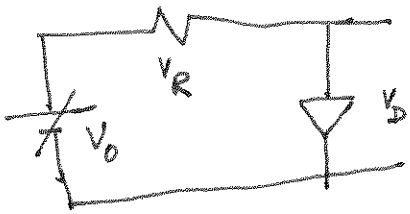
Experiment 6
Diode characteristic and Applications

1. Diode Characteristics

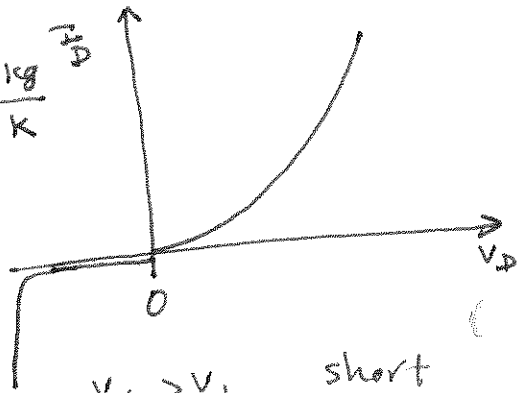
$$I = \begin{cases} I_0 \, e^{qV_D/kT} & V_D > 0 \\ -I_0 & V_D < 0 \end{cases}$$



q: Electron charge $= 1.6 \times 10^{-19}$ C

k: Boltsman's constant $= 1.38 \times 10^{-23} \frac{m^2 kg}{s^2 K}$

T: Temperature in kelvin. $(273+30)$



Diode Models:

Ideal Diode (ideal switch)

when $V_a > V_b$ short

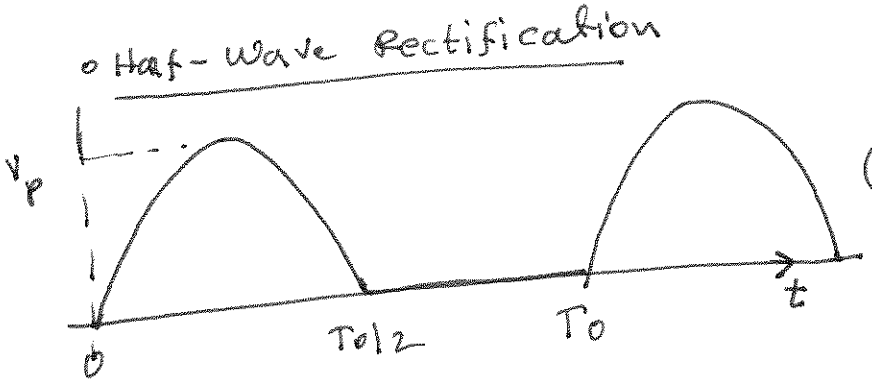
" $V_a < V_b$ open

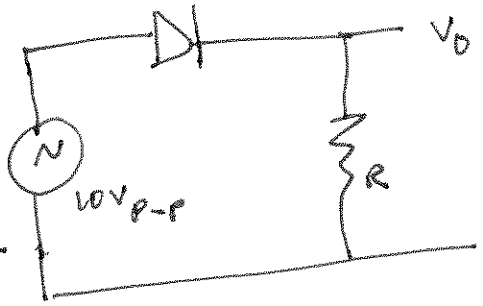
Practical Diode

$\simeq 0.7$ for silicon

$\simeq 0.2$ for Germanium

Half-Wave Rectification

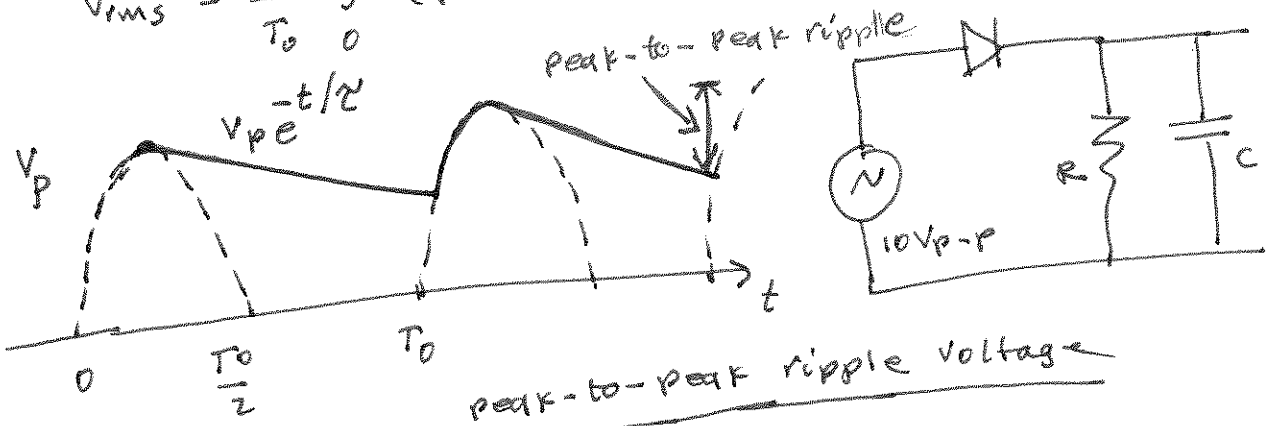




DC and RMS Values

$$V_{av} = \frac{1}{T_0}\int_0^{T_0/2} V_p \sin\omega_0 t\, dt = \frac{V_p}{\pi} = \frac{1}{\pi}\text{ Peak voltage}$$

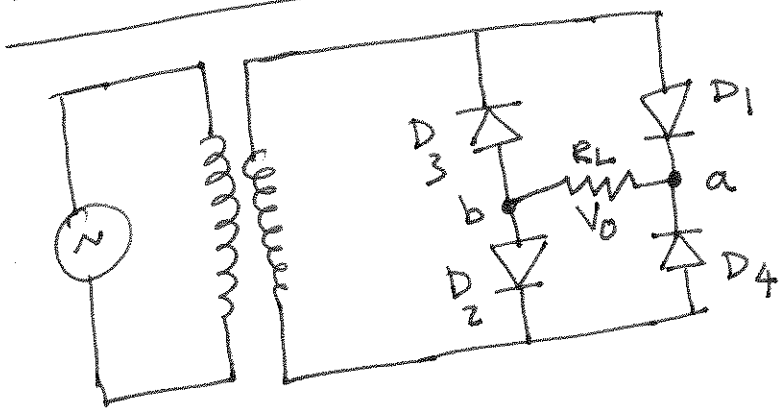
$$V_{rms}^2 = \frac{1}{T_0}\int_0^{T_0/2} (V_p \sin\omega t)^2 dt \Rightarrow V_{rms} = \frac{V_p}{2\sqrt{2}}$$

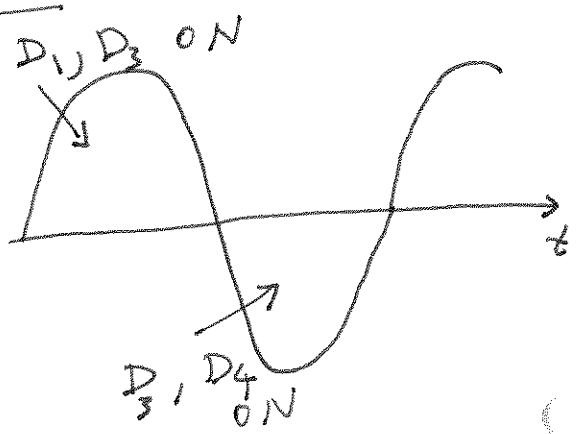


$$\text{ripple factor} = \frac{\text{peak-to-peak ripple voltage}}{V_p}$$

$$V_{dc} \simeq V_p - \frac{\text{peak-to-peak ripple voltage}}{2} \quad \text{(with capacitor)}$$

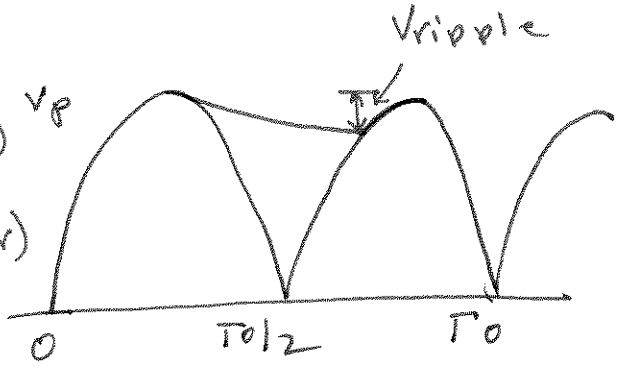
Full-Wave Rectification: Diode Bridge





$$V_{av} = \frac{2V_p}{\pi} \quad \text{(without capacitor)}$$

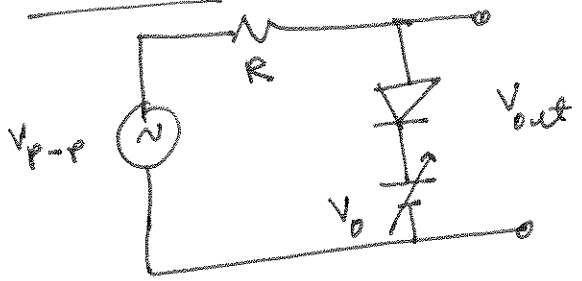
$$V_{rms} = \frac{V_p}{\sqrt{2}} \quad \text{(without capacitor)}$$

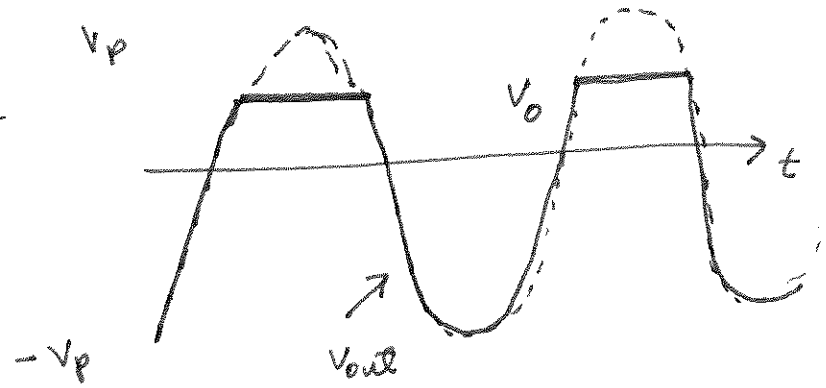


- Adding a capacitor in parallel with R_L improves the dc value and reduces the ripple factor.

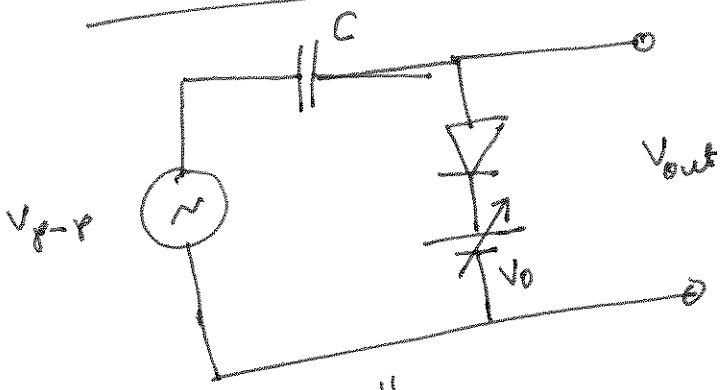
$$V_{av} = V_p - \frac{V_{ripple}}{2} \quad \text{with capacitor}$$

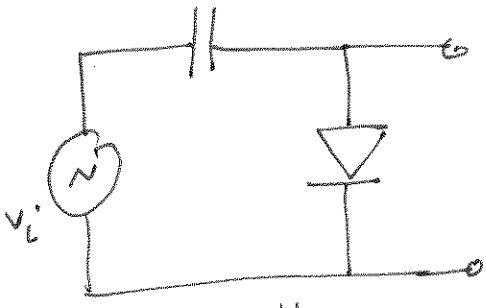
clipping :

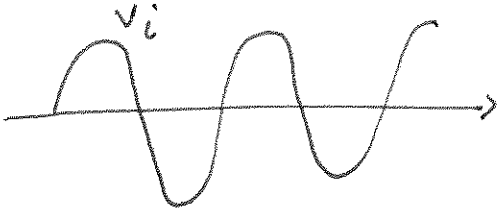


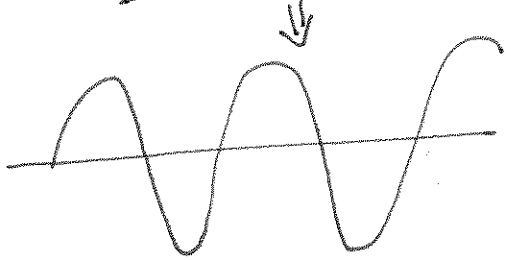


clamping :

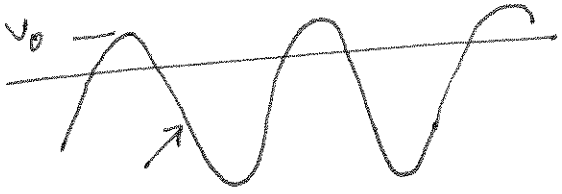




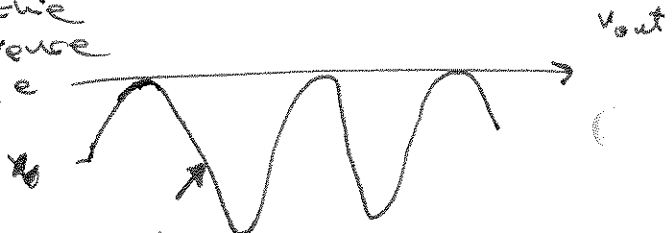




waveform shifted up due to the +ve reference voltage



negative clamping.



negative clamping.

Voltage Multiplication Circuit