UNIVERSITÀ DI PAVIA

Anno Accademico 2019/2020

INTEGRATED CIRCUIT DEVICES	
Anno immatricolazione	2019/2020
Anno offerta	2019/2020
Normativa	DM270
SSD	ING-INF/01 (ELETTRONICA)
Dipartimento	DIPARTIMENTO DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE
Corso di studio	ELECTRONIC ENGINEERING
Curriculum	Microelectronics
Anno di corso	1°
Periodo didattico	Secondo Semestre (02/03/2020 - 12/06/2020)
Crediti	9
Ore	74 ore di attività frontale
Lingua insegnamento	Italian
Tipo esame	ORALE
Docente	CASTELLO RINALDO (titolare) - 9 CFU
Prerequisiti	The knowledge of the subjects included within the course Quantum Mechanics is required to successfully follow the lectures of the course Integrated Circuit Devices
Obiettivi formativi	The course has the overall objective to provide the students that will attend it an in dept knowledge of the physical mechanisms that define the operation of the more relevant solid-state electronic devices. Starting from a basic knowledge in quantum mechanics and statistical mechanics the student will acquire a detailed understanding of the analytical circuit model that describe the behavior of such devices including an introduction to the numerical model used by circuit simulators. To provide a knowledge that is both reasonably broad and of practical value for the future career of the students, the course will concentrate on the more largely used devices i.e. those available within both Bipolar and CMOS integrated circuit technologies.

Programma e contenuti	The course will build upon the knowledge acquired in the course on Solid State Semiconductor Physics to derive the analytical and circuit model of the more relevant solid state electronic devices. Below is a short list of covered topics. Review of the physics background To ensure a smooth transition between the know how already acquired by the students and the new material presented, the course starts with a review of the key point of the Semiconductor device physics course. Metal Semiconductor junction: Unique value of the Fermi Level in Thermal Equilibrium for a generic structure (even non-uniform). Criteria for the derivation of the band diagram of the Metal Semiconductor junction. Voltage-current relationship for a M-S junction in forward and reverse bias condition. Simplified and analytical analysis. Different types of Ohmic contacts. Surface effects. p-n junction Non-uniform doping in a semiconductor material. Reverse biased p-n junction. Forward biased p-n junction, current-voltage characteristic. Charge storage and transient analysis. Small and large signal model of the p-n junction (diode). Bipolar Junction Transistor BJT Transistor effect and Linking Current. Ebers–Moll model. Models used in circuit simulators (e.g. SPICE). Description of a BJT within an integrated circuit. Early effect. Very low and very high injection levels. Kirk and Webster effects. Charge control model and its use for transient analysis. Small signal model (“pi” model). MOS Structure Capacitance-voltage characteristic of the two terminal MOS structure. Possible surface condition: accumulation, depletion and inversion. Flat-band voltage. Three terminal MOS structure. Threshold voltage and surface mobile charge density versus the three terminal voltages. MOS transistor Current-voltage characteristic of the 4 terminal MOS structure. Small signal and large signal model for the MOS transistor. Second order effects: short and narrow channel devices, sub-threshold conduction, high field (vertical and horizontal) effects and scaling laws. JFET Transistor Current–voltage characteristic of the JFET using the same assumptions used for the MOS Transistor
Metodi didattici	Lectures (hours/year in lecture theatre): 51 Practical class (hours/year in lecture theatre): 15 Practical workshops (hours/year in lecture theatre): 20 Lecture are done with the use of the black-board without the use of transparencies Practical Classes are done with the use of the black board to review

	prerequisites and weekly to verify the level of understanding of the explained material Practical/workshops are done using the circuit simulator on the computer to evaluate the device behavior in different operating conditions
Testi di riferimento	The adopted text book is written in English and is the following R.S. Muller and T.I. Kamins Electronics for Integrated Circuits Second Edition. John Wiley & Sons New York. The course cover from Chapter 3 to the end. The last chapter is useful but not required to pass the exam. Chapter 1 can be used as a review of the background material.
Modalità verifica apprendimento	The exam consists of an oral evaluation divided in two parts. The first on the model and characteristics of the Bipolar transistor and the second on the characteristics and model of the MOS transistor. Each of the two parts of the exam produce a score of up to 32 points. The overall score is obtained taking the average of the scores obtained in the two parts. If such an average is above 30 the final score will 30 cum laude.
Altre informazioni	The exam consists of an oral evaluation divided in two parts. The first on the model and characteristics of the Bipolar transistor and the second on the characteristics and model of the MOS transistor. Each of the two parts of the exam produce a score of up to 32 points. The overall score is obtained taking the average of the scores obtained in the two parts. If such an average is above 30 the final score will 30 cum laude.
Obiettivi Agenda 2030 per lo sviluppo sostenibile	$lbl_legenda_sviluppo_sostenibile