(3) 非线电公式 I

$\lambda: U_Q + U_1 \cos\omega t$.

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Chap. 2.

① 二极、三极管 指数律 静：$I_K = I_{EQ} = I_{ES}\exp\left(\frac{U_{BE}}{U_T}\right)$. $U_T = 26\,mV$.

动：$I_K = I_{E0} = \frac{I_0(x)}{e^x} \cdot I_{EQ}$.

$u_o = V_{CC} \pm G_{m1}(x) R_L U_1 \cos\omega t$.

$$\begin{cases} G_{m1}(x) = \frac{2I_1(x)}{xI_0(x)} g_{mQ} \\ g_{mQ} = \frac{\alpha I_{EQ}}{U_T} \end{cases}$$

$G_{m1}(x) = \frac{2I_1(x)}{xI_0(x)} g_{mQ} \left(1 + \frac{\ln I_0(x)}{x_\lambda}\right)$. $x_\lambda = \frac{V_{BB} - 0.7}{U_T}$

② 折线律：$U_Q + U_1 \cos\varphi = U_T$

$I_K = I_{E0} = I_p \alpha_0(\varphi)$.

$I_{E1} = I_p \alpha_1(\varphi)$

$I_p = G U_1 (1 - C\varphi)$.

$G_{m1} = \frac{I_{E1}}{U_1} = G \frac{\varphi - \sin\varphi\cos\varphi}{\pi}$

$G_{m0} = \frac{I_{E0}}{U_1} = G \frac{\sin\varphi - \varphi\cos\varphi}{\pi}$

③ 双曲律：$x = \frac{U}{U_T}$: $I_{c1} = I_K a_1(x)$

$G_{m1}(x) = \frac{\alpha I_K}{4U_T} \cdot \frac{4a_1(x)}{x}$.

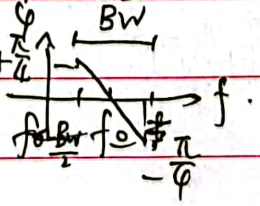
④ RLC：$\omega_0 = \frac{1}{\sqrt{LC}}$. $f_0 = \frac{1}{2\pi\sqrt{LC}}$. $Q_T = \omega_0 RC$. $THD = \frac{D(x)}{Q_T}$. $BW = \frac{\omega_0}{Q_T}$.

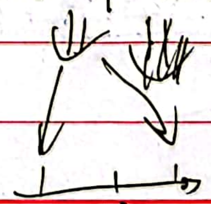
⑤ 平方律：$i_D = I_{DSS}\left(1 - \frac{u_{GS}}{U_T}\right)^2$.

⑥ $g(\omega_1 t) = \left.\frac{\partial i_D}{\partial u_{GS}}\right|_{u_{GS} = U_Q + U_1\cos\omega_1 t}$ → 提 $\omega_1 t$ 分量 g_1 $\pm g_{1m} R_L U_1 \cos\omega_1 t$.

$u_o = V_{CC} \pm \frac{1}{2} g_1 R_L U_2 \cos\omega_3 t$. $\omega_3 = \begin{cases}\omega_1 + \omega_2 \\ \omega_1 - \omega_2\end{cases}$

⑦ RLC 回带边缘：$|R_L'| = \frac{|R_L|}{\sqrt{2}}$.





$\omega_1 \pm \omega_2$

⇓

不带分析

Chap 3,

① 甲类：

$R_L' = N^2 R_{L0}$.

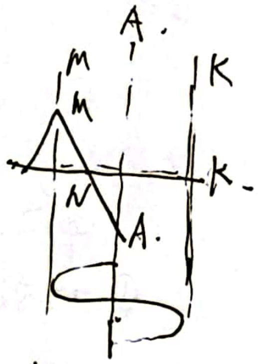
最佳：I_{CQ}

R_L 过大：$P_o = \frac{1}{2}\frac{V_{cc}^2}{R_L'}$

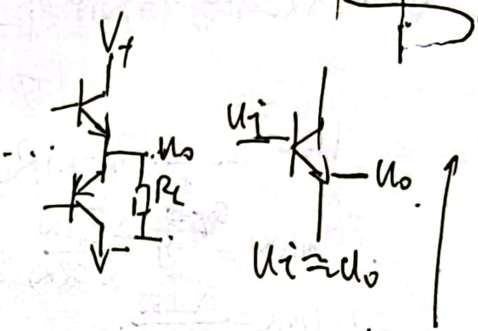
R_L 过小：$P_o = \frac{1}{2} I_{CQ}^2 R_L'$.

$P_{DC} = V_{cc} I_{CQ}$.

$\eta = \frac{P_o}{P_{DC}}$.



② 乙类：$I_Q = \frac{I_c}{\pi}$. $P_{DC} = I_Q V_{cc}$. $P_o = \frac{1}{2} I_c^2 R_L$.



③ 丙类：$u_{BE} = -E_B + U_b \cos\omega t$

$u_{CE} = V_{cc} - U_c \cos\omega t$

$\xi = \frac{V_c}{V_{ce}}$ $\quad \eta_c = \frac{1}{2}\frac{\alpha_1(\varphi)}{\alpha_0(\varphi)}\xi = \frac{P_o}{P_{DC}}$.

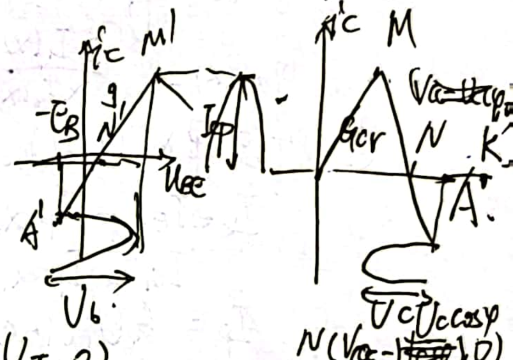
临界：$1 + \frac{G_{cr} U_c}{g_m U_b} = \frac{V_{cc} - U_c}{V_{cc} - U_c\cos\varphi} = \frac{1-\xi}{1-\xi\cos\varphi}$.

$-\frac{G_{cr} U_c}{g_m U_b} = \frac{\xi - \xi c\varphi}{1 - \xi c\varphi}$.

$I_{cp} = g_m U_b (1 - c\varphi)$.

$I_{c1} = I_{cp}\,\alpha_1(\varphi)$.

$P_o = \frac{1}{2} I_{c1} V_c$. $\quad R_L = \frac{U_c}{I_{c1}}$



$N'(U_T, 0)$ $\quad N(V_{cc} - U_c\cos\varphi, 0)$

$A'(-E_B, -g_m U_b c\varphi)$. $\quad A(V_{cc}, -g_m U_b c\varphi)$

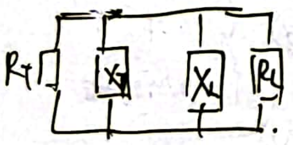
$K'(-E_B - U_b, 0)$. $\quad K(V_{cc} + U_c, 0)$

M'：$-E_B + U_b$. $\quad M$ 横：$V_{cc} - U_c$.

④ 谐振 ~~(struck)~~ 匹配网络 ~~~~ 等效电路

~~X+R~~ $X+R$：$Q = \frac{X}{R}$ $\quad$ ~~$X+R \to X // RQ^2$~~ $\quad X+R \to (1+Q^{-2})X // (1+Q^2)R$.

$X//R$：$Q = \frac{R}{X}$. $\quad$ ~~$X//R \to X + \frac{R}{Q^2}$~~ $\quad X//R \to \frac{X}{1+Q^{-2}} // \frac{R}{1+Q^2}$.



$\begin{cases} R_T = R_L \\ X_T + X_L = 0 \end{cases}$

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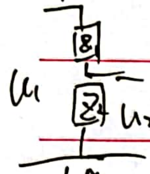
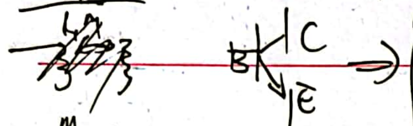
Chap.4

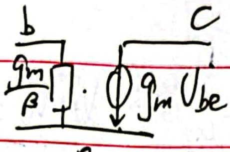


$n=\frac{u_2}{u_1}=\frac{z_2}{z_1+z_2}$ 阻抗变

$G_{in}=n^2G$

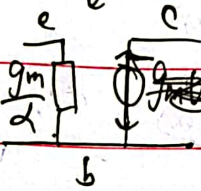


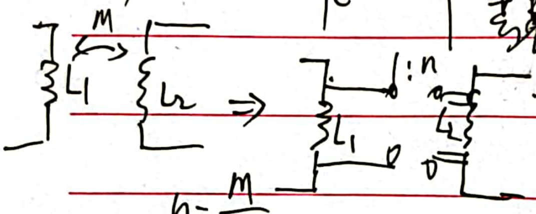
共射：



$g_{m_Q}=\frac{\alpha I_{EQ}}{U_T}$

共基：



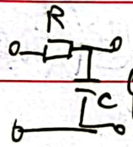


$n=\frac{M}{L_1}$

起振：$\frac{n g_m}{\beta}>1$。忽略 L_2 平衡算 $Q^*=\frac{1}{\omega_{osc}L_2G_{in}}\gg10$，$Q_T^*=\cdots\gg10$.

$\frac{G_{m1}(x)}{g_{mQ}}\Rightarrow x=\frac{nU_0}{U_T}$ $\quad U_0=U_C$.

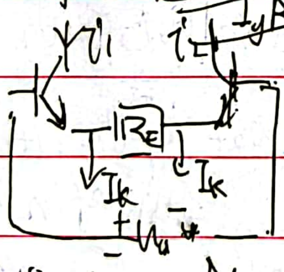
$\varphi\in(0,90^\circ)$. $\varphi\in(-90^\circ,0)$. $o-(R+\frac{1}{j\omega C})$ $(R/\!/\frac{1}{j\omega C})$ $\varphi\in(-90^\circ,90^\circ)$



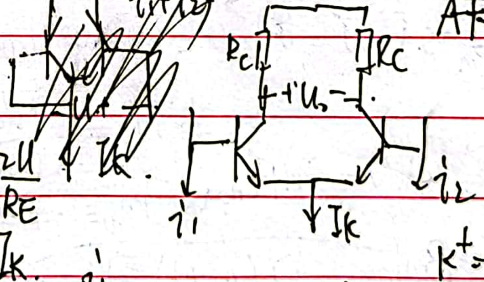
$\omega_0=\frac{2}{RC}$. $\frac{R_1}{R_2}>2$.

Chap.5

模拟乘法：$\cancel{u_0=\frac{2\alpha^2R_c}{I_yR_xR_y}u_xu_y}$ $\quad$ $\cancel{A_T=\frac{R_1}{R_2}\geq3}$



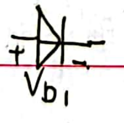
$\begin{cases} i_1-i_2=\frac{2u}{R_E} \\ i_1+i_2=I_k \end{cases}$



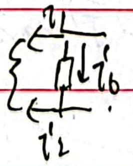
$u_0=-I_kR_c\frac{i_1-i_2}{i_1+i_2}$.

$k^+=\frac{1}{2}+\frac{2}{\pi}\cos\omega t$

开关模拟：

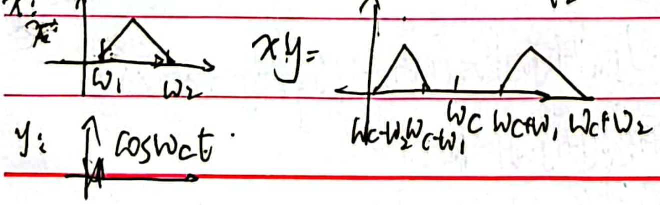


$i_{D1}=gV_{D1}$

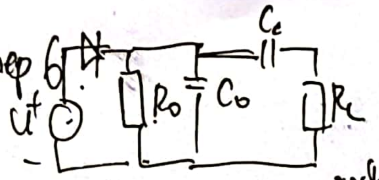


$i_0+i_1=i_2$. $\quad k^-=\frac{1}{2}-\frac{2}{\pi}\cos\omega t$

$u_0=u^+k^+(\omega_ct)+u^-k^-(\omega_ct)$,



Chap 6



$\tau = (R_0 // R_L) C_0$.

$k = \dfrac{R_0 // R_L \cdot 交负载}{R_L \cdot 直负载}$.

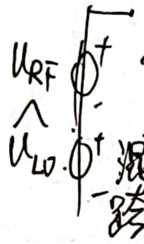
$u_{AM} = U_c(1 + m\cos\Omega_m t)\cos(\omega_c t)$：

非失真要求：$k - m\sqrt{1 + (\Omega_{max}\tau)^2} > 0$.

Chap.7.

三极管：

混频：



$g_{m\alpha}(0) = g_0$　　输入阻抗：$g_{in} = \dfrac{g_0}{\beta}$.

$g_1 = 2g_0 \dfrac{I_1(x)}{I_0(x)}$.

混频跨导：$g_c = \frac{1}{2} g_1 = g_0 \dfrac{I_1(x)}{I_0(x)}$.

$g_c = \dfrac{I_{IF}}{U_{RF}}$

MOS管：

$\cancel{g_{m\alpha}(0)} = g_{p(0)} \dfrac{2 I_{DSS}}{|U_p|}$.

$g_1 = g_p \alpha_1(\varphi)$. 折线.

$g_c = \frac{1}{2} g_1$

Chap.8. 载波：~~$U_c(t)$~~ 基带：~~$\frac{...}{...}$ $U\cos\omega_0$~~ k_p, k_f. 单位电压引起相/频的变化

$u(t) = U\cos\omega_0 t$.　$u_\Omega(t)\ U_\Omega S(t)$.

$k_p U_\Omega = m_p$ 最大相移

调相：$u_{PM}(t) = U_{PM}\cos(\omega_0 t + \varphi)$. $\varphi = k_p U_\Omega S(t)$ $= U_{PM}\cos(\omega_0 t + k_p U_\Omega \cos\Omega_{max} t)$

调频：$u_{FM}(t) = U_{FM}\cos(\omega\ \ t)$. $\omega = \omega_0 + k_f U_\Omega S(t) = U_{FM}\cos(\omega_0 t + k_f U_\Omega \int S(t))$.

$\downarrow \frac{\partial}{\partial t}$

调制指数（最大相移）$\begin{cases} m_f = \dfrac{k_f U_\Omega}{\Omega_{max}} \\ m_p = k_p U_\Omega \end{cases}$ $\Delta\omega = m\Omega_{max}$　$m_f = \dfrac{\Delta\omega}{\Omega_{max}}$　$m_p = $

$\omega_0 + k_f U_\Omega S(t)$

$\Delta\omega = k_f U_\Omega$ 最大频移.

PM, FM：$BW_{CR} = 2(m+1)\Omega_{max}$　　$= U_{FM}\cos(\omega_0 t + m_f \sin\Omega_{max} t)$

AM：$BW = 2\Omega_{max}$　　m_f：最大相移

$u_{FM} \to \boxed{H(j\omega)} \to u_o$

准静态条件：$\begin{cases} \dfrac{\Delta\omega \cdot \Omega_{max}}{\alpha^2} \ll 1. \\ \alpha = \frac{1}{2} BW = \dfrac{1}{2RC}(\text{全角Hz}) \end{cases}$

$u_o = U_{FM}|H(j\omega)|\cos[\omega_0 t + k_f U_\Omega \int S(t) + \varphi(\omega)]$

$\sim \omega_0$附近 $|H(j\omega)| = R$

$\varphi(\omega) = -\dfrac{\Delta\omega}{\alpha} S(t)$.

5） 非线电公式.

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变容二极管 $u = U_Q + U_1\cos\Omega_{max} t$

$C_j = C_{j0}\left(1+\frac{u}{U_\phi}\right)^{-\gamma}$ u:反偏电压.

$= C_{jQ}(1+M\cos\Omega_{max}t)^{-\gamma}$

$C_{jQ} = C_j|_{u=U_Q}$.

$M = \frac{U_1}{U_Q+U_\phi}$

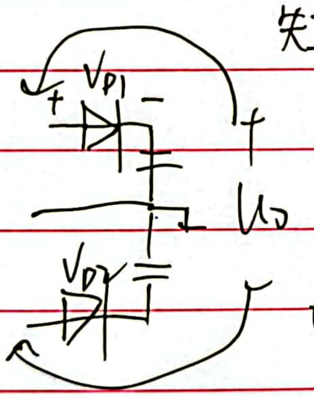
$A = \frac{C_{jQ}}{C_{jQ}+C_{open}}$ Copen:电感开路,二极管外电容

$B = \frac{C_{jQ}}{C_{jQ}+C_{close}}$

$D_1 = \frac{1}{2}M\gamma(A-B)$ $\Delta\omega = D_1\omega_0$.

中心频率漂移 $\Delta A \rightarrow \varepsilon = \frac{D_2}{2}$.

失真: $\xi = \frac{\varepsilon}{D_1}$



$u_0 = \pm U_{D1} \pm U_{D2}$.

先算出幅值!!!

$\theta \approx \frac{\Delta\omega\, S(t)}{\alpha}$.