Chapter 3:
SEMICONDUCTOR DEVICES & INTEGRATED-CIRCUIT TYPES

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Chapter 3: Semiconductor Devices & Integrated-Circuit Types

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INTEGRATED CIRCUIT RESISTORS

(a) & (b) Diffused Integrated-Circuit Resistors

(c) Thin-Film Integrated-Circuit Resistor
INTEGRATED CIRCUIT CAPACITORS

Formula used to calculate the capacitance, C, of a parallel-plate capacitor, in terms of the area of the plates (A), the dielectric that separates the the plates (k), and the distance between the plates (d).

Sequence of steps used to fabricate a planar, MOS-capacitor structure.
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**pn-Junction Diodes**

- **pn-Junction Diode**: (a) Valve analogy; (b) Circuit Symbol; (c) Schematic drawing of; (d) IV-curve of *pn*-diode

- **pn-Junction Diode with**: (a) no externally-applied bias; (b) forward-bias; (c) reverse-bias.

- **Junction potential under**: (a) no bias; (b) forward-bias; (c) reverse-bias
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Bipolar Junction Transistors (BJTs)
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Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs)

Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs)
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Types of Integrated Circuits (ICs): Analog ICs & Digital ICs

Example of a circuit schematic of one type of analog IC (Operational Amplifier)

Example of a digital IC (Photograph of a Pentium4 microprocessor - Courtesy of Intel Corp.)
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Types of Integrated Circuits: Random-Access Memories (RAMs) & Static RAMs (SRAMs)

Schematic of the random access memory array-structure

SRAM: (a) Schematic of an SRAM cell; and (b) Layout of an SRAM cell
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**Types of ICs: Dynamic RAMS (DRAMs)**

(a) Trench-capacitor DRAM-cell; (b) Stacked-capacitor DRAM-cell

Single-transistor DRAM-cell with storage capacitor: (a) Circuit schematic; (b) Cell Layout; (c) Cross-section through A-A
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Summary of Key Concepts

• A *monolithic* (single-stone) integrated circuit consists of many circuit components all fabricated on a single piece of silicon (a *chip*), including:
  • Resistors
  • Capacitors
  • *pn* Diodes
  • Bipolar Junction Transistors
  • Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs)

• Integrated-Circuit Types include:
  • Analog ICs
  • Digital ICs (Microprocessors)
  • Application Specific ICs (ASICs)
  • Memory ICs (DRAMs, SRAMS, EPROMs)