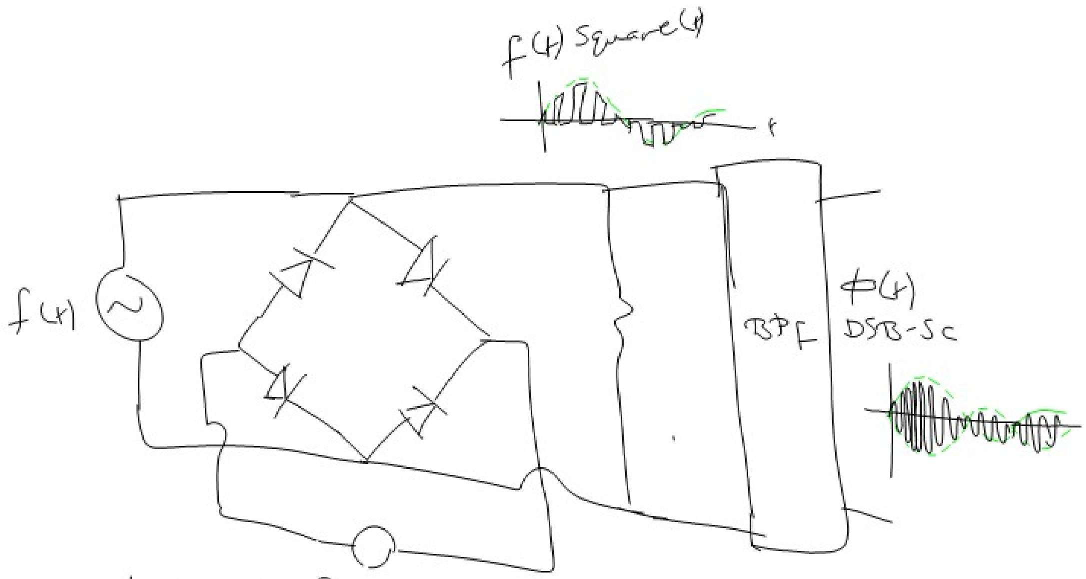
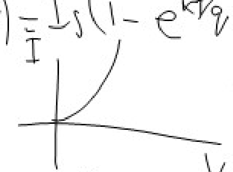


* Note that
the amplitude of the Carrier must be greater than the message signal

Use of non linear device

* We can perform the mixing process by using some non linear devices such as diodes
* The nonlinearity of the diode can be understood from the IV characteristics

$$I(V) = I_s\left(1 - e^{\frac{-V}{kT/q}}\right)$$

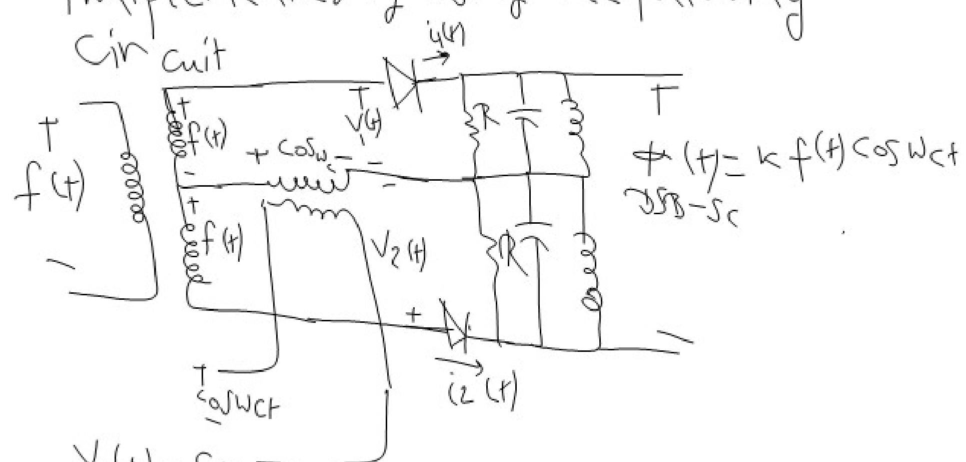


* The nonlinearity can be approximated by using the power series expansion for $I(v)$

$$i(v) = a_1 V + a_2 V^2 + a_3 V^3 + a_4 V^4 + \dots$$

Note that for small voltages the higher order terms can be neglected

* Higher order terms are $a_3 V^3 + a_4 V^4 + \dots$
* The nonlinear mixing action can be implemented by using the following circuit



$$V_1(t) = \cos\omega_c t + f(t)$$

$$V_2(t) = \cos\omega_c t - f(t)$$

$$i_1(t) = a_1 V_1(t) + a_2 V_1^2(t)$$

$$i_2(t) = a_1 V_2(t) + a_2 V_2^2(t)$$

The voltage at the resistors is given by

$$V_o(t) = R\, i_1(t) - R\, i_2(t)$$

$$= R\left[a_1 V_1(t) + a_2 V_1^2(t) - a_1 V_2(t) - a_2 V_2^2(t)\right]$$

$$= R\left[a_1\left(V_1(t) - V_2(t)\right) + a_2\left(V_1^2(t) - V_2^2(t)\right)\right]$$

$$= R\left[a_1\, 2f(t) + a_2\, 4 f(t)\cos\omega_c t\right]$$

* The signal measure at the BPF output is given by

$$\phi(t) = 4 a_2 R f(t) \cos\omega_c t$$

5.1.2 Demodulation of DSB-SC

* In order to recover $f(t)$ from $\phi(t)$ we just multiply $\underset{DSB-SC}{\phi(t)}$ by the carrier. Howeve the Locally generated carrier in the receiver must be synchronized with carrier in the transmitter

Synchronization can be acheived sending a sine wave whose frequency and phase are related to the carrier in the receiver

* This sine wave is called a pilot signal