Semiconductor Diode

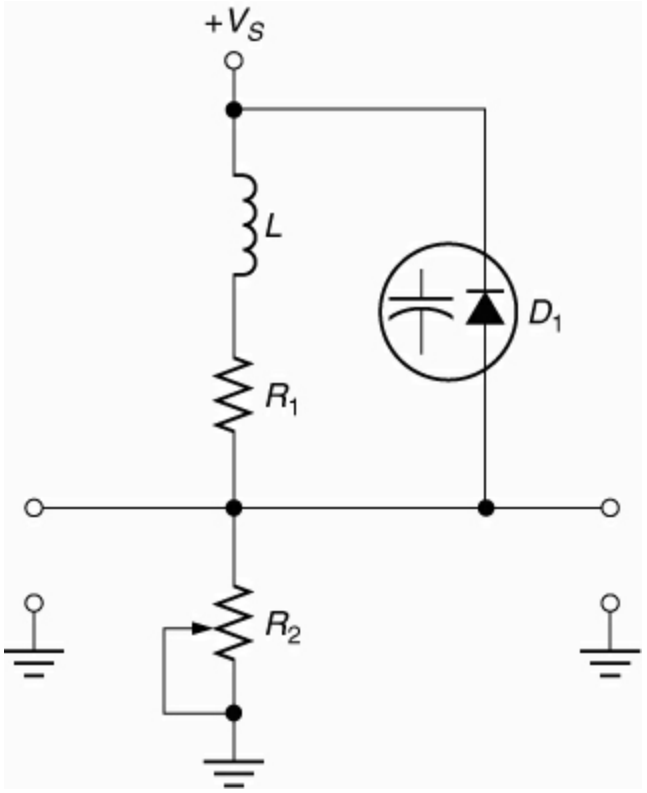
Varactor Specifications

- Diode capacitance temperature coefficient (TC_C) – The amount by which varactor capacitance changes with changes in temperature.
  - Temperature has little effect on the capacitance rating of most varactors.
- Diode capacitance (C_t) – The rated value (or range) of C for a varactor at a specific value of V_R.
- Capacitance ratio (C_R) – The factor by which C changes from one specified value of V_R to another.

Varactor-Tuned LC Circuit

- The varactor acts as a voltage-controlled capacitance.
  - The R_2 setting is varied to adjust varactor capacitance.
- The varactor capacitance determines (in part) the resonant frequency of the LC circuit.

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

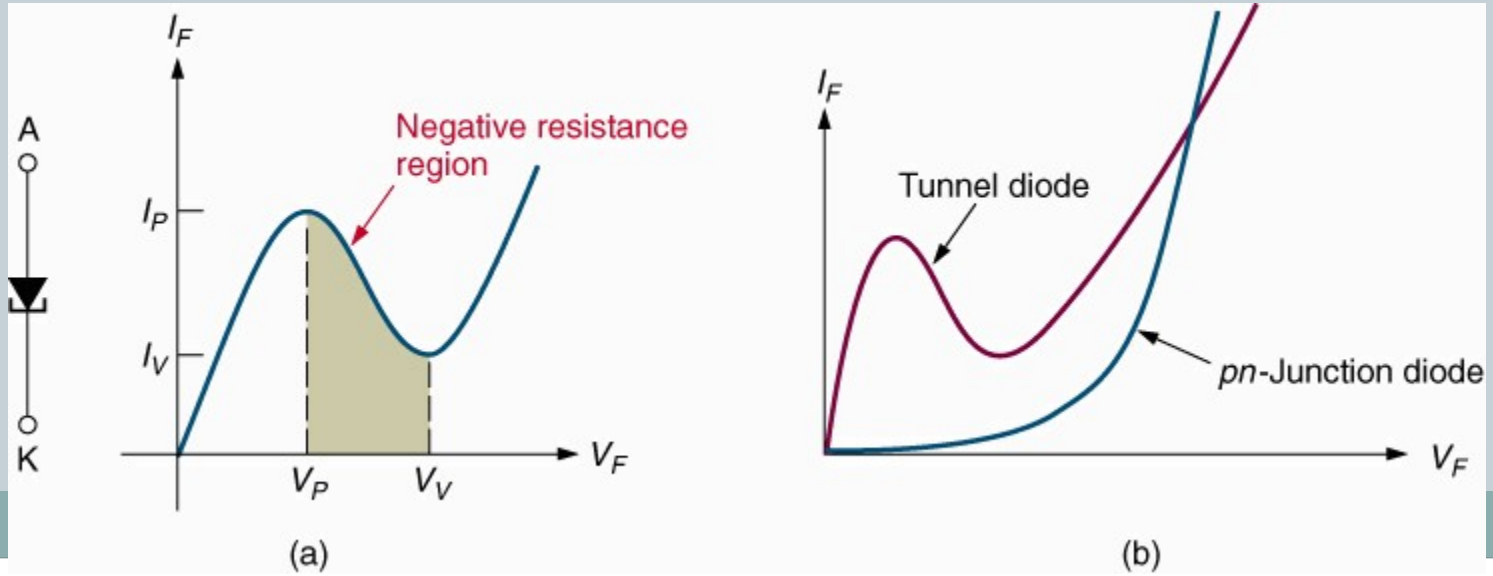


Tunnel Diodes

- Tunnel diodes are heavily-doped, making them suitable for use in high-frequency communications circuits.
  - They are commonly used in ultra-high frequency (UHF) circuits. UHF circuits operate in the range of 100 MHz to GHz.
  - Tunnel diodes exhibit a property referred to as negative resistance.

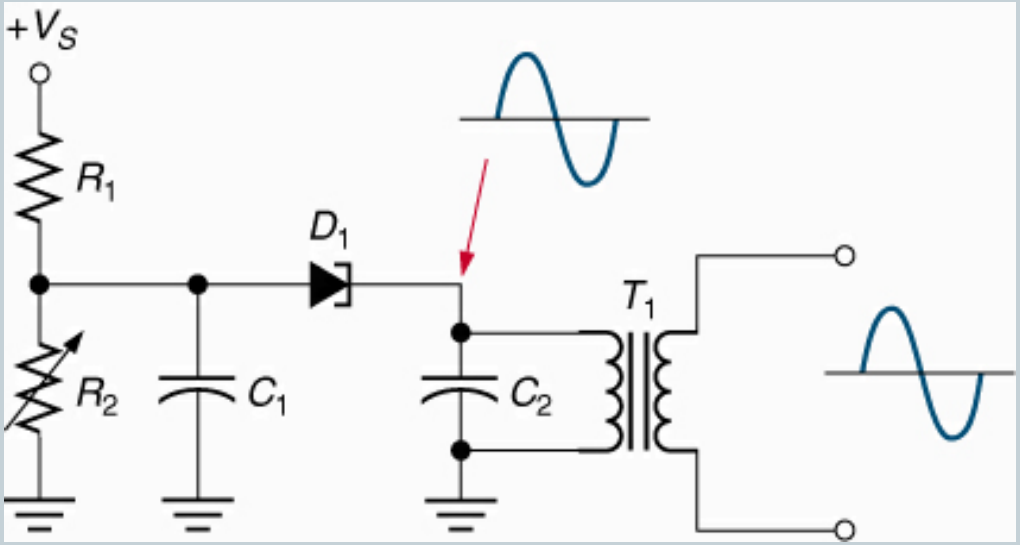
Negative Resistance

- Negative resistance – A term used to describe any device with current and voltage values that are inversely related.
  - The negative resistance portion of the tunnel diode curve falls between its peak and valley voltage and current values.



Tunnel Diode Oscillator

- Oscillator – A circuit that converts dc to ac. An ac signal generator.
  - The tunnel diode oscillator is also referred to as a negative resistance oscillator.



Tunnel Diodes (Esaki Diode)

- Tunnel diode is the p-n junction device that exhibits negative resistance. That means when the voltage is increased the current through it decreases.
- Electron Tunneling in p-n junction
- • When the p and n region are highly doped, the depletion region becomes very thin (~10nm).
- • In such case, there is a finite probability that electrons can tunnel from the conduction band of n-region to the valence band of p-region
- • During the tunneling the particle ENERGY DOES NOT CHANGE

Tunnel Diode Operation

- When the semiconductor is very highly doped (the doping is greater than N o) the Fermi level goes above the conduction band for n-type and below valence band for ptype material. These are called degenerate materials.
- Under Forward Bias

Step 1: At zero bias there is no current flow

Step 2: A small forward bias is applied. Potential barrier is still very high – no noticeable injection and forward current through the junction. However, electrons in the conduction band of the n region will tunnel to the empty states of the valence band in p region. This will create a forward bias tunnel current