Universitatea Națională de Știință și Tehnologie Politehnica București

Facultatea de Electronică, Telecomunicații și

Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Advanced Wireless Communications

2. Date despre disciplină

2.1 Course name (ro) (en)				RF IC Design - Proiectarea circuitelor integrate de radio-frecvență			
2.2 Course Lecturer				Dr.ing. Traian Visan			
2.3 Instructor for practical activities				Dr.ing. Traian Visan			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M3.O.04-33		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	3.5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	49.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	21
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					24
Tutoring					0
Examinations					2
Other activities (if any):					0

3.7 Total hours of individual study	26.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Bachelor Degree in Electrical Engineering Gaduation of the following courses: • Fundamental Electronic Circuits • Analog Integrated Circuits • Analog Blocks
4.2 Results of learning	Following knowledge is necessary: • Electronic Devices • Analog electronic circuits • Analog Blocks

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	• Course classes will take place in a classron having videoprojector and computer. • For synchronous broadcasting/recording, high speed Internet connection is necessary.
5.2 Seminary/ Laboratory/Project	• Laboratory classes will take place in a classroom having ate least as many computers as the number of students • Computers have to run a Linux like operating system and the Cadence IC design software suite • Software licenses for the Cadence software.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

Basic RF circuits specific performance parameters will be presented. Most important transceiverarchitectures will be studied. Technology related topics will be presented. Main RF functionalcircuits will be studied (LNAs, Mixers, VCOs, PLLs, and PAs).

The basic circuits for a typical RF receiving chain will be designed and simulated. The students will beinvolved in evaluating different circuit solutions in order to emphasize application related tradeoffs. Studentswill learn how to use both time and frequency domain simulators.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Demonstrates that the graduate has basic and advanced **knowledge** in the domain of RF analog IC design. **Correlates knowledge** **Applies knowledge** **Applies** standard methods and instruments specific to the domain in order to **evaluate and diagnose** the status of the task to be performed and, based on the conclusions identified/reported identifies solutions. **Analizes and arguments** coherently and correctly the base knowledge application context using key concepts and specific methodology. **Oral and written communication in Romanian language**: uses appropriate scientific vocabulary in order to effectively communicate. **Oral and written communication in English language**: demonstrates specific vocabulary mastering.

Transversal (General) Competences	**Works in a team and efficiently communicates**, coordinating her/his efforts to others efforts in order to **solve medium size/complexity issues**. **Autonomy and critical thinking**: ability to think using appropriate scientific terms, to independently search and analyze data and to draw and present conclusions / identify solutions. **Analysis and synthesis ability**: synthetically presents acquired knowledge via systematic analysis. **Follows academic ethics**: in the documentation activity properly cites the bibliographical sources.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • Basic Knowledge about the specific of RF technologies. Knowledge about specific RFdevices. Knowledge about RF Transceiver architectures and their performances. How todesign specific RF circuits. • **Enumerates** the most important RF analog building blocks types. • **Defines** domain specific terms. • **Describes/classifies** terms/processes/phenomena/structures. • **Points out relations and consequences**.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Ability to evaluate the performance of a RF semiconductor device base on data sheet.Ability to work with RF simulator both in Time Domain and Frequency Domain. Ability tomake basic trade off design decisions • **Selects and groups** relevant information in a specific context. • **Uses specific principles, based on arguments, in order to effectively design RF chips and achieve the "first-time-success" goal.** • The student graduating this course will be able to state the specification of an RF analog building block, create a simulation set-up, design the block, layout it and evaluate its characteristics. This course enables the student to work in Advanced Microelectronics area • **Works** productively **in a team**. • **Elaborates scientific texts.** • **Experimentally verifies identified solutions**. • **Solves** practical applications. • Correctly **interprets** de causality connections. • **Analyses and compares different design styles**. • **Identifies solutions and elaborates** solution plans/projects. • **Draws conclusions from the experiments**. • **Arguments identified** solutions.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • The **ability to work individually and independently** to design an RF circuit based on aspecification • **Selects** appropriate bibliography and analyses it. • **Follows academic ethics**, correctly citing sources. • **Proves receptivity** for new learning contexts. • **Collaborates** with her/his colleagues and teachers during the didactic process. • **Proves autonomy** in setting up teaching/solving problem context/. • **Proves social responsibility** by actively involving in student social live/implication in academic community events. • **Promotes/contributes** to social live improvement by new solutions in her/his specialization domain • **Is aware of her/his contribution in engineering field**, in identifying viable/sustainable solutions to solve socio-economic issues (social responsibility). • **Applies ethical principles/professional deontology** in analysis of environmental effects of proposed technological solutions. • **Analyzes and exploits business opportunities** /entrepreneurial development in the domain. • **Proves management abilities** in real life situations (time management collaboration vs. conflict).

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Based on students' study characteristics analysis and their specific needs, the teaching process will explore both exposing methods (lecture, exposition) and interactive dialogs, based pe on discovery teaching methods that are facilitated by direct reality exploration (experiment, demonstration, modelling), and also action based methods like exercises, practical activities and problem solving.

In the teaching activity exposition will be used based on both Power-Point and different recordings that will be available to the students. Each class will debut by reviewing previous chapters pointing out notions in the last previous class.

Presentations use images and graphs in order to facilitate notions understanding and assimilation.

This course covers information and practical activities aimed to support students in learning and optimal collaboration and communication relations development in an discovery learning favorable climate.

Active listening and assertive communication abilities practice and feedback will be main means to behavioral adjustment in various situations and for didactic activity adaptation to students' needs.

Team working abilities will be exercised in order to solve various learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction in RF Devices and technologies for RF circuits	4

2	Transceiver Architectures Receiver Transmitter	4
3	RF Amplifiers Linear Theory Low Noise Amplifiers	4
4	PLL Synthesizers	4
5	RF Oscillators	4
6	RF Mixers	4
7	RF Power Amplifiers	4
	Total:	28

Bibliography:
1. Behzad Razavi – RF Microelectronics – Prentice Hall – 1998;
.2. Thomas H. Lee – The Design of CMOS Radio-Frequency Integrated Circuits – Cambridge University Press – 2004;
3. John Rogers, Calvin Plett – Radio Frequency Integrated Circuits Design – Artech House – 2003;

LABORATORY

Crt. no.	Content	No. hours
1	Introduction of Time Domain simulator LTSpice	4
2	Introduction of Frequency Domain simulator Ansoft Designer	4
3	Design of Matching Networks using the Smith Diagram	4
4	Design of a Maximum Gain RF amplifier based on complex conjugate matching.	4
5	Design of a RF Low Noise Amplifier using both Time domain and Frequency domain simulators.	4
6	Design of a RF Voltage Controlled Oscillator using Time domain and Frequency domain simulators	4
7	Design of a RF Mixer using the Time Domain simulator	4
	Total:	28

Bibliography:
1. LTSpice - Reference manual
2. Ansoft Designer Student Version - Reference manual
3. Infineon Application Notes for RF Transistors
4. Smith Diagram - Tutorials

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	The ability to select the correctsolution for using a device in aspecified circuit or to select thecorrect circuit architecture to perform a certain function in an RF transceiver.	Quiz with multiple answers.	30
11.5 Seminary/laboratory/project	Capability to design some basic RF circuits using Time Domain and Frequency Domain simulators	3 Dedicated Home Worksfor designing LNA, VCO,Frequency Divider, Phase-Frequency Detector with Charge Pump	70
11.6 Passing conditions			
Minimum 50% accurate answers of the quiz. Minimum 50% of the Home Works evaluation.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

- Via the teaching activities, students develop integrated circuits analysis and design abilities that are in high demand due to the unprecedented microelectronics domain development. Engineers for analog, digital and mixed signal integrated circuits design are necessary to sustain this rapid development.

- The circuit types studied are in permanent use by all commercial companies active in this field. The Cadence design environment taught in the laboratory is used by virtual all companies active in Romania

- The course curricula is adapted to actual requests and tendencies of the technological evolution. Both classes and application activities provide to the students knowledge and competencies that facilitate fast enrolment into a prestigious company active in the IC design domain.

- Current semiconductor market status highlights major unbalances between offer and demand that generated active, sustained and decisive actions at all decision levels of all states including the European Union.

- In the course development both literature described aspects, knowledge and phenomena and own contributions published or acquired in industrial activities were used.

- The course has similar content to courses taught in: Lodz University of Technology, Poland, THE UNIVERSITY of EDINBURGH, Newcastle, Great Britain etc.

- Via the lab activities practical situation management abilities are formed and developed.

- The course was developed in agreement with microelectronic Romanian companies like Infineon Technologies, Romania, Microchip Romania and On Semiconductor Romania. Dr. Traian VIȘAN is team leader in Infineon Romania.

Date Course lecturer Instructor(s) for practical activities

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16.09.2024 Dr.ing. Traian Visan  Dr.ing. Traian Visan 

Date of department approval

27.10.2024

Head of department

Conf. Dr. Serban Georgica Obreja 

Date of approval in the Faculty Council

25.10.2024

Dean

Prof. Dr. Mihnea Udrea