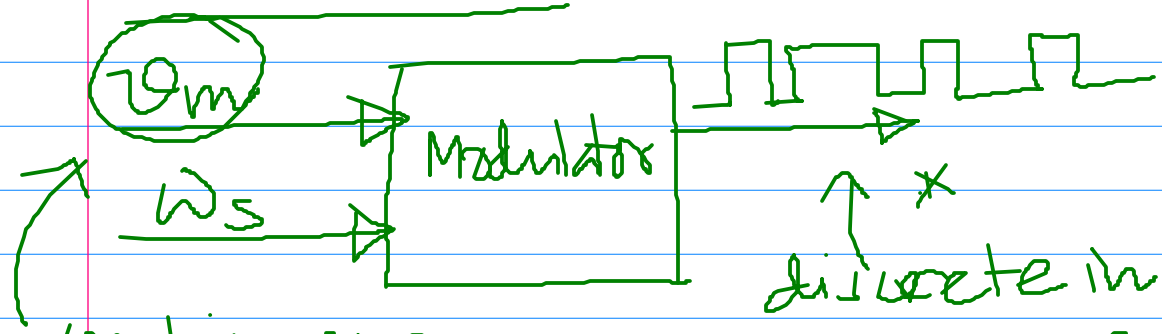
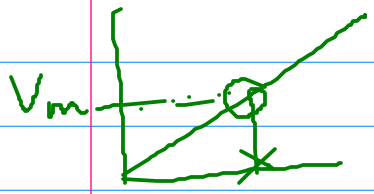
Modulator



$v_m = V_m \sin \omega_s t$

$\omega_s = \omega_{sm} \times \frac{P}{2}$

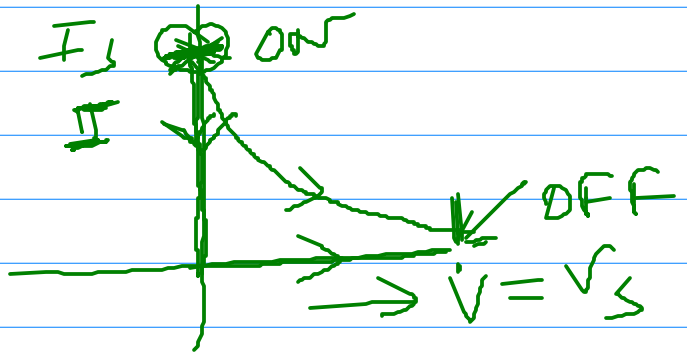
switched mode operation of semiconductor devices

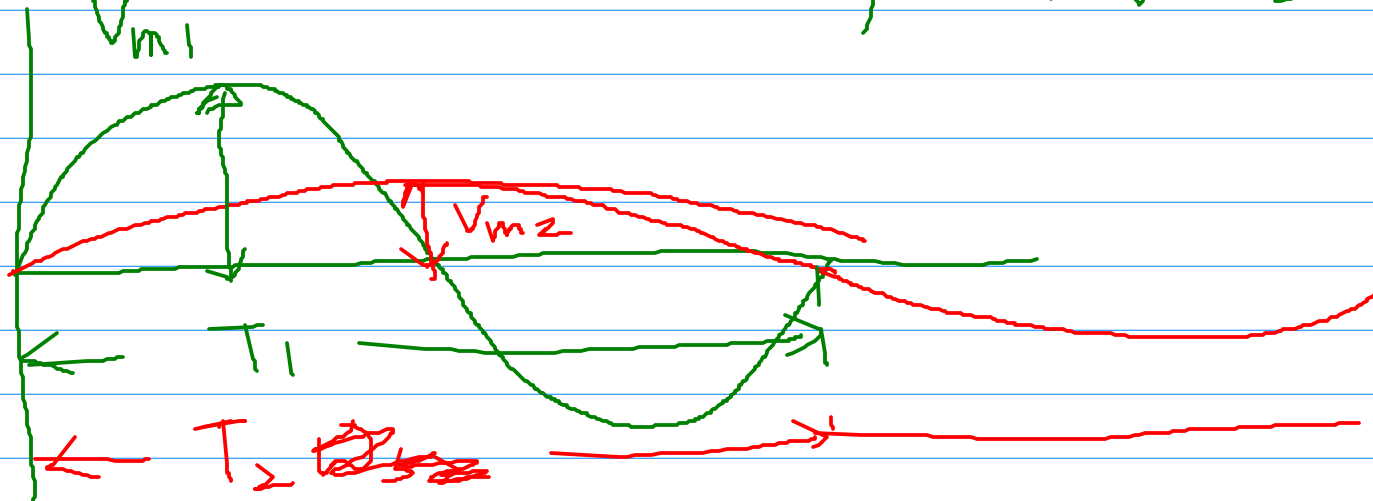


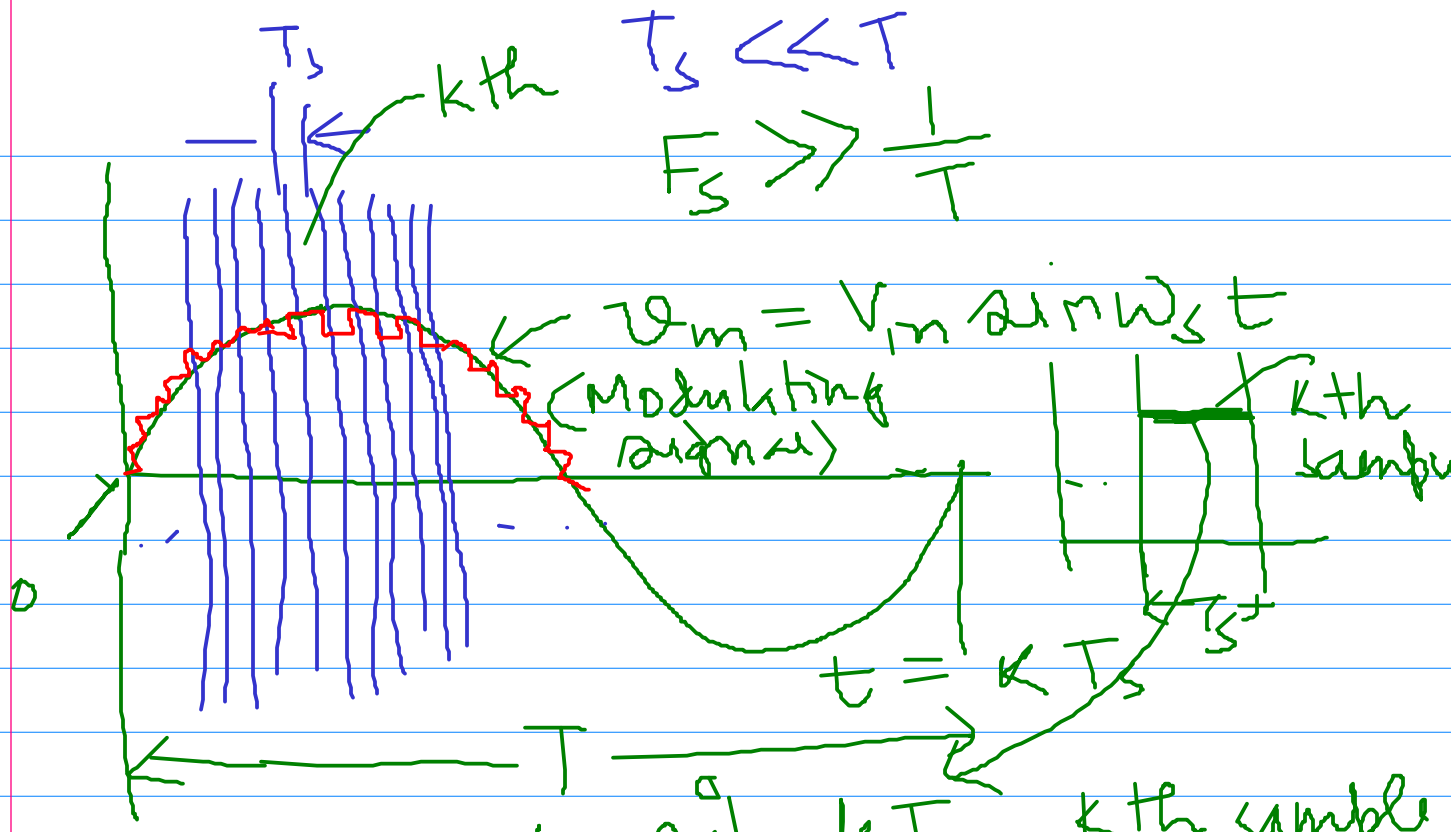
OFF: $V_s = V_{device}$, $0 = I_{device}$, $P_{device} = 0$

ON: $0 = V_{device}$, $I_s = I_{device}$, $s \rightarrow$ system, $P_{device} = 0$

Objective: No Loss in the semiconductor devices







$v_{mk} = V_m \sin kT_s$ kth sample

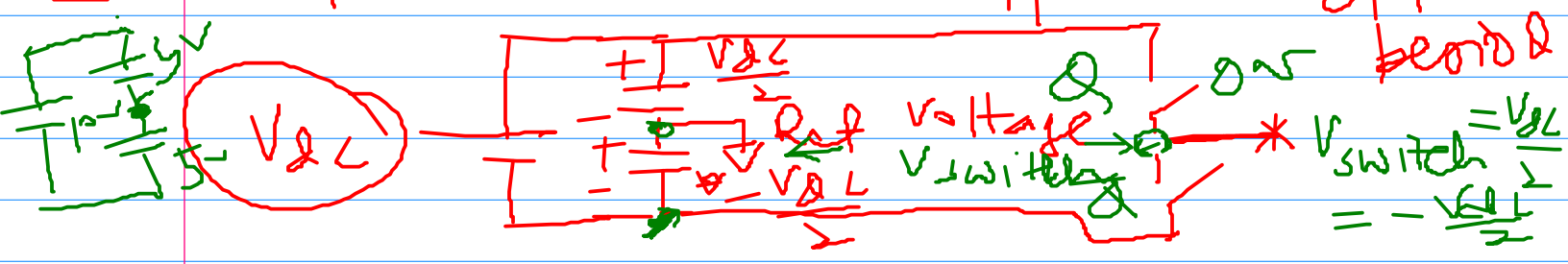
$k = 0, 1, \ldots, 1999$

$$\frac{1}{T_s}\int_0^{T_s} v_{mk}\,dt = \frac{1}{T_s}\int_0^{T_s} v_{switch}\,dt$$

T_1 ON Period

$$v_{mk} T_s = \int_0^{T_1} \frac{V_{dc}}{2}\,dt + \int_{T_1}^{T_s} -\frac{V_{dc}}{2}\,dt$$

$(T_s - T_1)$ OFF Period



$$v_{mk} T_s = \frac{V_{dc}}{2} \times T_1 - \frac{V_{dc}}{2}(T_s - T_1)$$

$T_1 = D T_s$

v_{ac} : Actual voltage

v_{mk} is a modulating signal that represents it

$$\frac{V_{dc}}{2} D - \frac{V_{dc}}{2}(1-D) = v_{mk}$$

$$2D\frac{V_{dc}}{2} - \frac{V_{dc}}{2} = V_{mk}$$

$$D = \frac{V_{mk} + \frac{V_{dc}}{2}}{V_{dc}}$$

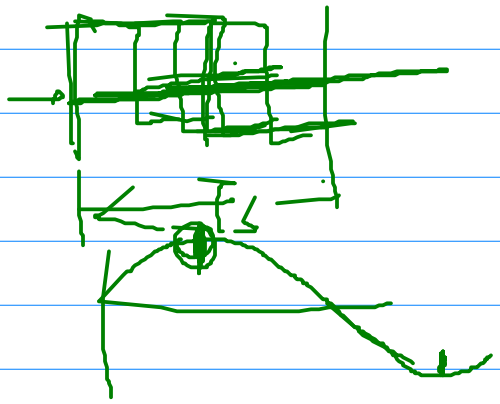
$V_{dc} = \text{Const}$

$$= \frac{1}{2} + \frac{V_{mk}}{V_{dc}}$$

$$= \frac{1}{2}\left(1 + \frac{V_{mk}}{V_{dc}/2}\right)$$

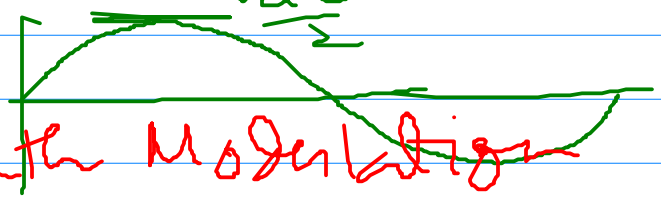
$V_{mk} = V_{tri}$ max $= \frac{V_{dc}}{2}$

$$= \frac{1}{2}(1+1) = 1$$



$D = 0$ when $V_{mk} = -\frac{V_{dc}}{2}$

$0 < D < 1$



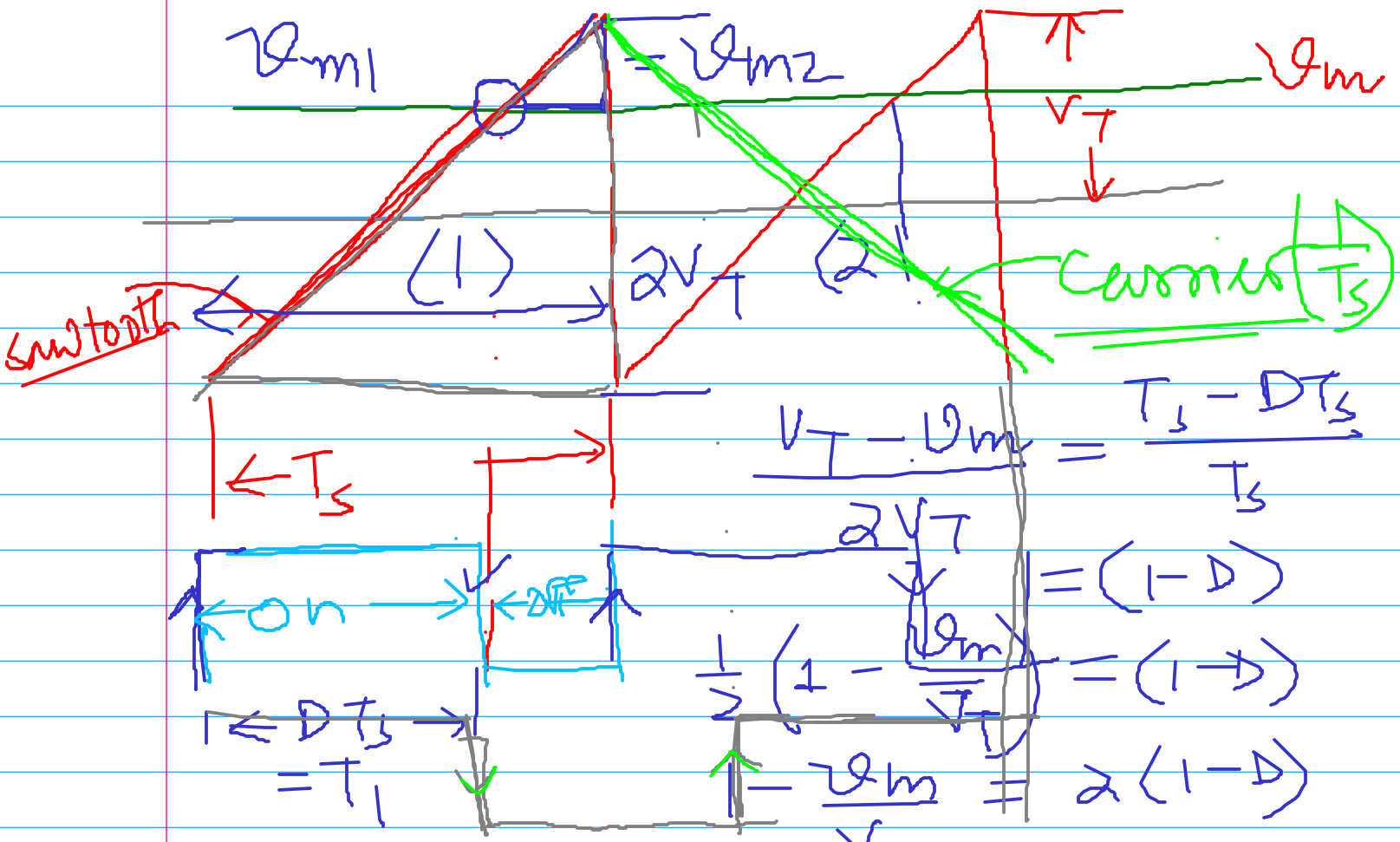
PWM : Pulse Width Modulation

T_s is constant only

Circuit voltage → Carrier → V_T

$\frac{V_{dc}}{2}$ → v_m → Modulator signal

v_{ac} → Modulating signal



$$\frac{V_T - v_m}{2V_T} = \frac{T_1 - DT_s}{T_s}$$

$$\frac{V_T - v_m}{2V_T} = (1 - D)$$

$$\frac{1}{2}\left(1 - \frac{v_m}{V_T}\right) = (1 - D)$$

$$-\frac{v_m}{V_T} = 2(1 - D)$$

$$\frac{v_m}{V_T} = 1 - 2(1 - D)$$

$$= 2D - 1$$

$$\rightarrow \quad D = \frac{1}{2}\left(1 + \frac{v_m}{V_T}\right)$$