UNIVERSITÀ DI PAVIA

Anno Accademico 2018/2019

INTEGRATED CIRCUIT DEVICES

Anno immatricolazione	2018/2019
Anno offerta	2018/2019
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 (06/03/2019 - 14/06/2019)
Crediti	9
Ore	74 ore di attività frontale
Lingua insegnamento	Italian
Tipo esame	SCRITTO E ORALE CONGIUNTI
Docente	CASTELLO RINALDO (titolare) - 9 CFU
Prerequisiti	Semiconductor Device Physics
Obiettivi formativi	The course is based upon the knowledge of the physical mechanisms that define the operation of the more relevant solid state electronic devices. Starting from this foundation the student will acquire a detail knowledge of the analytical circuit model that describe the behavior of such a devices including an introduction to the numerical model used by circuit simulators. 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 background know how and the new material presented, the course starts with a review of the key point of the Semiconductor device physics course.

Metal Semiconductor junction:
Uniformity of the Fermi Level in Thermal Equilibrium fear a generic structure (even non uniform). Criteria for the definition of the band diagram of the MS junction. Voltage- current relationship for a MS 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. Model of the p-n junction (diode) in the various operating regions.

Bipolar transistor BJT
Transistor effect. Ebers –Moll model. Overview of the models used by the circuit simulators (e.g. SPICE). Desription of a BJT transistor within an integrated circuit. Early effect. Very low and very high injection levels. Kirk effect and Webster effect. Charge control model and use of the model for the 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 MOS structure. Small signal and large signal model for the MOS transistor. Second order effects: short and narrow channel devices and sub-threshold conduction.

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
Practicals / 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
Practicals/workshops are done using the circuit simulator on the computer to evaluate the device behaviour 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 in a oral evaluation divided in two parts. The first deals with the characteristics and model of the Bipolar transistor and the second with the characteristics and model of the MOS transistor.
Altre informazioni	The exam consists in a oral evaluation divided in two parts. The first deals with the characteristics and model of the Bipolar transistor and the second with the characteristics and model of the MOS transistor.
Obiettivi Agenda 2030 per lo sviluppo sostenibile	$lbl_legenda_sviluppo_sostenibile