UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2020/2021
BACHELOR'S DEGREE (BSC)	ELECTRONICS ENGINEERING
SUBJECT	ELECTRONIC DEVICES
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50287-Ingegneria elettronica
CODE	02647
SCIENTIFIC SECTOR(S)	ING-INF/01
HEAD PROFESSOR(S)	BUSACCA ALESSANDRO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	153
COURSE ACTIVITY (Hrs)	72
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**BUSACCA ALESSANDRO** Monday 16:00 18:00 Laboratorio U 330

DOCENTE: Prof. ALESSANDRO BUSACCA

PREREQUISITES	Good knowledge of the analysis techniques for lumped parameters circuits for sinusoidal and pulsed regime, that students have acquired in the Electrotechnics course. Good knowledge of vector calculus and phasors. Basic knowledge of differential and integral calculus. Notions of Mathematics, Physics I and II
LEARNING OUTCOMES	Knowledge and comprehension capacity •At the end of the course, the student will have acquired knowledge of material properties and on the working principle of the most widely used electronic devices. In particular, the student will be able to understand set of problems such as the functions of the circuits in various working modes, and the fabrication technologies of both discrete and integrated devices. Ability to apply the acquired knowledge • The student will be able to apply the acquired knowledge on the working principles of semiconductors and of devices: a) to characterize semiconductor materials; b) to solve simple circuital problems typical of electronic engineering to obtain specific performances (signal amplification, simple digital functions and so on); c) to carry out the analysis of circuits containing electronic devices applying proper analytical methods and models. Ability to evaluate scenarios •The student will be able to understand the specifications provided by electronic devices manufacturers, to gather the data needed to evaluate the performances and to perform results analysis comparing device parameters. Finally, the student will be able to collect data needed to design the most widely used applications of the devices. Communication skills • The student will be able to: communicate and express in group projects problems related to the topics covered during the course. The student will be able to sustain conversation on topics related to the selection of semiconductor material and devices for a specific purpose, to underline problems related to their operating limits and to offer solutions. Learning ability • The student will have learned the interactions between devices physics and their employment in the most common applications. This will allow the student to go on the engineering studies in the Electronics field with a greater autonomy and discernment.
ASSESSMENT METHODS	Midterm examinations or Written final exam, Oral examination The learning evaluation will be carried out by means of midterm examinations all along the course duration and a final oral examination. The midterm examination will deal with topics covered during the course. Alternatively, the student that will not reach a sufficient score (minimum 18 out of 30) in the midterm examinations, will have to take a written examination that will also deal with topics covered during the course. Also in this case, the minimum score needed to pass the written test will be 18 out of 30. The final oral examination consists in the request to the student to discuss some topics covered during the course by the teacher. For each topic, the student will first have to contextualize the subject within the course, describe its meaning and importance, for example by means of formal definitions and scope of applications, and define the study methods and eventually the validity limits. Finally, the student will have to discuss the topic by a correct use of language and a fluent analytical treatment. The aim of the final examination will be to evaluate whether the student has a good knowledge and comprehension of basic electronic devices, circuits and systems and of their potential applications in the field of electrical engineering. At the end of the exam, the examination committee informs the student whether he/she has passed the exam. If the examination has been passed, the committee gives the final result to the student based on the following evaluation criteria: a) level of knowledge of the topics discussed during the oral examination, and the capacity of autonomously interconnecting such topics to other covered during the course (90% of the final grade); b) obtained level in the capacity of expressing correctly in the technical language of the subject (10% of the final grade).
EDUCATIONAL OBJECTIVES	The course provides the basic knowledge on the operation and on the characteristics of semiconductor electronic devices that are employed in analogue and digital electronics.
TEACHING METHODS	Frontal lectures and tutorials; Laboratory tutorials
SUGGESTED BIBLIOGRAPHY	•R.S.Muller and T.I.Kamins, Device electronics for integrated circuits (John Wiley, 1977). •G. Giustolisi e G. Palumbo, Introduzione ai dispositivi elettronici (Franco Angeli, 2005)

SYLLABUS

Hrs	Frontal teaching
1	Introduction to Electronics in the Information Engineering field.
1	Atomic physics. Energy levels and energy bands for solids.
5	Semiconductors. Mobile carriers and concentrations in thermal equilibrium condition. Drift conduction. Mobility. Diffusion and diffusion current. Non-equilibrium conditions.
4	Characterization of semiconductors. p-n junction at equilibrium and when biased. I-V characteristics of a junction diode. Capacitive effects. Circuits with one or more diodes. Diode switching times.
4	Power supplies: block diagrams. Half-wave and full-wave rectifier. Diode bridge rectifier. Zener diode: characteristic and parameters. Zener diode used as voltage regulator: Zener voltage, maximum power and minimum current. Tunnel diode. Tunnel effect. Tunnel characteristic and combination with the normal characteristic. Negative resistance. Stable and non-stable points.
2	Metal-semiconductor junction: band diagram, barrier capacitance and methodologies for extracting the doping concentration using capacitance measurements. Schottky diodes. Ohmic M-S junction
1	Semiconductor materials technologies. Epitaxial growth and planar technology. Photolitographic techniques. Impurity diffusion and ion implantation.
4	Three-terminal devices: FET and BJT. Types of FET transistors: JFET, MESFET and MOSFET. JFET analysis and characteristics. Bias circuits, small-signal equivalent circuit model and circuit functions.
6	MOS structure: band diagrams. MOSFET analysis and working principle. Bias circuits, small-signal equivalent circuit model and circuit functions. CMOS technology: logic inverter.
9	BJT transistor: input and output characteristics for common base and common emitter configurations. BJT parameters. Early effect. Bias circuits. Low-frequency and high-frequency small-signal equivalent circuits. Circuit functions with BJT stages: amplification and impedance matching. Cascode and Darlington configurations.
2	Integrated circuits biasing. Current mirror and differential amplifiers.

Hrs	Practice
6	Characterization of semiconductors. p-n junction at equilibrium and when biased. I-V characteristics of a junction diode. Capacitive effects. Circuits with one or more diodes. Diode switching times.
3	Half-wave and full-wave rectifier. Diode bridge rectifier. Zener diode: characteristic and parameters. Zener diode used as voltage regulator: Zener voltage, maximum power and minimum current. Tunnel diode. Tunnel effect. Tunnel characteristic and combination with the normal characteristic. Negative resistance. Stable and non-stable points.
9	Three-terminal devices: FET and BJT. Types of FET transistors: JFET, MESFET and MOSFET. JFET analysis and characteristics. Bias circuits, small-signal equivalent circuit model and circuit functions.
6	BJT transistor: input and output characteristics for common base and common emitter configurations. BJT parameters. Early effect. Bias circuits. Low-frequency and high-frequency small-signal equivalent circuits. Circuit functions with BJT stages: amplification and impedance matching. Cascode and Darlington configurations.

Hrs	Workshops
3	Diodes.
6	Three-terminal devices.