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	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Micro and Nanoelectronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Tranzistoare pe filme organice si nanocompozite Transistors on organic and nanocomposite films			
2.2 Course Lecturer				Prof. Dr. Cristian Ravariu			
2.3 Instructor for practical activities				Prof. Dr. Cristian Ravariu			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M3.O.05-35		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	0
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	0
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.					54
Tutoring					5
Examinations					8
Other activities (if any):					5

3.7 Total hours of individual study	72.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	The design of precision integrated circuits in submicron technologies • Advanced modeling of MOS transistors • Modeling Spice and MCMA devices Research project
4.2 Results of learning	Accumulation of knowledge results at: advanced electronic devices and modeling of thin film electronic devices

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

5.1 Course	Completion and/or promotion of the following subjects: The course will take place in a room equipped with video projector and computer. Knowledge of the mode of operation of field effect transistors; Knowledge of technological processes for electronic devices on a micro and nano scale;
5.2 Seminary/ Laboratory/Project	Applications

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)*

The discipline Transistors with organic and nano-composite films is studied within the field of micro-nanoelectronics and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications and problems, with relevance for stimulating the learning process to students.

The discipline approaches organic micro-nano-electronics as a specific topic, with advanced notions of nanocomposites such as ferrite nano-core shell doped with organic acids, specific concepts and principles of organic semiconductors, all of which contribute to transmission/training to/to students of an overview of the methodological and procedural benchmarks related to the field of global Organic Electronics

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 the structure and properties of nanomaterials and organic materials for electronics, as well as their important applications in the manufacture of screens; - Use of software tools for the advanced simulation of both device operation (Atlas) and technological processes (Athena); -The acquisition and deepening of some knowledge for training students in the optimization of organic electronic devices or with nano-composite materials, including nano-porous films, with the help of technological tools and CAD simulation techniques by calling the skills to apply the theoretical knowledge from Electronic Devices or Spice Models or Modeling of Active Microelectronic Components, adding specific knowledge of organic electronics and work on semiconductor nanofilms, including SOI.

Transversal (General) Competences	- Identifying the need for continuous training and the effective use of information sources and communication resources and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian and in a language of international circulation. -Identifying the need for continuous training in the increasingly obvious field of organic electronics, with development potential in Romania, because these transistors can be manufactured at temperatures close to room temperature and do not require white rooms, but lend themselves to gray rooms as well, with an advantage both at costs and at average impact; efficient use of information sources, connection to updated international communication resources and assisted professional training (Internet portals, general software applications such as Elsevier, IEEE databases, online courses, both in Romanian and in a language of international circulation.

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.* The most important stages that marked the development of the field of organic micro-nano-electronics and nano-composites: the development of the TFT transistor, first with amorphous Si, then with poly-granules, then with IZGO and finally with organic semiconductors. Notions specific to the field of organic micro-nano-electronics and with nano-composites: SOI technologies such as SIMOX, FIPOS, WB, ZMR, SOS, CNT-FET transistors, physics of organic semiconductors - elements, organic technologies. Notions/processes/phenomena/structures of organic and nano-composite micro-nano-electronics: Nano-composite technologies: NCS, Nano-core Shell, Nano-porous, Carbon Nanotubes, Ge Nanocore, SOI / Specific devices: CNT-FET, FET with nano-porous Si, NCS-FET / Organic semiconductors: synthesis , classification, technologies / Organic transistors OTFT, OFET, configurations, applications. Consequences and relationships for organic micro-nano-electronics and with nano-composites: the co-existence of these fields, their interdisciplinarity, a typical example is the TFT thin film transistor but from Nano-core shell as semiconductor substrate and doped with organic acids - PABA to confer the p-type, or SSA to confer the n-type semiconductor.

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).* Graduates of this discipline are stimulated to select and group relevant information in a context of current organic electronics. Graduates of this course are encouraged to use specific principles in a reasoned way in order to apply organic micro-nano-electronics and nano-composites. Graduates of this course are encouraged to work productively in a team, on some homework. Graduates of this course are encouraged to prepare a scientific text, within the framework of some topics along the way in the field of organic micro-nano-electronics and nano-composites. Graduates of this discipline are encouraged to experimentally verify identified solutions. Graduates of this discipline are encouraged to solve practical applications, in course exercises or individual homework assignments. Analyze and compare characterization results for organic / nanocomposite transistors. Identifies solutions and develops project resolution plans. Formulate conclusions to the experiments carried out. Argue the identified solutions/workarounds.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Graduates of this discipline are encouraged to select appropriate bibliographic sources and analyze them for the distinct field of organic micro-nano-electronics and nano-composites. Graduates of this discipline are encouraged to respect the principles of academic ethics, correctly citing the bibliographic sources used in the homework. Graduates of this discipline are encouraged to demonstrate receptivity to new learning contexts, being invited and trained to exhibit their original works at student sessions and even at specialized conferences; there are many articles published together with the students. Graduates of this discipline are encouraged to show collaboration with other colleagues and teaching staff in carrying out teaching activities, during the courses. Graduates of this discipline are encouraged to demonstrate autonomy in organizing the learning situation/context or the problem situation to be solved, while solving individual homework. Graduates of this discipline are encouraged to show social responsibility through active involvement in the student social life/academic community, for example to become IEEE Student Members, to be members of student juries, etc. Graduates of this discipline are stimulated to promote new solutions, related to the specialized field, offering papers and being stimulated to continue them for Dissertation or even Doctorate. Graduates of this discipline are encouraged to be aware of the value of their contribution in the field of engineering to the identification of sustainable solutions to solve problems in social and economic life (social responsibility). Graduates of this discipline are encouraged to appreciate the analysis of the technological impact of the solutions proposed in the specialized field on the environment. Graduates of this discipline are encouraged to demonstrate real-life situation management skills such as managing time to collaborate on a common theme.

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.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and interactive conversational teaching methods, based on discovery learning models facilitated by direct exploration and indirect way of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.

In the teaching activity, lectures will be used, based on Power Point presentations or different videos that will be made available to students on the platforms indicated by UPB, such as Moodle or Teams. Each course will begin with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.

Presentations use images and diagrams so that the information presented is easy to understand and assimilate.

The Organic and Nano-composite Transistors discipline covers information and practical activities aimed at supporting students in their learning efforts and the development of optimal collaboration and communication relationships in a climate conducive to learning through the discovery of technical-scientific developments in the last 20 years in this field.

It will be considered the practice of active listening and assertive communication skills, as well as feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.

Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Presentation of the evolution of transistors on organic and nanocomposite films	4
2	Technologies generating nanocomposite materials and organic semiconductors	8
3	Transistors with nano-films including SOI and nanocomposites	8
4	Transistors with organic films	4
5	Techniques for simulating transistors with organic films	4
	Total:	28

Bibliography:
1. Moodle course materials website: https://curs.upb.ro/2021/course/view.php?id=9481#section-1
. 2. C. Ravariu, C. Pârvulescu, E. Manea, A. Dinescu, R. Gavrila, M. Purica, V. AroraDL IEEE-USA. Manufacturing of a Nothing On Insulator Nano-Structure with two Cr/Au Nanowires Separated by 18 nm Air Gap, Nanotechnology, 31(27), pp.1-9, 2020, (IOP Journal, ISSN: 0957-4484 Q1-Red zone /2020, IF=3.39), https://dx.doi.org/10.1088/1361-6528/ab7c45 SRI=3. WOS:000531248700001.=https://doi.org/10.1007/s10854-019-02851-3
. 3. C. Ravariu, D. Istrati, D. Mihaiescu, A. Morosan, B. Purcareanu, R. Cristescu, R. Trusca, B. Vasile, Solution for green organic thin film transistors: Fe3O4 nano-core with PABA external shell as ptype film, Journal of Materials Science - Materials in Electronics, 31(4), pp. 3063-3073, 2020, (Springer Journal, ISSN: 0957-4522, Q2-Yellow zone/2020, IF=1.9), https://doi.org/10.1007/s10854-019-02851-3 SRI=2.
. 4. Cristian Ravariu, Avireni Srinivasulu, Dan E. Mihaiescu, Elena Manea, Cătălin Parvulescu, Can metals replace semiconductors in a Nothing On Insulator nanotransistor?, Proceedings of the Romanian Academy Series A, vol. 21, no.3, pp. 255-261, 2020. IF=1.3, DOI-nu are!, WOS:000576257000008. ISSN: 1454-9069. Q3-zones. Aug-Sept 2020. SRI=1.
. 5. C. Ravariu. Vacuum nano-triode in Nothing-On-Insulator configuration working in Terahertz domain, IEEE Journal of the Electron Devices Society, 6(1), pp. 1115-1123, 2018, (IEEE Journal ISSN: 2168-6734, Q2-Yellow zone/2018, IF=2.69, DOI: 10.1109/JEDS.2018.2868465 SRI=1.7 WOS:000445354800001
. 6. C. Ravariu. Gate Swing Improving for the Nothing On Insulator Transistor in Weak Tunneling, IEEE Transactions on Nanotechnology, 16(6), pp. 1115 - 1121, 2017, (IEEE Journal ISSN: 1536-125X, Q2-Yellow zone/2017, IF=2), DOI: 10.1109/TNANO.2017.2764802 SRI=1.32
. 7. C. Ravariu. Deeper Insights of the Conduction Mechanisms in a Vacuum SOI Nanotransistor, IEEE Transactions on Electron Devices, 63(8), pp. 3278 - 3283, 2016, (IEEE Journal ISSN: 0018-9383, Q1-Red zone/2015 Q2-Yellow zone/2016, IF=2.2), DOI: 10.1109/TED.2016.2580180 SRI=1.69
. 8. Ravariu C., Manea E., Babarada F., et al, "Organic Compounds Integrated on Nanostructured Materials for Biomedical Applications", Chapter 2 at section Biomedical Engineering in the book:Smart Industry & Smart Education. Editors: Auer M., Langmann R., Series - Lecture Notes in Networks and Systems, vol 47, Jan 2019, pp 489-497, WOS:000455197300055, DOI:10.1007/978-3-319-95678-7_55, Publisher Name - Springer, Print ISBN 978-3-319-95677-0, Online ISBN 978-3-319-95678-7, ISSN: 2367-3370, https://link.springer .com/chapter/10.1007%2F978-3-319-95678-7_55
9. Cristian Ravariu, Dan Eduard Mihaiescu, Green Electronics starting from Nanotechnologies and Organic semiconductors, Chapter 1 in Book: Green Electronics, In-Tech Publisher House (London), with Editors: Cristian Ravariu & Dan E. Mihaiescu, Published June 2018, ISBN: 978-1-78923-304-9, pp. 3-13 DOI: 10.5772/intechopen.71456, ISBN: 978-1-78923-305-6, Print ISBN: 978-1-78923-304-9, available at: https://www.intechopen.com/books/green-electronics.

Bibliography:

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 fundamentally	A written exam in session	20%
	- knowing how to apply the theory to specific problems;	A written exam in session	20%
	- individual application during the semester, by solving a homework	A written exam in session	60%

11.5 Seminary/laboratory/project			
11.6 Passing conditions			
Obtaining 50% of the total score. Learning the classification and types of transistors with organic and nano-composite films The basic description of the functionality and applications of transistors made on SOI substrate.			

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)

Organic electronics has become an important component in the field of devices, passive and active circuits, with extremely wide applications in the technology of flat screens, organic LEDs and organic solar cells. In addition, it has a special potential for the industry in Romania, for now represented only at the level of research institutes for the design and development of O-TFT, instead with particular expansion to all mobile phone companies, tablets that use flat screens made in technology TFT. If TFT nanocomposites offer more precise technologies, on the other hand, the variants on organic support offer flexible, rollable substrate facilities, etc.

Therefore, the industry makes a lot of use of these modern electronic components and is expected to have an important demand for qualified engineers in the near future.

The course curriculum responds concretely to these current development and evolution requirements, subscribed to the European economy of services in the field of electronic engineering and telecommunications. In the context of the current technological progress of electronic devices, the targeted fields of activity are practically unlimited in the future.

In this way, the graduates are provided with adequate competences with the needs of the current qualifications and a modern, quality and competitive scientific and technical training, which will allow them to be employed quickly after graduation, the course being perfectly framed in the policy of the Politehnica University of Bucharest, both from the point of view of the content and structure, as well as from the point of view of the skills and international openness offered to the students.

Date	Course lecturer	Instructor(s) for practical activities
01.09.2024	Prof. Dr. Cristian Ravariu	Prof. Dr. Cristian Ravariu

Date of department approval	Head of department
31.10.2024	Prof. Dr. Claudius DAN

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