Course program

Introduction to Electronics

Signals. Frequency spectrum of signals. Analog and digital signals. Amplifiers and their circuit models. Frequency response of amplifiers. Single-time-constant networks.

Operational Amplifiers

Ideal Operational Amplifier: definition, characteristics, inverting and non-inverting configurations. Difference amplifier. Integrators and Differentiators. Real operational amplifier.

Diodes

Ideal diode. Voltage-current characteristic: the forward-bias region, the reverse region, the breakdown region. Modeling the diode forward characteristic. Small signal model and applications. Zener diode. Rectifier circuits: half-wave rectifier, full-wave rectifier, bridge rectifier, precision half-wave rectifier (super diode). Limiting and clamping circuits.

MOS field effect transistors (MOSFET)

Device structure and physical operation of the enhancement and depletion MOSFETs. Current-voltage characteristics: circuit symbols and characteristics of the MOSFETs. Continuous analysis of MOSFET circuits. MOSFET as an amplifier. Biasing in MOS amplifier circuit. Small-signal operation and models. Fundamental configurations of MOSFET amplifiers with resistive and active load. Single-stage MOS amplifiers. MOSFET High frequency model. Frequency response of single-stage amplifier.

Bipolar junction transistors (BJT)

Device structure and physical operation: operation of the *pnp* and *npn* transistors in the active mode. Current-voltage characteristics: continuous analysis of transistor circuits. BJT transistor as an amplifier. The polarization of the BJT amplifier circuits. Small-signal operation models. Single-stage BJT amplifiers. High frequency model of BJT. Frequency response of single-stage amplifiers.

Digital circuits

Introduction to digital electronics. Fundamentals of digital electronics: logical inverter as a fundamental binary element. Elementary logic gates. Transfer characteristic of a logic inverter. Nominal logical levels. Noise margins. Propagation time. Power dissipation. Propagation delay.

Integrated circuit technologies

Moore's law: scales of integration of integrated circuits. Silicon: main material in electronic and optical devices. Processes P-N junction realization. Oxidation, Deposition (CVD, PVD - Electron beam), Lithography and photolithography. X-ray and electron beam lithography. Etching: Dry and wet etching. Doping. Implantation. MOS, nMOS and CMOS process.

MOS transistor

MOS transistor structure. Threshold voltage and current-voltage characteristics. Capacity and mapping of the MOS device.

NMOS logic ports

NMOS inverter with resistive load. MOS devices as active loads. Inverters with active NMOS load. Transfer characteristics and logical levels. Noise margins and minimization of the inverter area. Circuit capacity, dynamic analysis and propagation times. Power dissipated. NMOS elementary logic gates.

CMOS logic ports

CMOS inverter, transfer characteristics and noise margins. Dynamic behavior and propagation times. dissipated power. CMOS elementary logic gates. Fan-in and Fan-out of CMOS ports. Output separator stages. Scale reduction of CMOS circuits.

Advanced logic circuits

Input/output interconnect circuits. Gates A-O-I. Combining circuits. Gates NOR, NAND, XOR. Adders and subtractors circuits. Circuit comparators. Encoders and decoders circuits. Multiplexer circuits with demultiplexer. Sequential circuits. Bistable circuits. SR Bistable. Synchronized flip-flops. JK flip-flop. Master-Slave flip-flop. D-T flip-flop.

Programmable logic circuits

Introduction. Programmable Logic Arrays (PLA), PAL Devices. Logic in two steps. Programmable door matrices (FPGA). Programming techniques.

Semiconductor memories

Classification of semiconductor memories (volatility, versatility, access). Non-volatile memories. Examples of ROM read-only memories and reprogrammable EPROM memories. Reading and writing memories (RAM). Elementary cells for static RAM (SRAM). Reading and writing circuits. Organization of RAM memories.