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	Bachelor/Undergraduate
1.6 Programme of studies	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Circuite electronice fundamentale Basic Electronic Circuits			
2.2 Course Lecturer				Prof. Dr. Gabriel Dima			
2.3 Instructor for practical activities				Prof. Dr. Gabriel Dima			
2.4 Year of studies	2	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.04.O.016		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	6	Out of which: 3.2 course	3.00	3.3 seminary/laboratory	3
3.4 Total hours in the curricula	84.00	Out of which: 3.5 course	42	3.6 seminary/laboratory	42
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.					60
Tutoring					0
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	66.00
3.8 Total hours per semester	150
3.9 Number of ECTS credit points	6

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Fundamentals of Electrical Engineering and Electronic Devices

4.2 Results of learning	Knowlege regarding electronic devices physics and operation, electric circuits analysis and be able to use general purpose measurement equipment.

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

5.1 Course	Lecture room equipped with multimedia projector, white or chalkboard and internet connection.
5.2 Seminary/ Laboratory/Project	Seminar room/Laboratory equipped with multimedia projector, white or chalkboardand internet connection. Minimum 15 experimental platforms that includes measurement boards and general purpose measurement equipment for the measurement and characterization of electrondevices. 15 personal computers with circuit simulation 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)*

A systematic study of both fundamental analogic circuits - amplifiers, voltage regulators and oscillators - and the building blocks utilized in the design of analog IC's such as: the differential amplifier, the cascode configuration, voltage references, current mirrors, etc.

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	Knowledge of fundamental analogic circuit analysis and design methods. Ability to select the adequate circuit configuration for a specific application and optimal bias which guarantees the stability of circuit parameters.
Transversal (General) Competences	**Team work, efficient communication:** ability to efficient cooperate with the other member of the team to **solve problems** of medium complexity**.** **Critical thinking:** ability to think scientifically, to inquire and to analyze data independently and to draw conclusions as well as to identify solutions. **Capacity of analyse and synthesise:** ability of presenting the acquired knowledge following a systematic analysis. **Follow the academic ethical principles:** during the desk research, cite correctly the reference 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.* Ability to list and describe the most important properties of the fundamental electronic circuits. Ability to define specific characteristics of electronic circuits. Ability to describe/clasify concepts/fenomena/models for multistage amplifiers, negative feeback amplifiers, voltage regulators and AF and RF oscillators. Ability to define DC biasing modes and AC modes for the studied electronic circuits. Ability to develop models for electronic circuits used in aplications.
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 of working in teams. Ability to solve practical exercises using the acquired knowledge. Ability to propose practical schemes for circuits incorporating studies electronic devices. Ability to identify the electrical behaviuor of electron devices within given circuits. Ability to diferentiate between the electron devices behaviour in DC and small-signal dinamic modes. Ability to differentiate between the linear and non-linear behaviour of electron devices Ability to analyse elementary circuits with diodes and transsistors. Ability to acknowledge the importance of model parameters for electrical behaviour of studies electron devices.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Ability to undertake a proper desk research and analysis of references. Respect the academic ethical principles, by corrected citing the used references. Prove openess for new learning contexts. Cooperate with other colleagues and academic staff in the implementation of academic activities. Prove authonomy in setting-up the learning context or of the problem to be solved. Contribute through new solutions related to its field of study pfor the improvement of the quality of life. Be aware of its contribution within the engineering through identification of solutions forreallife problems from the society (social responsibility). Apply the ethical principles in analysing the impact the proposed solutions on the environment. Analise and take advantage of opportunities of personal antrepreneural development. Prove management abilities in real life settings.

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.)*

The course is taught based on PowerPoint course notes following the structure presented at section 10 – the presentation includes detailed information regarding the studied subjects and, if needed, extensive explanation for complex matters at the whiteboard/chalkboard. The course resources (the course notes, additional reading, model solved exercices) are published within the Moodle platform.
The seminar is focus on solving practical exercises aiming at asseing the ability of students to transfer the taught theory in practice – model exercices are presented and solved by the teacher (all the seminar notes are

also uploaded on the Moodle platform). The common practice is that the students actively contribute to the seminar by responding to open quizes or solving given exercises of part of them at the whiteboard/chalkboard. The basic resources for seminar activities are the course notes, solved exercises and the exercise book "*Circuite Electronice Fundamentale-Probleme*".
The laboratory activities are splited within two rooms: the first one is equiped with 15 experimental platforms that includes measurements boards and general purpose measurement equipments for the measurement and characterisation of electronic circuits while the second one is equiped with 15 personal computer having installed PSPICE circuit simulation software. In the begining of each laboratory, the students are introduced to the given topic by the tutors that afterwards guide them during the whole time – the laboratory notes consist in all the needed information in terms of theoretical background, measurement settings, practical steps as well as hints in order that the students to succesfully finalize the required tasks (the laboratory notes are available within the laboratory book "*Circuite electronice-Îndrumar de laborator*" and online at *https://wiki.dcae.pub.ro/index.php/Pagina_principal%C4%83#Platforme_de_aplicatii_sau_laborator*).
Within the first meeting, the students are introduced to the lab rules and procedures (working security included), equipment operation hands-on and measurements boards

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Amplifier fundamentals 1.1 Definition 1.2 Parameters 1.3 Amplifier band 1.4 Distortions. Noise in amplifier 1.5 Operation class 1.6 Classification of amplifiers 1.7 Applications	3
2	Fundamental amplifiers 2.1 Single transistor amplifier stages 2.2 Cascode and paraphase configurations 2.3 Differential amplifiers 2.4 Ideal operational amplifiers 2.5 Applications	9
3	Negative feedback 3.1 Ideal feedback amplifier topology 3.2 Negative feedback properties 3.3 Feedback amplifier configurations 3.4 Shunt-shunt feedback amplifier 3.5. Series-series feedback amplifier 3.6 Shunt-series feedback amplifier 3.7 Series-shunt feedback amplifier 3.8 Applications	9

4	Linear voltage regulators 4.1 Definition 4.2 Parameters 4.3 Operation principles 4.4 Classification 4.5 Parametric regulators 4.6 Feedback regulators 4.7 Integrated voltage regulators 4.8 Applications	6
5	Switching regulators 5.1 Definition 5.2 Parameters 5.3 Operation principles 5.4 Classification 5.5 Flyback converter 5.6 Forward converter 5.7 Half-bridge converter 5.8 Switching regulators vs. linear voltage regulator comparison 5.9 Applications	6
6	Sinusoidal oscillators 5.1 Definition. Parameters 5.2 Classification 5.3 RC Oscillators 5.4 LC oscillators 5.5 Applications	9
	Total:	42

Bibliography:

1. G. Dima, Fundamental Electronic Circuits – Lecture notes (electronic / Moodle), 2011.
2. A. Rusu, G. Dima, *Fundamental Electronic Circuits*, Ed. Politehnica Press, 2009.
3. D. Dascălu et all, Dispozitive şi Circuite Electronice, Ed. Didactica şi Pedagogică, 1982.
4. G. Brezeanu, Circuite electronice, Ed. Albastră, Cluj-Napoca, 1999.
5. A. Rusu, G. Dima, Fundamental Electronic Circuits, Ed. Politehnica Press, 2009.
6. G. Brezeanu, F. Drăghici, Circuite electronice fundamentale, Ed. Niculescu, Bucureşti, 2013.
7. R. Muller, T. Kamins, Devices Electronics for Integrated Circuits, Wiley and Sons, New York, 1988.
8. K. R. Laker,W. M. C. Sansen, Design of Analog IC's and Systems, McGrawHill, 1994.
9. P. R. Gray, P. J. Hurst, S. H. Lewis, R. G. Meyer, Analysis and Design of Analog IC's, 5th Edition, J. Whiley & Sons, 2009.
10. B. Razavi, Fundamentals of Microelectronics, 2nd Edition, Wiley Global Education, 2013;
11. A. Sedra, K. C. Smith, Microelectronic Circuits, ediţia a V-a,Oxford University Press, 2004.

LABORATORY

Crt. no.	Content	No. hours
1	The differential amplifiers.	2
2	Negative feedback amplifier. Configurations and measurements.	2
3	Negative feedback amplifier simulations with PSPICE.	2
4	The operation of the linear voltage regulator by using the PSPICE simulator.	2

5	Low frequency oscillators	2
6	The simulation of the Wien bridge oscillator,	2
7	Final quiz.	2
	Total:	14

SEMINARY

Crt. no.	**Content**	**No. hours**
1	Multistage amplifiers - bias points, AC analysis techniques.	2
2	Cascode configuration. CMOS inverter.	2
3	Differential and paraphase amplifiers.	2
4	Frequency behavior of amplifiers stages. Miller effect. Comparison between cascode – CE/CS, respectively CB/CG.	2
5	Negative feedback amplifier- analysis techniques. Shunt – shunt configuration.	2
6	Series-shunt negative feedback amplifiers.	2
7	Shunt-series and series-series negative feedback amplifiers.	2
8	Linear voltage regulators - analysis techniques. Linear parametric and feedback voltage regulators.	2
9	Linear feedback voltage regulators.	2
10	Linear feedback voltage regulators (cont').	2
11	Sinusoidal Oscillators - analysis techniques. RC oscillators.	2
12	RC oscillators - voltage transfer positive feedback networs.	2
13	RC oscillators - current, transimpedance and transadmitance transfer positive feedback networs.	2
14	LC Oscillators	2
	Total:	

Bibliography:

1. G. Dima, Fndamental Electronic Circuits - Seminar notes (electronic / Moodle), 2011.
2. D. Dascălu et all, Dispozitive şi Circuite Electronice – Probleme, Ed. Didactica şi Pedagogică, 1982.
3. G. Brezeanu, G. Dilimoţ, F. Mitu, F. Drăghici, Probleme de dispozitive şi circuite electronice, Ed. IT Grup, Bucureşti, 2006.
4. G. Brezeanu, F. Drăghici, F. Mitu, G. Dilimoţ, Circuite electronice fundamentale- Probleme, Ed. Rosetti Educaţional, Bucureşti, 2008.
5. R. Muller, T. Kamins, Devices Electronics for Integrated Circuits, Wiley and Sons, New York, 1988.
6. K. R. Laker,W. M. C. Sansen, Design of Analog IC’s and Systems, McGrawHill, 1994.
7. P. R. Gray, P. J. Hurst, S. H. Lewis, R. G. Meyer, Analysis and Design of Analog IC’s, 5th Edition, J. Whiley & Sons, 2009.
8. B. Razavi, Fundamentals of Microelectronics, 2nd Edition, Wiley Global Education, 2013;
9. A. Sedra, K. C. Smith, Microelectronic Circuits, ediţia a V-a,Oxford University Press, 2004.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of fundamental theoretical concepts, of using theory to solve specific problems and understanding the operation, performances and applications of single and multiple transistor amplifiers and negative feedback amplifiers.	A written midterm test, which covers 50% of the lecture, focusing both on theoretical knowledge evaluation and solving problems that illustrate parameters and operation of fundamental multi-stage and feedback amplifier topologies.	30
	Knowledge of fundamental theoretical concepts, of using theory to solve specific problems and understanding the operation, performances and applications of voltage regulators and sinusoidal oscillators.	Final examination, with the possibility of retaking the midterm test. This exam is focused both on theoretical knowledge evaluation and solving problems that illustrate parameters and operation of fundamental voltage regulator and sinusoidal oscillator topologies.	30
11.5 Seminary/laboratory/project	Analysis, by numerical data, of specific circuits representing multi-stage amplifiers, negative feedback amplifiers, voltage regulators and sinusoidal oscillators.	Two written tests of equal weight, at dates fixed at the beginning of the semester; test topics are based on problems with numerical data on amplifier, voltage regulator and sinusoidal oscillator circuits.	20
	Laboratory: - knowledge of the measurement methods and characterization of fundamental analog circuits: amplifiers, oscillators, linear voltage regulators.- knowledge of both analog and digital electronic circuit simulation software.	Evaluations, during the semester, of practical activities. Grading based on the understanding of measurement methods and elaboration of main electrical characteristics of studied electronic circuits. Final laboratory examination, evaluating both theoretical knowledge (multiple choices test) and practical abilities (implementation and testing of a specific electronic circuit)	20
11.6 Passing conditions			
Acquiring a minimum score of 50% for seminar (10 points out of 100) and laboratory (10 points out of 100), 50% for the midterm test (15 points out of 100) and 50% for the final examination (15 points out of 100).			

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)

Fundamental Electronic Circuits studies the basic blocks of analogic circuits, typical products of microelectronics. This field has known explosive advancements, especially after the year 2000, following bold and spectacular developments of CMOS nanometer technologies. The microelectronics has a near encyclopedic trait, by the multifunctional circuits and systems it has come to incorporate, offering a wide horizon of applications in many domains for students and specialists alike. Multinational microelectronics companies, well-known producers of integrated circuits (Infineon, Microchip, ON Semiconductor), with strong branches in Romania, have considerably increased the demand for qualified engineers, with solid knowledge and competences in the field of analog and mixed signal. The course familiarizes the students with the fundamental concepts of modelling and design in microelectronics, including original ideas and methods of the specialized Romanian school. Based on the MOS and bipolar models, analysis and design techniques for basic analog circuits – amplifiers, regulators, oscillators – are studied and exemplified. The operation, performances, limitations and typical applications of these circuits are demonstrated through numerical data and comments. Thus, the policy of promoting subjects strongly correlated with the requirements of present top industry such as electronics, is followed.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Gabriel DIMA	Prof. Dr. Gabriel DIMA
		Sl. Dr. Laurentiu TEODORESCU

Date of department approval	Head of department
22.10.2024	Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea

Universitatea Națională de Știință și Tehnologie Politehnica București

Facultatea de Electronică, Telecomunicații și

Tehnologia Informației