Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti

Facultatea de Electronică, Telecomunicaţii şi

Tehnologia Informaţiei

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	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Computers and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Information Engineering

2. Date despre disciplină

2.1 Course name (ro) (en)				Dispozitive electronice şi electronică analogică 1			
2.2 Course Lecturer				Prof. Dr. Ing. Gheorghe Brezeanu			
2.3 Instructor for practical activities				Prof. Dr. Florin Draghici			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.03.O.702		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	3
3.4 Total hours in the curricula	70.00	Out of which: 3.5 course	28	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.					73
Tutoring					0
Examinations					7
Other activities (if any):					0

3.7 Total hours of individual study	80.00
3.8 Total hours per semester	150
3.9 Number of ECTS credit points	6

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	• Electro-technical Fundamentals • Solid State Physics

4.2 Results of learning	General principles of solid state physics, electricity, mathematics, electric circuit analysis

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

5.1 Course	Lecture room equiped with multimedia projector, white or chalkboard and connection to internet.
5.2 Seminary/ Laboratory/Project	Seminar room/Laboratory equiped with multimedia projector, white or chalkboard and connection to internet. Minimum 15 experimental platforms that includes measurement boards and general purpose measurement equipments for the measurement and characterization of electron devices. 15 personal computers with device and 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)*

Study of semiconductors' solid state physics together with the electrical behaviour and steady state and dynamic models for basic electron devices: pn junction diode, Schottky diode, Jonction Field Effect Transistor (J-FET), Metal Oxide Semiconductor Transistors (MOS-FET) and Bipolar Junction Transistor (BJT). Recap of solid state physics with special regards to semiconductors and intoduction to pn- junction, metal-semiconductor interface and MOS capacitor.

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	• Basic knowledge related to solid state physics with special regards to semiconductor physics. • Advance knowledge related to device physics, operation modes and steady state and dinamic modelling for pn junction, Schottky diode, JFET, MOSFET and BJT. • Ability of applying the knowledge acquired related to device modelling and equivalent circuits for analysis and desing on analog as well as digital circuitry. • Ability of optimal parameter extraction for devices for given circuit topologies.

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 semiconductor materials used in the production of semiconductor devices. • Ability to define specific characteristics of studied electron devices • Ability to describe/clasify concepts/fenomena/models for diodes and trasnsistors • Ability to define DC biasing modes and dinamic circuit models for studied electron devices
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. • Realizes the value of its contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (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 “Dispozitive electronice-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 electron devices while the second one is equiped with 15 personal computer having installed different devices and 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 „Dispozitive 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	Semiconductors Fundamentals 1.1 Semiconductors. Insulators. Metals 1.2 Electrons and holes 1.3 Intrinsic and extrinsic semiconductors 1.4 Drift and diffusion 1.5 Generation and recombination 1.6 Semiconductor equations 1.7 Electrical signals for semiconductor devices 1.7.1 Analog and digital signals 1.7.2 Small signal and large signal 1.73 Stationary and Quasi-Stationary Signals. Operation at high frequencies. The effect of internal capacities	2
2	2. Fundamental semiconductor structures 2.1 pn junction 2.2.1 Electrostatics of the pn junction 2.2.2 Relations between current and voltage 2.2.3 pn junction breakdown 2.2.4 Small-signal modeling. Internal capabilities 2.3 The MOS capacitor 2.4 Metal-semiconductor contact (CMS) 2.7 Applications	6
3	3. Semiconductor diodes 3.1 Classes of diodes. Use, applications 3.2 Junction diodes 3.3 Schottky diode 3.4 Light emitting diode (LED) 3.5 Thermal behavior of semiconductor diodes	4
4	F4. Field effect transistors 4.1 The field effect. TEC classification 4.2 The induced channel MOS transistor 4.2.1 Structure. Channel inducing 4.2.2 Threshold voltage. Channel conductance 4.2.3 Operating modes 4.2.4 Current voltage relationships. 4.2.5 MOS transistor models 4.2 Depletion MOS. Structure and operation 4.3 Applications	8

5	Bipolar junction transistor (BJT) 5.1 Device structure. npn and pnp transistors 5.2 Transistor effect 5.3 Ebers-Moll equations 5.4 Operating modes. Configurations 5.5 Modeling the bipolar transistor in forward active mode 5.6 Second order characteristics of transistors 5.7 High frequency transistor response 5.8 Transistor breakdown voltages 5.9 Transistor temperature behavior 5.10 Comparison between bipolar junction transistor and MOS transistor	8
	Total:	28

Bibliography:

1. G.Brezeanu, Dispozitive Electronice – suport de curs (electronic) - Moodle, 2025.
2. G. Brezeanu, F. Drăghici, Circuite electronice fundamentale, Ed. Niculescu, Bucureşti, 2013.
3. G. Brezeanu, G. Dilimoţ, F. Mitu, F. Drăghici, Dispozitive electronice-Probleme , Ed. Rosetti Educaţional, Bucureşti, 2009.
4. R. Muller, T. Kamins, Devices Electronics for Integrated Circuits, Wiley and Sons, New York, 1988.
5. R. F. Pierret, G. W. Neudeck, Modular Series on Solid State Devices, Addison – Wesley, New York, 1990
6. P. R. Gray, P. J. Hurst, S. H. Lewis, R. G. Meyer, Analysis and Design of Analog IC's, ediţia 4, J. Whiley & Sons, 2005.
7. B. Razavi, Design of Analog CMOS Integrated Circuits, McGrawHill, 2001.
8. A. Sedra, K.C. Smith, Microelectronic Circuits,ediţia a 5-a, Oxford University Press, 2004.

LABORATORY

Crt. no.	Content	No. hours
1	Semiconductor Diodes. Measuring of static and dynamic parameters.	3
2	Field effect transistors. Measuring of static and dynamic parameters. Common source amplifier stage.	3
3	Bipolar transistor. Measuring of static and dynamic parameters. Common emitter amplifier stage.	3
4	Bipolar transistor circuit simulations.	3
5	Final verification.	2
	Total:	14

SEMINARY

Crt. no.	Content	No. hours
1	Electrons and holes. Extrinsic semiconductors. Semiconductor resistivity	2
2	PN junction. Depletion region.	2
3	Pn junction. Current-voltage relationships.	2
4	Semiconductor diodes. Diode dc operating point.	2
5	Diode circuits. DC and Small signal analysis	2

6	JFET. JFET current sources.	2
7	JFET amplifier stages. Common source.	2
8	MOS transistor. MOS current sources.	2
9	JFET and MOS amplifier stages. Common gate and common drain.	2
10	JFET and MOS amplifier stages. Common source stage with source degeneration.	2
11	Bipolar transistor. Device DC operating point. Bias circuits.	2
12	Bipolar transistor current sources.	2
13	Bipolar transistor amplifier stages. Common emitter and emitter degeneration.	2
14	Bipolar transistor amplifier stages. Common base and common collector.	2
	Total:	28

Bibliography:

1. I. Rusu, F. Babarada, F. Drăghici, “Dispozitive Electronice - Îndrumar de Laborator”, Editura Rosetti Educaţional, Bucureşti, 2011, ISBN 978-973-7881-71-7.
2. G.Brezeanu, Dispozitive Electronice – suport de curs (electronic), 2020.
3. G. Brezeanu, G. Dilimoţ, F. Mitu, F. Drăghici, Dispozitive electronice-Probleme , Ed. Rosetti Educaţional, Bucureşti, 2009.
4. G. Brezeanu, F. Drăghici, Circuite electronice fundamentale, Ed. Niculescu, Bucureşti, 2013.
5. S.M. Sze, K.W. Ng, Physics of Semiconductor Devices, 3rd edition, Wiley Interscience, New Jersey, USA, 2007;
6. Elettronica Veneta SPA, Power Supply Unit, mod. PSLC/EV, Teacher/Student handbook, Treviso, Italy, 2008
7. Elettronica Veneta SPA, Electronic Devices and Circuits Mod. MCM3/EV, Volume 1/2, Theory and Experiments, Teacher/Student manual, ”Final English version provided by Cambridge Open Learning”, Treviso, Italy, 2008
8. Elettronica Veneta SPA, Electronic Devices and Circuits Mod. MCM3/EV, Volume 2/2, Service Manual, Teacher manual, Treviso, Italy, 2008
9. Elettronica Veneta SPA, Electronic Devices and Circuits Mod. MCM4/EV, Volume 1/2, Theory and Experiments, Teacher/Student manual, ”Final English version provided by Cambridge Open Learning” Treviso, Italy, 2008
10. Elettronica Veneta SPA, Electronic Devices and Circuits Mod. MCM4/EV, Volume 2/2, Service Manual, Teacher manual, Treviso, Italy, 2008
11. P.R. Gray, P.J. Hurst, S.H. Lewis, R.G. Meyer, Analysis and Design of Analog Integrated Circuits, 5th edition , Wiley, 2009
12. T.L. Floyd, Electronic Devices- Electron Flow Version, 9th edition, Prentice Hall, 2012;
13. B. Razavi, Fundamentals of Microelectronics, 2nd edition, Wiley Global Education, 2013
14. http://wiki.dcae.pub.ro/index.php/Electronic_Devices(lab)
15. Situl cursului: http://www.dce.pub.ro

11. Evaluation

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

11.4 Course	Knowledge of theoretical notions fundamentals regarding the operation of the pn junction, MOS capacitor and of the metal-semiconductor contact. The model parameters and equivalent circuits for dynamic regime at diodes and J-FET.	A written midterm test, which covers 50% of the lecture, focusing both on theoretical knowledge evaluation and solving problems that illustrate the operation of pn junction, MOS capacitor, diodes and J-FET in specific electronic circuits.	30
	Knowledge of the fundamental theoretical notions and the way of application of theory to specific problems. The appropriation and use the model parameters and the equivalent circuits for MOS transistors and BJT.	Final exam held in session. This exam, by subjects theoretical and problems, check knowledge relating to MOS and bipolar transistors and their operation in specific single transistor amplifiers.	40

11.5 Seminary/laboratory/project	Seminar - Appropriation and use in specific circuits of the models established for diodes, FETs and BJTs. Problems with circuits that includes diodes, J-FET, MOS and bipolar transistors. Determination of DC bias for the devices and parameters for dynamic regime. Calculation input/output resistances, voltage and current amplifications and other transfer functions for diode circuits, J-FET, MOS and bipolar transistors.	Two written tests of equal weight, at dates fixed at the beginning of the semester. Grading students who take an active part at solving of the proposed problem	20
	Laboratory - Knowledge of measurement methods and characterization of fundamental electronic devices: diodes and transistors. Knowledge of analysis and characterization software for electronic devices.	Evaluation over the semester of practical activities undertaken. Grading based on the understanding of measurement methods and elaboration of main electrical characteristics of studied electronic devices. Final laboratory examination, evaluating both theoretical knowledge (questions) and practical abilities (implementation and testing of a specific electronic circuit).	10
11.6 Passing conditions			
• Obtaining 50% of the total score related to the activity during the semester(seminar/laboratory/course) • Obtaining 50% of the total score related to the verification along the way and respectively the final exam. • In order to pass the laboratory, students must obtain at least 50% of the allocated score (minimum of 5 points).			

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)

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Electronic Devices represents a fundamental topic for an electrics and electronics engineering specialist. Thorough knowledge of physics and semiconductor electronics devices have made possible major progress, explaining the unparalleled achievements in mobile communications, computers or audio and video electronic systems.

This course illustrates, by comments and numerical data, the electrical behavior, models and equivalent circuits of diodes, field effect and bipolar transistors, as well as their uses inside a circuit. Special emphasis is made on amplifier stages.

By professional selection of important knowledge, of immediate or timeless topicality, the students are offered complete scientific and technical training, allowing employment opportunities after graduation in any electronics, telecommunications or information technology company. Thus, the policy of "Politehnica" University of Bucharest, 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
25.09.2025	Prof. Dr. Ing. Gheorghe Brezeanu	Prof. Dr. Florin Draghici

Date of department approval	Head of department

Date of approval in the Faculty Council	Dean
26.09.2025	Prof. Dr. Mihnea Udrea