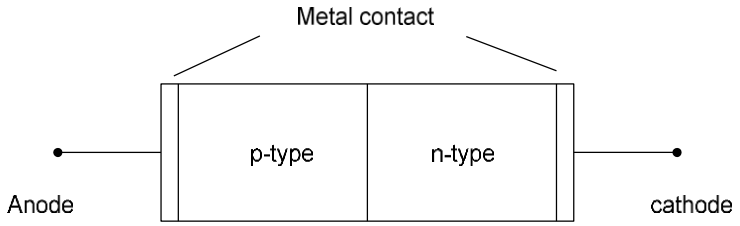
# BASIC ELECTRONIC CIRCUITS

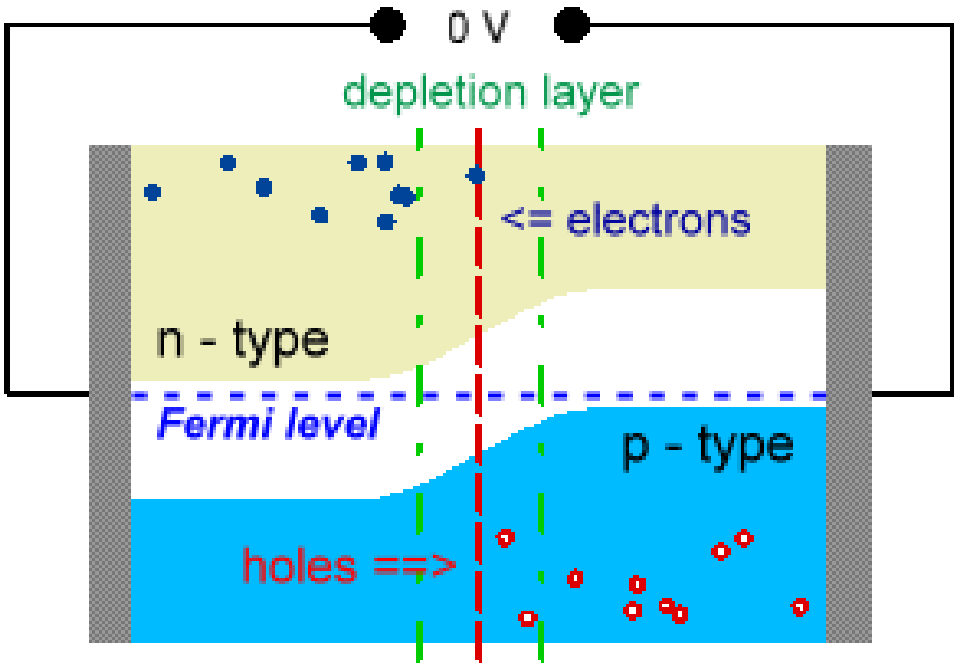
INSTITUTE CORE

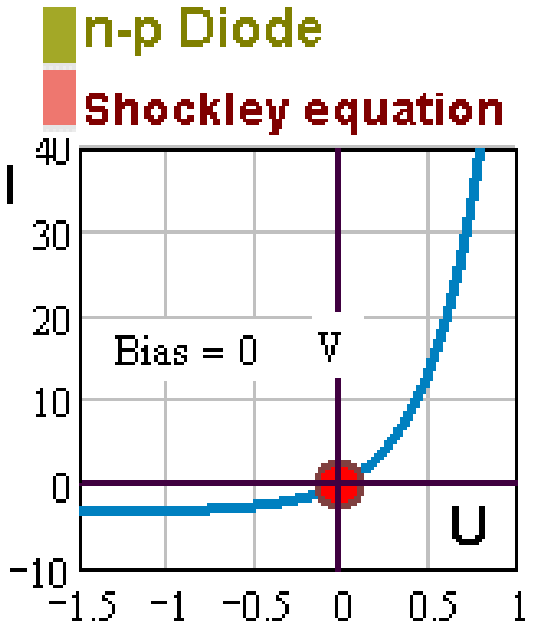
# PN junction with open-circuit terminals

- pn junction is a practical semiconductor structure.




- Typically, p and n regions are part of the same silicon crystal, by creating regions of different doping (p and n regions)
- External contacts are made to the p and n regions through metal.
- Terminals of the pn junction are labeled as anode and cathode.



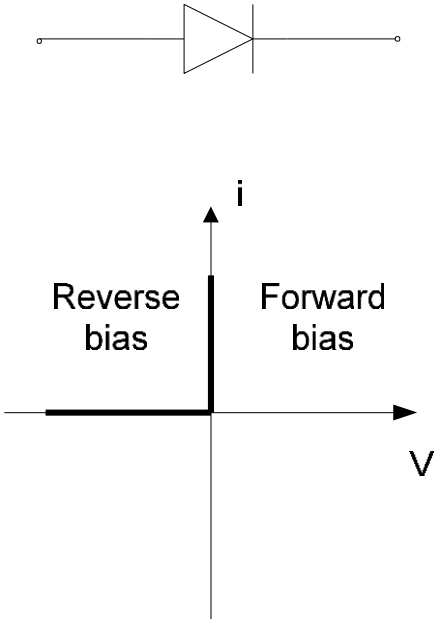

*We create a p-n junction by joining together two pieces of semiconductor, one doped n-type, the other p-type.*

# Diodes

- A simple and fundamental nonlinear circuit element
- has nonlinear i-v characteristics
- Application of the nonlinear elements in generating:
  - DC voltage from AC voltage, rectifier circuits.
  - Signals of various waveforms
  - Digital logic and memory circuits

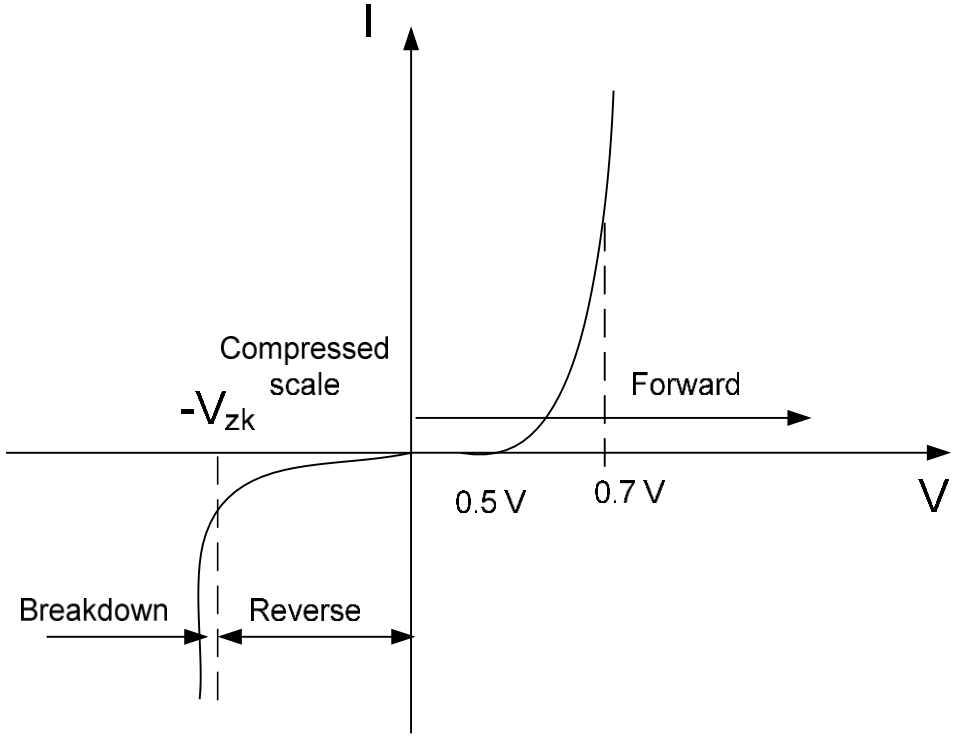
# The Ideal Diode

- The most fundamental nonlinear circuit element.
- For –ve voltage, no current flows and the diode behaves as open circuit, then the diode operation mode is said to be reverse biased.
- It has '0' current in the reverse operation, and said to be "cut-off" or "off".
- If a +ve current is applied, 0 voltage drop appears, it behaves as a short circuit in forward direction.
- A forward-biased circuit is said to be "turned on" or "on".



# Terminal characteristics of a junction diodes

- The most common implementation of the diode utilizes a pn junction.
- PN junction can conduct substantial amount of current in forward direction and almost no current in the reverse direction.
- i-v char. of pn junction has three regions:
  - Forward $V > 0$
  - Reverse $V < 0$
  - Breakdown $V < -V_{zk}$



# The forward region $I = I_s \left( e^{V/nV_T} - 1 \right)$

- n varies between 1 and 2, depending on material and physical construction.
- $I_s$ is constant for given diode for given temp., Saturation current, scale current-> due to directly proportional to the cross-sectional area of the diode.
- $I_s$ is very strong funct ion of temp., of the order of $10^{-15}$ A, it gets double for each 5 °c rise in temperature.
- The voltage ($V_T$) is a thermal voltage = kT/q.
- At room temp. (20 °C), $V_T$ = 25.3 mV.
- the exponential relation of the current i to the voltage V holds over many decades of the current ($10^7$), remarkable property of junction diodes.

$$V = V_T \ln \frac{I}{I_s}$$

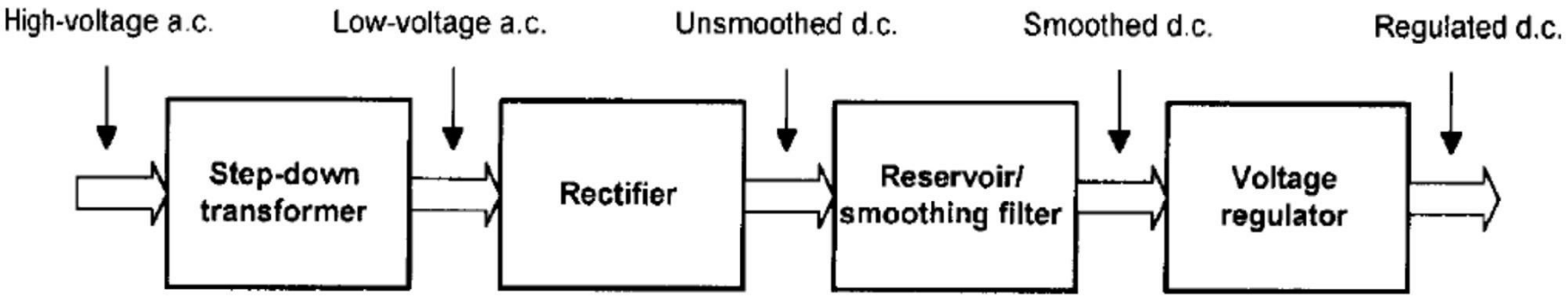
# The reverse bias region

- In the RB region, the diode voltage is made negative.
- For V negative and few times grater than thermal voltage, leads to corresponding exponential function becomes much less than unity.
- $i = -I_s$.
- Real diodes exhibit reverse currents that though quite small, and much larger than $I_s$.
- Large part of the reverse current due to leakage effects, and they are proportional to junction area, the reverse current gets double for every 10 deg. Rise in temp.

# The Breakdown region

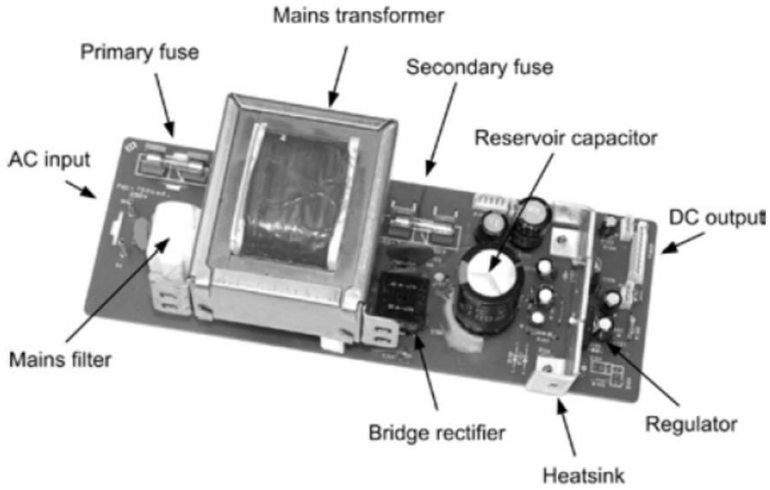
- The magnitude of the reverse voltage exceeds a threshold value that is specific to the particular diode breakdown voltage.
- This is the voltage at the 'knee' of the i-v curve, and is denoted by $V_{zk}$.
- In the breakdown region the reverse current increases rapidly with the associated increase in voltage drop being very small.

# DC Power Supply:




Block diagram of a dc power supply.

- Power supply is fed from the $V_s$ volts ac line, and it delivers a dc voltage $V_o$ to an electronic circuit called load.
- $V_o$ required to be as constant as possible in spite of variations in the ac line voltage and current drawn by the load.



# Thank You