COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	University Politehnica of Bucharest
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Electronic Devices, Circuits and Architectures
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	Licence (engineering)
1.6 Program of studies/Qualification	Tehnologii şi Sisteme de Telecomunicaţii (în limba engleză)

2. Course identification information

2.1 Name of the course				Electronic Devices			
2.2 Lecturer				Prof.dr.ing. Gabriel DIMA			
2.3 Instructor for practical activities				As.dr.ing. Laurentiu TEODORESCU			
2.4 Year of studies	II	2.5 Semester	3	2.6 Evaluation type	Final Examination	2.7 Course choice type	Mandatory

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

3.1 Number of hours per week, out of which	5	3.2 course	3	3.3 practical activities	2
3.4 Total hours in the curricula, out of which	70	3.5 course	42	3.6 practical activities	28

3.7 Distribution of time	hours
Study according to the manual, course support, bibliography and hand notes	25
Supplemental documentation (library, electronic access resources, in the field, etc)	3
Preparation for practical activities, homework, essays, portfolios, etc.	5
Tutoring	0
Examinations	3
Other activities	0

3.8 Total hours of individual study	70
3.9 Total hours per semester	130
3.10 Number of ECTS credit points	5

4. Prerequisites (if applicable)

4.1 curricular	Electrotechnical Fundamentals, Physics
4.2 competence-based	General principles of quantum physics, electricity, mathematics, electric circuit analysis

5. Requisites (if applicable)

5.1 For running the course	None
5.2 For running of the applications	None

6. Specific competences

6.1 Professional competences	C1. Using of fundamental elements that refer to the electronic devices, circuits and instrumentation
6.2 Transversal Competences	Not applicable.

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	The course introduces the students the physics, electrical behavior and operating modes of the most important solid state devices: diodes, MOSFETs, JFETs and bipolar transistors. In order to understand the physical operation of these devices, basic concepts regarding semiconductor physics, the p-n junction theory and the MOS capacitor are presented.
7.2 Specific objectives	• Modeling of the devices by analytical equations and small signal equivalent circuits; • Simplified relations for model parameters suitable for hand calculations; • High frequency operation and thermal issues of the devices; • Several techniques for obtaining the *dc* operating point of the device • Different biasing methods and a large variety of *dc* circuits; • Analysis using static and small - signal for various diode circuits and configurations of single stage amplifiers with bipolar transistors, MOSFETs and JFETs.

8. Contents

8.1 Lectures	Teaching techniques	Remarks
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 1.7.3 Stationary and Quasi-Stationary Signals. Operation at high frequencies. The effect of internal capacities	Teaching is based on Power point slide-show lecture notes. Each slide is explained in detail by means of oral presentation. All course materials are available on-line on the course's website (Moodle – http://electronica.curs.pub.ro).	6 Hrs
2. Semiconductor Diodes 2.1 Diodes applications 2.2 *pn* Junction 2.2.1 Electrostatics of *pn* junction 2.2.2 Current voltage relationships 2.2.3 *pn* junction breakdown 2.2.4 Small signal modeling 2.3 *pn* Junction diode 2.4 Metal-semiconductor contact 2.5 Light-emitting diode (LED) 2.6 Thermal behavior of semiconductor diodes 2.7 Applications		9 Hrs

3. Junction field effect transistor(J-FET) 3.1 Field effect transistor concept. Classification 3.2 J-FET structure. Operation mode 3.3 Threshold voltage. Channel conductance 3.4 Current voltage relationships 3.5 J-FET modeling 3.6 Temperature dependence 3.7 Applications		5 Hrs
4. Metal Oxide Semiconductor (MOS) Field Effect Transistor 4.1 MOS capacitor 4.2 Enhancement MOS. 4.2.1 Structure. Channel inducing 4.2.2 Threshold voltage. Channel conductance 4.2.3 Operation modes 4.2.4 Current voltage relationships. 4.2.5 MOS transistor models 4.3 Depletion MOS. Structure and operation 4.4 Applications		10 Hrs
5. Bipolar transistor 5.1 Device structure. *npn* and *pnp* transistors 5.2 Transistor effect 5.3 Ebers-Moll equations 5.4 Operating modes. Configurations 5.5 Simplified modeling 5.6 Second order characteristics of transistor 5.7 Full modeling in forward active mode 5.8 High frequency transistor response 5.9 Transistor breakdown voltages 5.10Transistor temperature behavior 5.11 Comparison between bipolar junctions transistor and MOS transistor		12 Hrs

References

1) G. Dima, *Electronic Devices* – lecture notes (electronic), 2011.
2) R. Muller, T. Kamins, *Devices Electronics for Integrated Circuits*, Wiley and Sons, New York, 1988.
3) R. F. Pierret, G. W. Neudeck, *Modular Series on Solid State Devices*, Addison – Wesley, New York, 1990
4) P. R. Gray, P. J. Hurst, S. H. Lewis, R. G. Meyer, *Analysis and Design of Analog IC's*, ediţia 4, J. Whiley & Sons, 2001.
5) B. Razavi, *Design of Analog CMOS Integrated Circuits,* McGrawHill, 2001.
6) A. Sedra, K.C. Smith, *Microelectronic Circuits,*ediţia a 5-a, Oxford University Press, 2004.
7) Course entry on the Moodle eLearning platform: http://electronica.curs.pub.ro

8.3 Seminars	Teaching techniques	Remarks
Seminar1 - Electrons and holes. Extrinsic semiconductors. Semiconductor resistivity	Oral exposition. The teaching method used is problem-solving. Direct involvement of students in this process is stimulated. The main seminar materials are: lecture	2 Hrs
Seminar 2 – PN junction. Depletion region.		2 Hrs

Seminar 3 – PN junction. Current-voltage relationships.	notes and the "Dispozitive şî circuite electronice-Probleme" şi "Dispozitive electronice-Probleme" exercises books.	2 Hrs
Seminar 4 - Semiconductor diodes. Diode dc operating point.		2 Hrs
Seminar 5 - Diode circuits. DC and Small signal analysis		2 Hrs
Seminar 6 - JFET. JFET current sources.		2 Hrs
Seminar 7 - JFET amplifier stages. Common source.		2 Hrs
Seminar 8 - MOS transistor. MOS current sources.		2 Hrs
Seminar 9 - JFET and MOS amplifier stages. Common gate and common drain.		2 Hrs
Seminar 10 - JFET and MOS amplifier stages. Common source stage with source degeneration.		2 Hrs
Seminar 11 - Bipolar transistor. Device DC operating point. Bias circuits.		2 Hrs
Seminar 12 – Bipolar transistor current sources.		2 Hrs
Seminar 13 - Bipolar transistor amplifier stages. Common emitter and emitter degeneration.		2 Hrs
Seminar 14 - Bipolar transistor amplifier stages. Common base and common collector.		2 Hrs

References

1) G. Brezeanu, G. Dilimoţ, F. Mitu, F. Drăghici, *Dispozitive electronice-Probleme* , Ed. Rosetti Educaţional, Bucureşti, 2009.
2) P. R. Gray, P. J. Hurst, S.H.Lewis,R.G.Meyer, *Analysis and Design of Analog IC's*, ediţia 4, Whiley & Sons, 2001.
3) D. Dascălu et all, *Dispozitive şi Circuite Electronice – Probleme*, Ed. Didactica şi Pedagogică, 1982.
4) Course entry on the Moodle eLearning platform: http://electronica.curs.pub.ro.

9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

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.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	1. Knowledge of fundamental theoretical concepts; 2. Knowledge of using theory to solve specific problems; 3. Understanding and use of model parameters and equivalent circuits for diodes, field effect and bipolar transistors.	A written midterm test, which covers 50% of the lecture, focusing both on theoretical knowledge evaluation and solving problems that illustrate semiconductors use in devices fabrication and the operation of *pn* junction and diodes in specific electronic circuits.	40%
		Final examination, with the possibility of retaking the midterm test. This exam is focused both on theoretical knowledge evaluation and solving problems that illustrate operation and parameters of field effect and bipolar transistors, in specific single transistor amplifiers.	40%
10.5 Seminars	Understanding and use of established models for diodes, field effect and bipolar transistors in specific circuits.	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 semiconductor physics and specific circuits with diodes, field effect and bipolar transistors.	20%
10.6 Minimal performance standard			
• Acquiring a minimum score of 50% of the points allocated for the activities seminar/course. • Acquiring a minimum score of 50% for the midterm test and a minimum of 50% for the final examination.			

Date, 11.09.2017

Lecturer, Prof.dr.ing Gabriel DIMA

Instructor for practical activities, As.dr.ing. Laurentiu TEODORESCU

Date of department approval, 18.09.2017

Head of Department, Prof.dr.ing. Claudius DAN