire the advanced physics background of standard and modern electronic devices, micro and nano-technologies.

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
Electric charge and electric field Electric charge. Coulomb interactions. Intensity of the electric field The electric potential. Potential gradient and electric field intensity Electric dipole.	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation, learning by discovery	Mainly use the blackboard, the projector used only for presentation of some movies with recorded experiments of physics.
Gauss law and Applications. Infinite wire Infinite plaque Spherical charge distributions.		

Capacitance and dielectrics Capacitor and capacitance. Capacitors in series and parallel Energy storage in capacitors and electric field energy. Dielectrics. Gauss's law in dielectrics		
Current, resistance and electromotive force Current. Resistivity. Resistance. Electromotive force and circuits The Ohm's law. Continuity equations Energy and power. Dissipation. Joule's law Theory of metallic conduction Current circuits. Resistors in series and parallel Kirchhoff's rules Electrical measuring instruments Charging a capacitor: RC circuits		
Magnetic field and magnetic forces Magnetism. Magnetic field. Magnetic field lines. Magnetic induction. Motion of charged particles in magnetic fields: the Lorentz force. Magnetic force on a current carrying conductor: The Ampere's force between I and B Force and torque on a current loop. The direct current motor The Hall effect. *Sources of magnetic field* Magnetic field of a moving charge. Magnetic field of a current element. The law Biot-Savart . Magnetic field of a **straight** current carrying conductor. Force between parallel conductors. Magnetic field of a circular current loop. Ampere's law and applications (Infinite wire, solenoid, toroid). Magnetic dipole.		
Magnetic materials The Bohr magnetron. Magnetization. Paramagnetism. Diamagnetism. Ferromagnetism. Antiferromagnetism. Ferrimagnetism. Characteristic lengths in magnetism. Magnetic anisotropy. Magnetic domains. Hysteresis. Magnetic dynamics. Landau–Lifshitz–Gilbert equation and mechanical analogy. Tailoring of magnetic properties by dimensionality. Micro/nano-patterning.		
Electromagnetic induction Induction experiments Faraday's law. Lenz's law Motional electromotive force Induced electric fields Eddy currents Displacement currents and Maxwell's equations *Inductance and magnetic field energy* Mutual inductance. Self-inductance and inductors. Magnetic field energy . The R-L, L-C and R-L-C series circuits *Superconductivity*. Definitions. The Meissner effect. Levitation and other applications		
Maxwell equations and electromagnetic waves. Electricity, magnetism and light. Generating electromagnetic radiation. The electromagnetic spectrum. Plane electromagnetic waves and the speed of light. Sinusoidal electromagnetic waves. Energy and momentum in electromagnetic waves. Standing electromagnetic waves. Cavities.		

Origins of quantum mechanics *Limitations of the classical physics and historical hypotheses* Experiments with strange results within the classical theory: The black-body radiation, The photoelectric effect, Stability and emission spectra of atoms *Historical hypotheses*: The Planck constant, The concept of corpuscular structure of the light, The emission spectra of atoms: the Bohr model		
The wave-particle duality The photon: wave or particle? The Young's double slit experiments and incompatibility with the classical approach. The influence of the measurement The particles of matters are they waves? Introduction in relativity The de Broglie hypothesis The Bohr model Applications. Diffraction with particles. Microscopy LASER with photons, LASER with electrons		
The wave quantum mechanics Representation of particles as wave packets. Wave function. Uncertainty on measurement. Wave equation for the particles The Schrodinger equation. Stationary and time-dependent equation. *Basis of the wave QM* The postulates of the quantum mechanics. Stationary states, the time-independent Schrodinger equation. Average values. Particle flux. Continuity equation.		
Direct applications of wave Quantum Mechanics General formalism of solving a QM problem (Particle in a box. Potential well. Potential barriers and tunneling. Tunneling microscope.) *The quantum harmonic oscillator* Wave functions. Boundary conditions. Energy levels Comparing quantum and Newtonian oscillators.		
Quantum mechanics as basis for atomic physics and solid state electronics *The hydrogen atom: basis of the atomic physics.* Quantization of angular momentum Quantum numbers. Atomic structure. Periodic potential: energy bands, metals, insulators and semiconductors. Stern-Gerlach experiment and Uhlenbeck-Goudsmit postulate of electron spin. *The Schrodinger equation in three dimensions.: particle in 3D box.* Periodic limit conditions. Electrons in solids.		
Introduction in spintronics Basic concepts. The electron spin and magnetic materials. Magnetorezistance effects: AMR, GMR, TMR Spin torque effects Applications in sensors, data storage (MRAM, STT-RAM), high frequency oscillators (STT-HFO) Modern materials for spintronics.		

Recapitulation. Preparation for the final exam.		

Bibliography

1) H. D. Young, R. A. Freedman - Sears and Zemansky's University Physics with Modern Physics Technology Update (lb. engleza), Pearson - 2013; in romanian: Fizica, EDP Bucuresti (1993).
2) D. Halliday, R. Resnik, Physics (vol. I, II), John Willey et sons in Romanian: Fizica, EDP Bucuresti (1975).
3) Berkeley Physics Course (5 vol), vol.I Mechanics (Ch. Kittel, W. Knight, M.A. Ruderman), McGRAW-HILL BOOK COMPANY. in Romanian: EDP Bucuresti, 1981-. Editura Tehnica, Bucuresti, (1984).
4) E. Luca, Gh. Zet si altii ii – Fizică generală, Ed. Did. şi Pedag., Bucureşti.

On-line references

5) Tiusan Coriolan. *Elements of Physics* (course content, course an seminaries), https://spin.utcluj.ro/webphysics/Physics.html

8.2 Seminar / laboratory / project	Teaching methods	Notes
1) Introduction. Labor protection. Coulomb forces, electric field intensity and electric potential.	Didactic and experimental proof, didactic exercise, conversation, observation and analysis, individual and team work	Use of white/magnetic board, computers and computer programs for data analysis.
2) Applications of the Gauss law. Infinite wire Infinite plaque 3) Spherical charge distributions.		
4) Applications of the Ampere law.		
5) Tailoring of magnetic properties by dimensionality. Micro/nano-patterning.		
6) Photoelectric effect. Compton effect. De Broglie wave length of particles and applications.		
7) Potential well. Potential barriers and tunneling. Tunneling microscope. Spintronics and nanotechnologies.		
Bibliography 1) H. D. Young, R. A. Freedman - Sears and Zemansky's University Physics with Modern Physics Technology Update (lb. engleza), Pearson - 2013; 2) *On-line references* Tiusan Coriolan. *Elements of Physics* (course content, course an seminaries), https://spin.utcluj.ro/webphysics/Physics.html		

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, logical coherence, skills of operating with acquired knowledge in	Formative evaluation tests (sets of problems solving)	80%

	individual complex activities.	-Summative evaluation written exam (theory and problems)	
10.5 Seminar/ Laboratory	The level of acquired theoretical knowledge and abilities for problems analysis and solving	- Continuous formative evaluation - seminary individual work	20%

10.6 Minimum standard of performance

Quality level:

Minimum knowledge:

- Knowledge of the basic principles of Electricity and Magnetism: phenomena in electrostatics and electro-kinetics
- Knowledge of the phenomenological theory of charge transport, the physical origin of resistance and Joule effect, the classification of materials in metals, insulators, semiconductors.
-Knowledge of main concepts related to the sources of Electric Field and Magnetic Field and the phenomenology of electrostatic and magnetic interactions.
- Knowledge for the basis of electromagnetic field: generation, propagation, energy transport, applications in communications technologies.
-Knowledge of main concept of quantum physics, as basis of modern technologies: wave/particle duality, probabilistic approach of physical phenomena, applications of quantum mechanics in material science and electronic devices.

Minimum competences:

- Be able to calculate electric and magnetic fields generated by their respective sources (charge distributions, currents).
- Calculate electrostatic and magnetic interactions.
- Be able to explain the different properties for the different types of magnetic properties of materials: diamagnetic, ferromagnetic, paramagnetic.
- Be able to solve standard problems in Electricity, Magnetism, Electromagnetic waves, Elementary Quantum Physics.
- The exam and laboratory notes must be at least 5.
- The mark for the subject is calculated with the relation: 0.8 * Exam score + 0.2 * Worker grade (seminary contribution)

Date of filling in:	**Responsible**	**Title Surname NAME**	**Signature**
27.09.2021	Course	Prof. Coriolan TIUSAN, Ph.D	
	Applications	Fiz. Roxana ONE, Ph.D	

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.