SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Materials and Environmental Engineering
1.3	Department	Physics and Chemistry
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-E11.00, EA-E11.00

2. Data about the subject

2.1	Subject name					Advanced Physics						
2.2	Subject area					Physics						
2.3	Course responsible/lecturer					Prof. Coriolan TIUSAN, PhD						
2.4	Teachers in charge of applications					Prof. Coriolan TIUSAN, PhD						
2.5	Year of study	I	2.6	Semester	2	2.7	Assessment	Exam	2.8	Subject category	DID/DOB	

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			
I / 2	Advanced Physics	14	2	1			28	14			62	104	4

3.1	Number of hours per week	3	3.2	of which, course	2	3.3	applications	1
3.4	Total hours in the curriculum	42	3.5	of which, course	28	3.6	applications	14

Individual study	Hours
Manual, lecture material and notes, bibliography	40
Supplementary study in the library, online and in the field	-
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	28
Tutoring	3
Exams and tests	3
Other activities	0

3.7	Total hours of individual study	62
3.8	Total hours per semester	104
3.9	Number of credit points	4

4. Pre-requisites (where appropriate)

4.1	Curriculum	Basic background in Physics from High school Elementary Physics background from the Elements of Physics previous term course.

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 applications	The presence at the seminaries is compulsory.

6. Specific competences

Professional competences	Theoretical knowledge (what the student must know):	- Basic elements of general physics from high school in the following areas: Mechanics, Thermodynamics and Heat, Electricity and Magnetism, Optics, Atomic and Nuclear Physics. - Specific theoretical knowledge related to fundamental concepts: force, Energy, Conservation laws, Periodic motion and oscillations, Waves and Acoustics. - Elementary knowledge in Math: Linear Algebra, Differential an Integral calculus, function representation and analysis.
	Acquired skills (what the student is able to do):	After completing the discipline, the students will be able to: - Manipulate fundamental concepts in Physics, understand basic concepts of advanced physics: electromagnetism and quantum mechanics as basis for solid state electronics and modern applications in technics and electronics. - Extrapolate the basic concepts of physics to electronic circuits and understanding of working principles for modern devices (sensors, data storage, spintronics, molecular electronics, nano-technologies). - Extrapolate the knowledge of Physics, Math, technics of measuring, and data analysis in applied electronics area. - Solve problems based on a general algorithm with the following steps: Analyze the formulation and identify the relevant concepts, Set-up the problem (given the concepts identify the known and target quantities and write down the relevant equations, drive the relevant sketch), Execute the solution, Evaluate and discuss the answer.
	Acquired abilities: (what type of equipment the student is able to handle)	N/A.
	In accordance with Grila1 and Grila2 RNCIS	C1. To use the fundamental elements regarding electronic devices, circuits, systems, instrumentation and technology C2. To apply basic methods for signal acquisition and processing C4. To design, implement and operate data, voice, video and multimedia services, based on the understanding and application of fundamental concepts from the field of communications and information transmission. C5. To select, install, configure and exploit fixed and mobile telecommunications equipment. To equip a site with common telecommunications networks. 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	Developing the competences and knowledge related to Advanced Physics useful for Electronics and Telecommunications, 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
1	*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.
2	*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		
3	*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		
4	*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.		
5	*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.		
6	*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		
7	*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.		
8	*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		
9	*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		
10	*The ondulatory 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 ondulatory QM.* The postulates of the quantum mechanics. Stationary states, the time-independent Schrodinger equation. Average values. Particle flux. Continuity equation.		
11	*Direct applications of ondulatory 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.		
12	*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.		
13	*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.		
14	Recapitulation. Preparation for the final exam.		
8.2. Applications (seminary)		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, frontal experiments	Use of white/magnetic board, computers and computer programs for data analysis.
2	Applications of the Gauss law. Infinite wire Infinite plaque Spherical charge distributions.		
3	Applications of the Ampere law.		
4	Tailoring of magnetic properties by dimensionality. Micro/nano-patterning.		
5	Photoelectric effect. Compton effect. De Brogle wave length of particles and applications.		
6	Potential well. Potential barriers and tunneling. Tunneling microscope.		
7	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; 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 – Fizică generală, Ed. Did. şi Pedag., Bucureşti.

On-line references

Tiusan Coriolan. *Elements of Physics* (course content, course an seminaries), http://www.c4s.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 organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job, and the expectations of the national organization for quality assurance (ARACIS).

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 and practical skills, logical coherence, skills of operating with acquired knowledge in individual complex activities.	- 3 formative evaluation tests (sets of problems solving) - Summative evaluation written exam (theory and problems)	- T, max 10 pts. 20% - E, max 10 pts. 60%
Applications (seminary)	The level of acquired theoretical knowledge and abilities for problems analysis and solving	- Continuous formative evaluation - seminary individual work	- S, max. 10 pts. 20%
10.4 Minimum standard of performance			
S ≥ 5 and E ≥ 4 and 0,6E+0,2S+0,2T ≥ 4.5			

Date of filling in 28.01.2015

Course responsible Prof. Coriolan TIUSAN, PhD

Teachers in charge of applications Prof. Coriolan TIUSAN, PhD

Date of approval in the department 28.01.2015

Head of department Prof. Eugen CULEA, PhD