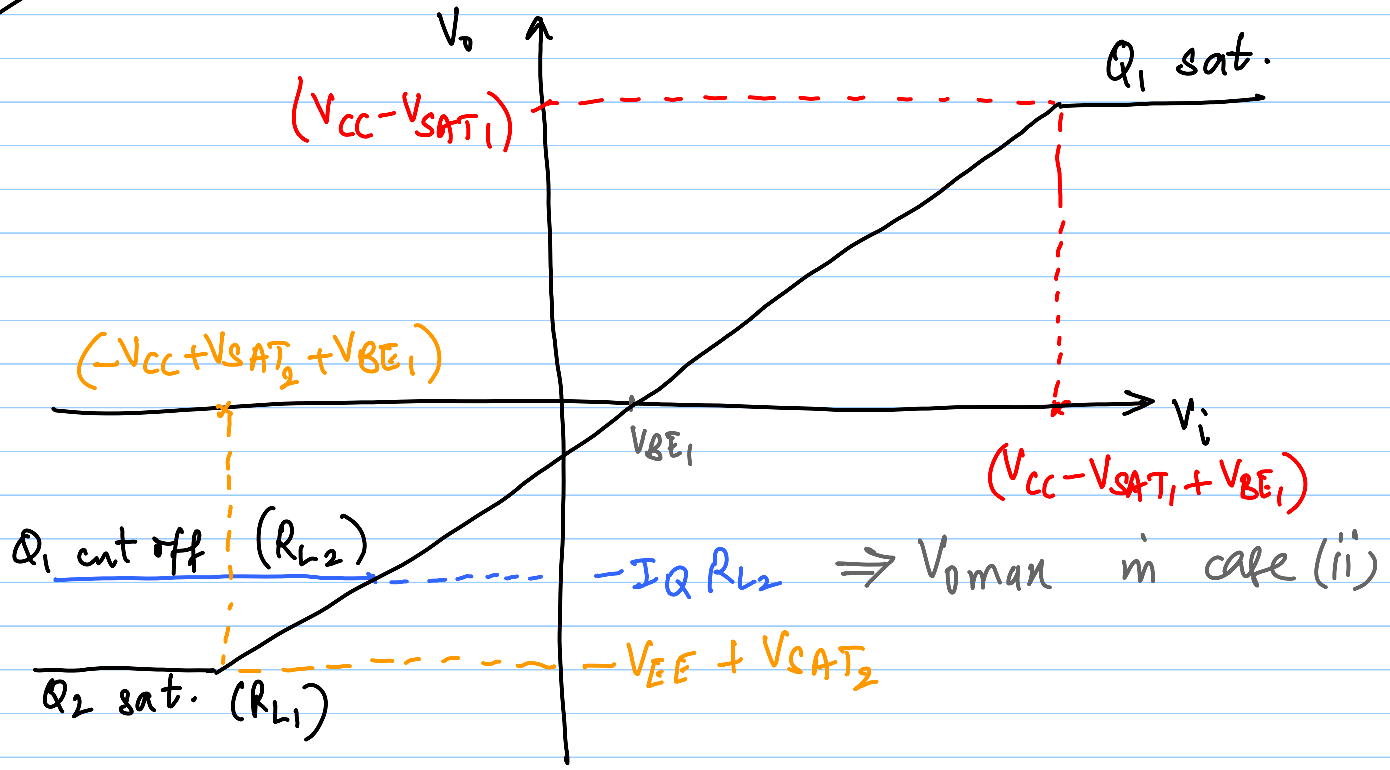
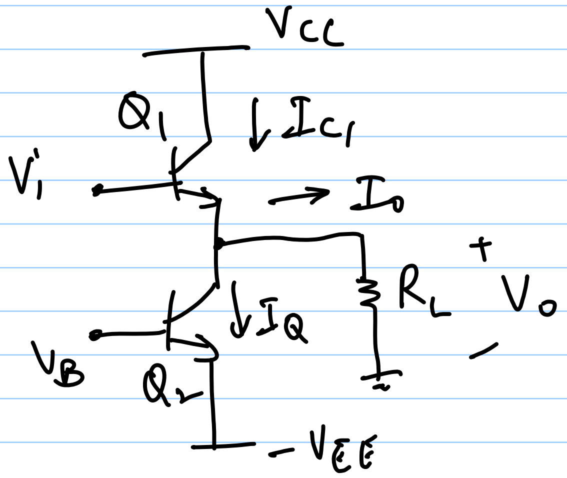
11-4-12

Lec 40



Power Output & Efficiency



$$V_{CE_1} = V_{CC} - V_o$$
$$= V_{CC} - I_o R_L$$
$$= V_{CC} - (I_{C_1} - I_Q) R_L$$

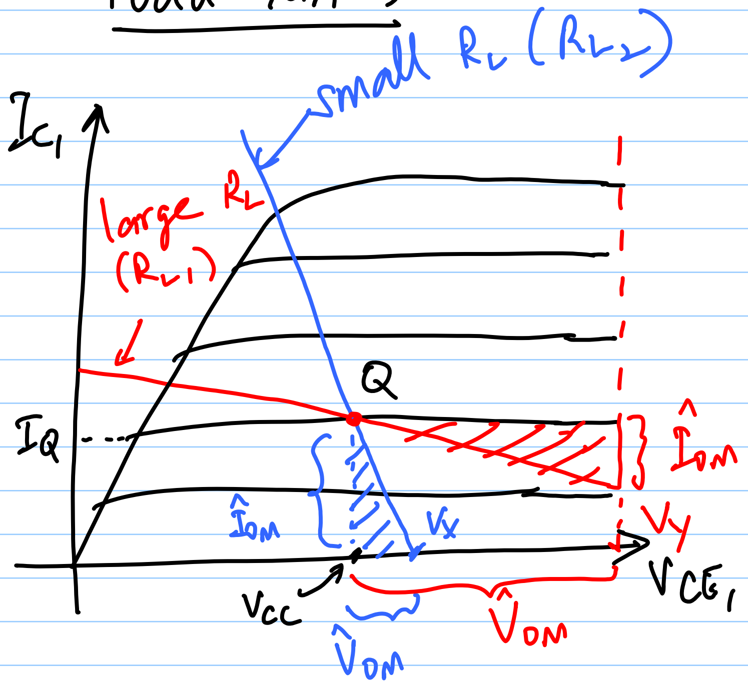
* Draw load lines for the 3 different cases

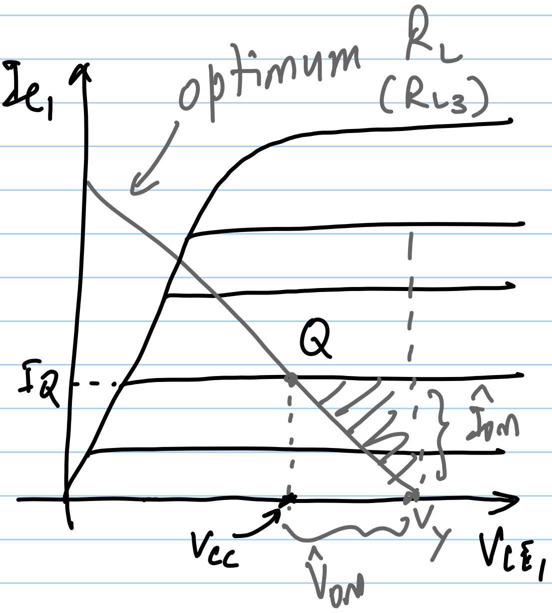
R_{L_1} – large R_L

R_{L_2} – small R_L

R_{L_3} – optimum R_L

load lines





$$V_x = V_{CC} + I_Q R_{L_2}$$

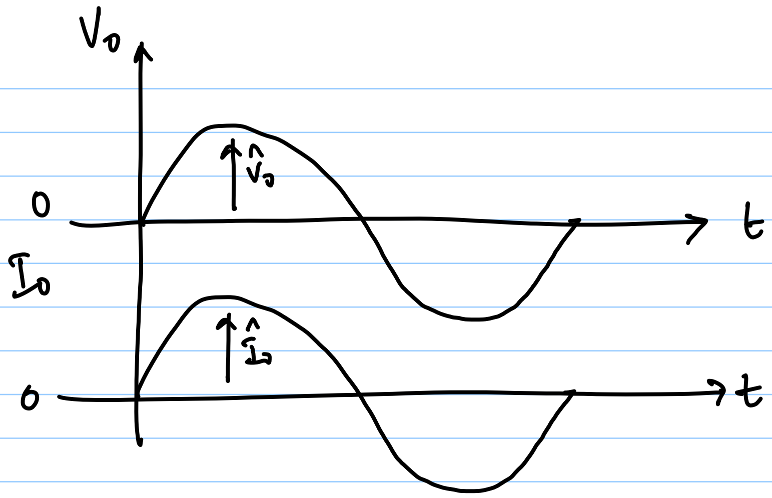
$$V_y = 2V_{CC} - V_{SAT_2} \quad (V_{CE_1} \text{ max.})$$

$$P_{av.} = \frac{\hat{V}_{om}}{\sqrt{2}} \cdot \frac{\hat{I}_{om}}{\sqrt{2}} = \frac{1}{2}\hat{V}_{om}\hat{I}_{om}$$ {shaded area = power} ✓

(i) large R_L – max. V-swing < max. I-swing ⇒ < max. P

(ii) small R_L – max. I-swing < max. V-swing ⇒ < max. P

(iii) Optimum R_L – max. I-swing & max. V-swing ⇒ max. P



P_L = power delivered to R_L

$= \frac{1}{2} \hat{V}_o \hat{I}_o$

$$P_{L,max.} \text{ (case iii)} = \frac{1}{2} \cdot \underbrace{(V_{CC} - V_{SAT})}_{\text{max. swing}} \cdot \underbrace{I_Q}_{\text{max. current}}$$

* Q_1 just cuts-off @ max I-swing

$$P_{supply} = [V_{CC} - (-V_{EE})] \cdot I_Q = 2 V_{CC} I_Q$$

$\eta_c \equiv$ power conversion efficiency

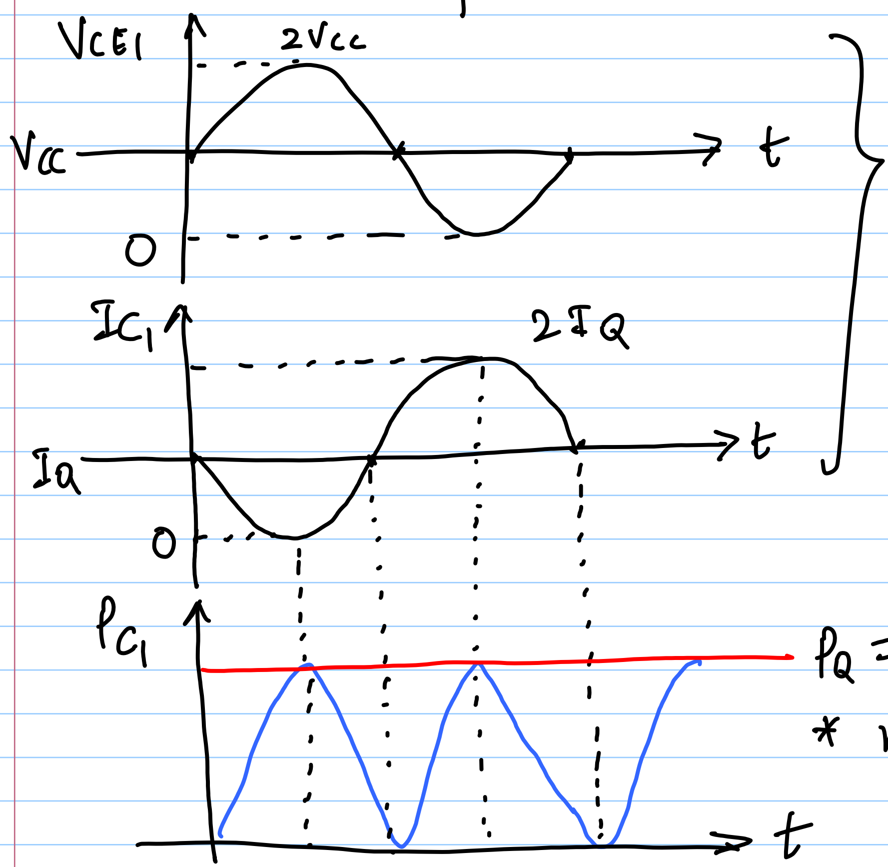
$$= \frac{P_L}{P_{supply}}$$

$$\eta_c (max.) = \frac{P_{L\,max.}}{P_{sup.}} = \frac{\frac{1}{2}(V_{CC} - V_{SAT}) \cdot I_Q}{2 V_{CC} I_Q}$$

$$= \frac{1}{4}\left[1 - \frac{V_{SAT}}{V_{CC}}\right] \approx 25\%$$

$\{V_{SAT} << V_{CC}\}$

power dissipated in Q_1 :



Power cycles @ 2x input freq.

$P_Q = I_Q \cdot V_{CC}$

* need to consider both P_{pk} & P_{ave} for device