Highlights of *Fundamentals of Microelectronics*

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1 Introduction to Microelectronics

### Voltage Gain

*Voltage gain* $A_v$ in a voltage amplifier:

$$A_v = \frac{v_{out}}{v_{in}}.$$  \hspace{1cm} (1)

Expressed in decibels (dB):

$$A_{v\text{dB}} = \frac{v_{out}}{v_{in}}.$$  \hspace{1cm} (2)

### Kirchoff’s Laws

*The Kirchoff Current Law (KCL).*

The sum of all currents flowing into a node is zero:

$$\sum_{j} I_j = 0.$$  \hspace{1cm} (3)

*The Kirchoff Voltage Law (KVL).*

The sum of voltage drops around any closed loop in a circuit is zero:

$$\sum_{j} V_j = 0.$$  \hspace{1cm} (4)

### Thevenin and Norton Equivalents

*Thevenin’s theorem.* A linear one-port network can be replaced with

- The equivalent voltage $v_{\text{Thev}}$ can be calculated by
- The equivalent impedance $Z_{\text{Thev}}$ can be determined by

*Norton’s theorem.* A linear one-port network can be replaced with

- The equivalent current $i_{\text{Nor}}$ can be obtained by
- The equivalent impedance $Z_{\text{Nor}}$ can be determined by
Note that $Z_{\text{Thv}} = Z_{\text{Nor}}$.

2 Basic Physics of Semiconductors

Bandgap Energy

The bandgap energy $E_g$ is

$$E_g = 1.12 \text{ eV} \quad (1 \text{ eV} = 1.6 \times 10^{-19} \text{ J})$$

Electron Density (Charge Carrier Density)

The density of electrons $n_i$, i.e., the number of electrons per unit volume is

$$n_i = 5.2 \times 10^{15} T^{-3/2} \exp\left(-\frac{E_g}{2kT}\right) \text{ cm}^{-3}.$$ (5)

where $k = 1.39 \times 10^{-23} \text{ J/K}$ is the Boltzmann constant.