MINISTRY OF NATIONAL EDUCATION

TECHNICAL UNIVERSITY
OF CLUJ-NAPOCA

SYLLABUS

1. Study Program

1.1	Higher Education Institute	Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Communications
1.4	Study domain	Electronics and Telecommunications Engineering
1.5	Study level	Master
1.6	Study program/ Qualification	Multimedia Technologies/ Telecommunications/ Master
1.7	Type of education	IF (Full-time learning)
1.8	Discipline code	TM-E16.50/TC-E04.00

2. Discipline

2.1	Discipline name					Antennas and RFID sensors					
2.2	Subject area					Electronics and Telecommunications Engineering					
2.3	Responsible					Associate Professor Nicolae Crisan, Ph.D. Nicolae.Crisan@com.utcluj.ro					
2.4	Titular					Associate Professor Nicolae Crisan, Ph.D.					
2.5	Year of study	II	2.6	Semester	3	2.7	Evaluation	Exam	2.8	Type of discipline	DS/DO

3. Total estimated time

Year/ Sem	Discipline name	No. of weeks	Course	Applications			Course	Applications			Indiv. study	TOTAL	ECTS
			[hours/week]				[hours/week]						
			C	S	L	P		S	L	P			
II/3	Antennas and RFID sensors	14	2	0	1	0	28	0	14	0	58	100	5

3.1	Number of hours per week	4	3.2	course	2	3.3	applications	1
3.4	Total hours per curriculum	56	3.5	course	28	3.6	applications	14
Individual study								Hours
Study based on manuals, course materials, references and notes								14
Supplementary documentation in libraries, electronic platforms and on field								10
Preparation of seminars/laboratories, homework, essays, portfolios								10
Tutorial work								7
Assessments								3
Other activities								14

3.7	Total hours of individual study	58
3.8	Total hours per semester	100
3.9	ECTS	4

4. Prerequisites (if necessary)

4.1	Curriculum	Microwaves, transmission lines (coaxial cables and waveguides)
4.2	Competences	Matlab (intermediate level), C/C++ (intermediate level)

1. Requisites (if necessary)

5.1	Course	Video-projector, screen, whiteboard
5.2	Applications	PCs with Internet access

6 Specific competences acquired

Professional competences	Theoretical knowledge (What do the student should know)	The students should know: - To use Windows computer graphic interfaces - To use Matlab's menu and commands - To use Microsoft Visual Studio
	Acquired skills (What the student is able to do)	The students will be able to: - To design RF networks for the link between the MIMO antenna and the RF front end. - To use and to design antenna arrays used now by the most important wireless communications service providers. - To process numeric signals acquired from MIMO antenna system offline using Matlab and online using signal processors under C. - To analyze/measure the parameters plotted by the antenna network analyzer like antenna pattern diagrams - To optimize & control the radiation patterns using weight coefficients for electronically steerable antennas - To program embedded radio systems using the microKeil Vision C platform and the SmartRF for the quality of services radio link assessment (like PER,BER,SNR) - To use RFID system for RF identification and for the deposits management - To use RFID network sensors against fraud temptation in supermarkets - To program RFID interfaces in C or C#
	Acquired abilities (what equipment/ instruments/ software the student is able to handle)	The students will be able to use: - Antenna network analyzer - Transmission line analyzer - Radio spectrum analyzer, frequency counter and digital scope - RF signal generator, transceivers - EM-CAD computer aided programs like ADS,HFSS,NEC - Dedicated software used by the most providers to test the radio interface for mobile terminals like C microKeil Vision - To measure main antenna parameters (like VSWR and RL) - To calibrate an antenna analyzer - To calibrate a RFID sensor
Transversal competences		CT3 Adapting to new technologies, professional and personal development through continuing education using electronic documentation and printed sources, in Romanian and in at least one international language (English). Competencies for analysis and synthesis and optimization systems thinking. Flexibility in thinking and ability to work with interdisciplinary concepts and tools.

7 Discipline objectives (based on the grid of specific competences acquired)

7.1	General objective	To develop abilities in radio interface maintenance, assessment and programming
7.2	Specific objectives	MIMO antennas, antenna array processing, RFID sensor calibration

8. Contents

8.1. Course (titles)		Teaching methods	Observations
1	Introduction. Antennas and RFID technology.	Presentation, discussions	Videoprojector
2	Antenna fundamentals. RFID tags.		
3	Using EM_CAD aided programs to analyze and design antennas.		
4	Impedance matching techniques. Antenna measurements.		
5	Impact of nanotechnologies in antenna design. Introduction in HFSS simulator.		
6	Antenna networks – Fundamentals		
7	Antenna arrays – Fundamentals. Matlab algorithms for beamforming and beamsteering		
8	Side lobes suppressing techniques and interference mitigation. Angles of arrival estimation.		
9	MIMO system with uniform linear antenna arrays. Pseudo-spectrum.		
10	Radio channel parameters assessment with uniform arrays		
11	Analog and digital beamforming		
12	Fading mitigation algorithms using beamforming (DBMF), implemented in Matlab		
13	Advanced techniques to counteract the effect of the radio channel using smart antennas. RFID components and standards.		
14	RFID technologies for deposits management		
8.2. Applications (laboratory work)		Teaching methods	Observations
1	Introduction in HFSS (High Frequency Structure Simulator)	Simulations, experiments	PC, simulator
2	A simple dipole antenna simulation		
3	RFID identification using protocols: EM4100, ISO11785FDX-B and tags		
4	Computer aided design of a microstrip patch for WLAN		
5	Computer aided design of a broadband antenna for UMTS		
6	SAR assessment for a mobile phone using HFSS		
7	Antenna measurements with antenna analyzer in L and X radio bands.		
8	Antenna arrays and RF network design in HFSS		
9	Using quadrature hybrid couplers for beamforming		
10	Horn antenna measurements and simulation for DVB		
11	Using SDR for MIMO communications system assessment		
12	Transceivers programing step by step for applications with wireless network sensors using SmartRF and C microKeil		
13	Parallel signal beamforming using MPI (Message Passing Interface) on SDR (Software Defined Radio) concept		
14	Projects defending at the end of semester		

References:

1. N. Crisan, L. Cremene, Antene adaptive – Tehnici de reconfigurare si fundamente matematice , ISBN - 978-606-17-0051-6, 220 pg, 2011
2. N. Crisan, *Antene si circuite pentru microunde*, ISBN-978-973-751-867-5, 301 pag., Ed. Risoprint Cluj-Napoca, 2008
3. N. Crisan, HFSS Tutorial – Antenna Modelling – Computer-assisted antenna design, UTPRESS, 2016, ISBN 978-606-737-192-5
4. L. C. Cremene, *Tehnici adaptive in sisteme de comunicatii wireless*, ISBN 978-973-133-785-2, 366 pag., Ed. Casa Cartii de Stiinta, Cluj-Napoca, 2010
5. Frank B. Gross, *Frontiers in antennas- Next Generation Design & Engineering, ISBN 978-0-07-163793-0,* Biblioteca Centrală UTCN, 520 pg, 2011
6. Li Yang, Amin Rida, s.a. *Design and Developement of Radio Frequency Identification (RFID) and RFID-Enabled Sensors on Flexible Low Cost Substrate,* ISBN 978-1-59-829860-4, Biblioteca Centrală UTCN, 520 pages, 2009

9. Discipline content corroborated with the expectations of the epistemic community representatives, associations, professional and related program employers

Acquired skills will be needed in the following possible COR occupations: electronics engineer, telecommunications engineer, system and computer design engineer, or new occupations proposed to be included in COR (sales support engineer, developer of multimedia applications, network operating engineer, test engineer, project manager, traffic engineer, communications system consultant.

10. Assessment

Type of activity	10.1	Evaluation criteria	10.2	Evaluation method	10.3	The weight of the final grade
Course		Written test with 9 questions (T = 1...10) Two problems (Pr = 1…10)		Written test (T=50%) + problems (Pr=50%) E = (T + Pr)/2		E = 50%
Applications		Project developed during the semester in the laboratory (P = 0 ... 10)		Project defended at the end of semester		P = 50%
10.4 Minimum performance standard						
The final grade (N) is calculated as average of marks obtained in the evaluation of ongoing activities and application type: N = (E + P) / 2. The condition for obtaining the ECTS credits is that both components of the final grade to be higher than or equal to 5 (five).						

Date
08.02.2020

Titular
Associate Professor
Nicolae CRISAN, Ph.D.

Responsible
Associate Professor
Nicolae CRISAN, Ph.D.

Date of approval

Head of Department
Professor Virgil DOBROTA, Ph.D.