Handout (1): **Microelectronics**

Microelectronics: sometimes referred to as solid state electronics which are semi-conductor based devices, and this is the science that made integrated circuits (ICs) possible.

Engineers and their Roles:

- Process Engineers: They are responsible for ensuring a high yield and repeatability of a certain process, and they are also responsible for equipment maintenance.
- Product Engineers: They are responsible for implementing a process sequence while ensuring that each component meets the specifications, and they also carry out the failure analysis.
- Design Engineers: They are responsible for the layout of the components on a chip to meet certain specifications.

Historical Background:

- Origins: The transistor was invented in 1947 in a failed attempt at bell laboratories to create another device. Furthermore, bipolar transistors were made in 1951, while MOS transistors were made in 1960, and both are still dominating the market. Also, early transistors and diode were made as discrete devices (.i.e. one piece of semi-conductor contains one device).
- Development of ICs: The idea of integrated circuits was first suggested in 1952, but it came to fruition when Jack Kilby of Texas Instruments produced the first IC in 1958. An integrated circuit is defined as follows: “a series of interconnected diodes, resistors, transistors, and capacitors, etc., all on one piece of semi-conductor.
- Shrinkage: To increase the function density, researches in shrinking devices dimensions were conducted. Thus, the number of transistors on a chip increase exponentially in the first 20 years. This trend was coined as Moore’s law as it was predicted in 1960 by Gordon Moore. However, since 1985 the exponential increase has slowed down.

ICs and their Categories: Integrated chips usually are categorized according to the number of transistors per chip, most of ICs could be categorized as follows:

Categories	Transistors Per Chip	Development Period
Small scale integration	<100	1960’s
Medium scale integration	100-1000	Early 1970’s
Large scale integration	1k-100k	Late 1970’s – Early 1980’s
Very large scale integration	>100k	Mid 1980’s and onwards

Advances in computing: with the increase of function density, the first microprocessor came to be true in 1971 – by definition a microprocessor is " a central processing unit (CPU) on a single chip" – It is known as intel 8008, it came with Intel 1103 which is a 1 Kb RAM, and that was outstanding at the time.

The processor was a 4-bit processor, and it sparked the start of the march towards faster and smaller microprocessors, by the 1980's the norm was 16-bit microprocessor and 64k RAM, and till now the field is still advancing as most computers and workstations nowadays have 32-bit processors and 4GB of RAM.

Modern semi-conductor businesses:

- Integrated Device Manufacture: companies like Intel, Toshiba, and Samsung as they operate their own fabrication facilities and sell their integrated circuits.
- Silicon Foundry: Typically operates a Silicon wafer processing line and sells fabrication services.
- Fabless Chip Vendor: Typically sells proprietary integrated circuits, but buys its fabrication services from a Silicon foundry (.e.g. NVIDIA).
- Virtual Component Vendor: They develop IC Architecture and license this to both traditional and fabless IC vendors.

Semi-conductor devices:

- Light Emitting Diodes (LED's): Used in displays.
- Lasers: Used in fibre optics communication, and CD players.
- Photodetectors: Used in infra-red images.
- Solar cells: Used as power sources.
- Microwave devices: Used in microwave communication.

Notes:

Silicon doesn't make good lasers or red light.

Germanium is better than Silicon in solar cells.

Microwave devices are regarded as high frequency devices.