2024秋非线性第6章作业答案

7.1　7.2　7.5　7.12(b)(c)　7.16　7.19

7.1

混频跨导 $g_c = \frac{1}{2}g_1$，$I_{1f} = \frac{1}{2}g_1 U_s$

1) $g(t) = \left.\frac{d^2}{du}\right|_{u=u_Q+u_{L0}\cos\omega_{L0}t} = (3 + 1.6u + 0.6u^2)\Big|_{u=0.5+2\cos\omega_{L0}t}$

$= 3 + 1.6(0.5+2\cos\omega_{L0}t) + 0.6(0.5+2\cos\omega_{L0}t)^2$

$= 5.95 + \underbrace{4.4\cos\omega_{L0}t}_{g_1(t)} + 2\cos 2\omega_{L0}t$

$g_c = \frac{1}{2}g_1 = 2.2(mS)$　　$I_{1f} = 2.2\times 1 = 2.2\,mA$

中频电流频率为 $\omega_L \pm \omega_{IF}$

2) $g(t) = \left.\frac{d^2}{du}\right|_{u=u_Q+u_{L0}\cos\omega_{L0}t} = (3+1.6u+0.6u^2)\Big|_{u=2\cos\omega_{L0}t}$

$= 3 + \underbrace{1.6\times 2\cos\omega_{L0}t}_{g_1(t)} + 0.6\times 4\cos^2\omega_{L0}t$

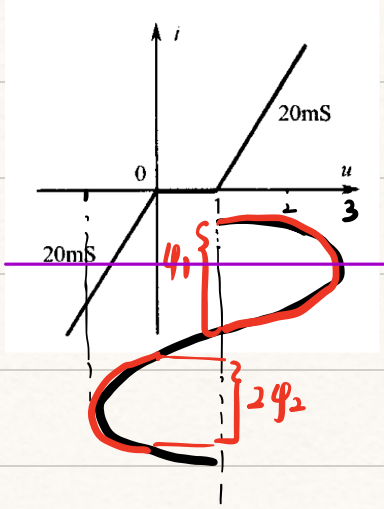
$g_c = \frac{1}{2}g_1 = 1.6(mS)$　　$I_{1f} = 1.6\times 2 = 3.2\,mA$

中频电流频率为 $\omega_L \pm \omega_{IF}$

7.2

第二章习题 2.11

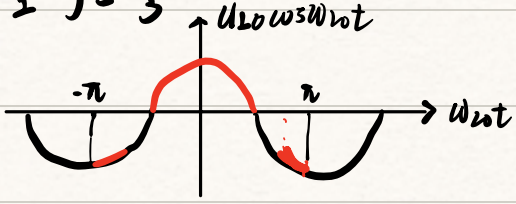
a)



$g(t) = \frac{d^2}{du} = \begin{cases} 20mS, & u>1 \text{ or } u<0 \\ 0, & \text{其它} \end{cases}$

$\theta_1 = \cos^{-1}\left(\frac{U_T - U_Q}{U_1}\right) = \cos^{-1}\left(\frac{1-1}{2}\right) = \frac{\pi}{2}$

$\theta_2 = \cos^{-1}\left(\frac{1-0}{2}\right) = \frac{\pi}{3}$



所以在 $(-\pi,\pi)$ 内 $g(t)$ 只在 $[-\pi,-\frac{2\pi}{3}]\cup[-\frac{\pi}{3},\frac{\pi}{3}]\cup[\frac{2\pi}{3},\pi]$ 导通

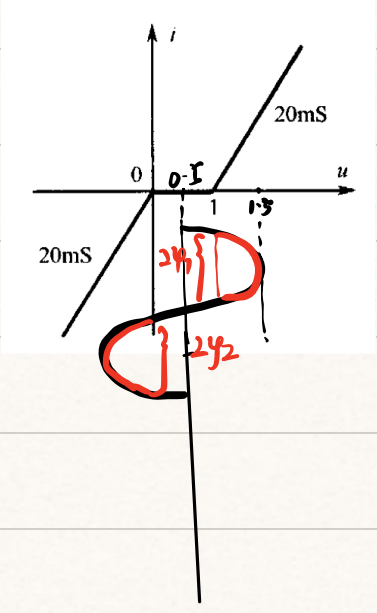
$$g_1(t)=\frac{1}{\pi}\int_{-\pi}^{\pi} g(t)\cos\omega_1 t\, d\omega_1 t$$

$$=\frac{2}{\pi}\int_0^{\frac{\pi}{3}} 20\cos\theta\, d\theta+\frac{2}{\pi}\int_{\frac{2\pi}{3}}^{\pi} 20\cos\theta\, d\theta$$

$$=\frac{40}{\pi}+\frac{40}{\pi}\left(0-\frac{\sqrt{3}}{2}\right)=\frac{40}{\pi}\left(1-\frac{\sqrt{3}}{2}\right)=1.706$$

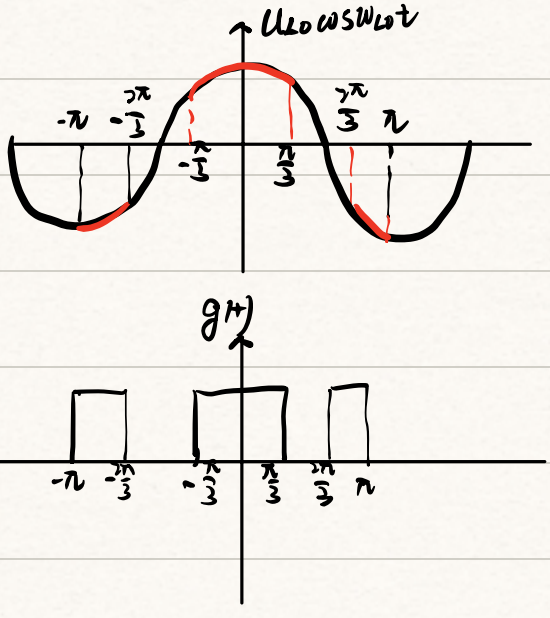
$$g_c=\frac{1}{2}g_1=0.85\,mS$$

(2)



$$\varphi_1=\cos^{-1}\left(\frac{1-0.5}{1}\right)=\frac{\pi}{3}$$

$$\varphi_2=\cos^{-1}\left(\frac{0.5-0}{1}\right)=\frac{\pi}{3}$$



所以在 $(-\pi,\pi)$ 内 $g(t)$ 只在 $[-\pi,-\frac{2\pi}{3}]\cup[-\frac{\pi}{3},\frac{\pi}{3}]\cup[\frac{2\pi}{3},\pi]$ 上导通

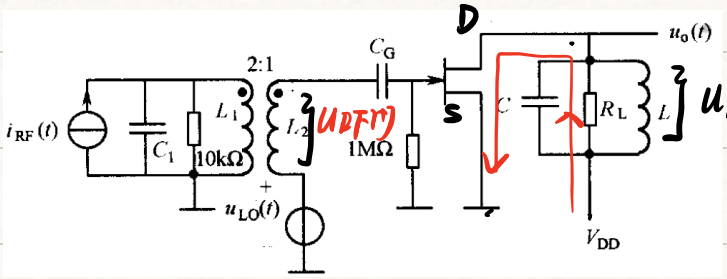
$$g_1(t)=\frac{1}{\pi}\int_{-\pi}^{\pi} g(t)\cos\omega_1 t\, d\omega_1 t$$

$$=\frac{2}{\pi}\int_0^{\frac{\pi}{3}} 20\cos\theta\, d\theta+\frac{2}{\pi}\int_{\frac{2\pi}{3}}^{\pi} 20\cos\theta\, d\theta$$

$$=\frac{40}{\pi}\left(\frac{\sqrt{3}}{2}-0\right)+\frac{40}{\pi}\left(0-\frac{\sqrt{3}}{2}\right)=0$$

$$\therefore g_c=\frac{1}{2}g_1=0$$

7.5



第七章 PPT 20~23

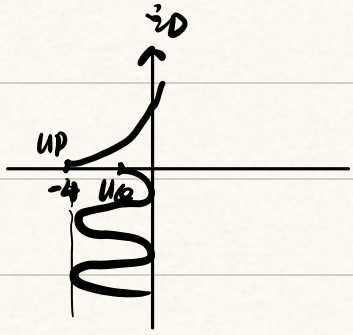
$V_{DD} = u_o(t) + u_{RL}(t)$, $u_{RL}(t) = i_{IF}(t) \cdot R_L$ $\therefore u_o(t) = -i_{IF}(t)R_L + V_{DD}$

$\therefore$ 只需求出混频电流即可!

变压器 $i_1 : i_2 = n_2 : n_1$ $u_1 : u_2 = n_1 : n_2$

$u_{DF}(t) = \frac{1}{2} \cdot 10k\Omega \cdot i_{DF}(t) = 0.1\cos 6\times10^6 t\,(V)$

(1) $u_{LO}(t) = 2\cos\omega_{LO}t$, $u_Q = -u_{LO}$



$\alpha = \frac{u_{LO}}{|u_P|} = \frac{2}{4} \le 0.5$ 故处于完全导通状态

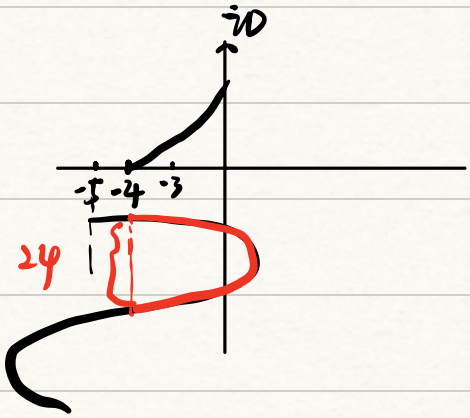
$g_c = \frac{I_{DSS}}{|u_P|} \cdot \alpha = \frac{16mA}{4V} \cdot \frac{1}{2} = 2mS$

$I_{IF} = g_c u_S = 2mS \cdot 0.1V = 0.2mA$

$\therefore u_o(t) = 12 - 0.2mA \times 10k\Omega \cos 3\times10^6 t = 12 - 2\cos 3\times10^6 t\ (V)$

(2) $u_{LO}(t) = 5\cos\omega_{LO}t$, $u_Q = -u_{LO}$

$\alpha = \frac{u_{LO}}{|u_P|} = \frac{5}{4} > 0.5$ 不完全导通



$\varphi = \cos^{-1}\left(\frac{-4-(-5)}{5}\right) = \cos^{-1}\left(\frac{1}{5}\right) \approx 1.37\,(rad)$

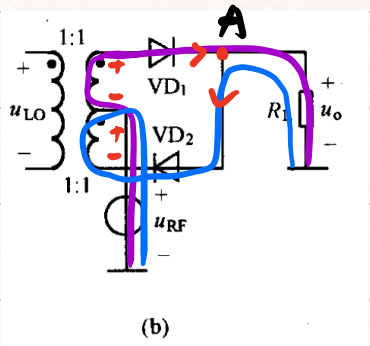
$g_c = \frac{I_{DSS}}{|u_P|} \cdot \frac{\phi - \sin\phi\cos\phi}{\pi(1-\cos\phi)}$

$= \frac{4mA}{4V} \cdot \frac{1.37 - \sqrt{1-\frac{1}{5}^2} \cdot \frac{1}{5}}{\pi(1-\frac{1}{5})} \approx 1.868\ mS$

$I_{if} = 1.868mA \times 10k\Omega = 1.868V$

$\Rightarrow u_{o(t)} = 12 - 1.868\cos 3\times10^{6}t \ (V)$

7.12



u_{LO}正半周时，VD_1，VD_2对导通

$$\begin{cases} -U_{RF} - u_{LO} + i_{D1}\cdot R_D + u_o = 0 & ① \\ -u_o + i_{D2}\cdot R_D - u_{LO} + U_{RF} = 0 & ② \end{cases}$$

① - ② $-2U_{RF} + 2u_o + R_D(i_{D1} - i_{D2}) = 0$

$$\Rightarrow i_{D1} - i_{D2} = \frac{2(U_{RF} - u_o)}{R_D}$$

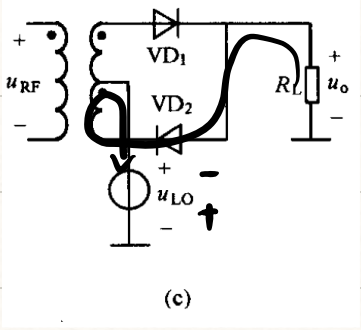
A点节点电流 $i_{D1} - i_{D2}$

$$\therefore u_o = (i_{D1} - i_{D2})R_L = \frac{2(U_{RF} - u_o)}{R_D}\cdot R_L$$

$$\Rightarrow u_o^{+} = \frac{2R_L}{R_D + 2R_L}U_{RF}$$

u_{LO}负半周时，VD_1，VD_2对不导通，$u_o^{-} = 0$

故 $u_o = u_o^{+}K^{+}(\omega_{LO}t) = \frac{2R_L}{2R_L + R_D}U_{RF}\,K^{+}(\omega_{LO}t)$



u_{LO}正半周：VD1导通，VD2不导通，此时只有i_{D1}，$i_{D2}=0$，$i_{RL}=i_{D1}$

$-u_{LO}+i_{D1}\cdot R_D+u_O-u_{RF}=0 \Rightarrow i_{D1}=\dfrac{u_{LO}+u_{RF}-u_O}{R_D}$ ①

又：$i_{D1}=\dfrac{u_O}{R_L}$ ②

①②解出 $u_O^+=\dfrac{R_L}{R_L+R_D}(u_{LO}+u_{RF})$

u_{LO}负半周时，VD2导通，VD1不导通，此时只有i_{D2}，$i_{D1}=0$，$i_{RL}=i_{D2}$

$-u_O+i_{D2}\cdot R_D-u_{RF}+u_{LO}=0 \Rightarrow i_{D2}=\dfrac{-u_{LO}+u_{RF}+u_O}{R_D}$ ①

又：$i_{D2}=\dfrac{u_O}{R_L}$ ②

①②解出 $u_O^-=\dfrac{R_L}{R_L-R_D}(u_{LO}-u_{RF})$

综上：$u_{OM}=u_O^+k^+(\omega_{LO}t)+u_O^-k^-(\omega_{LO}t)=\dfrac{R_L}{R_L+R_D}\left[u_{LO}+u_{RF}\left(k^+(\omega_{LO}t)-k^-(\omega_{LO}t)\right)\right]$

7.16

(1) $f_S=931\text{kHz}$，$f_I=465\text{kHz}$ $\therefore f_L=f_S+f_I=1396\text{kHz}$

$pf_L+qf_S\approx f_{IF}$ ⇒ 当$p=-1$，$q=2$时，$-f_L+2f_S=1\text{kHz}+f_{IF}$

故该现象属于组合频率干扰（哨叫，$p=-1$，$q=2$）

(12) $f_S = 550\text{kHz}$, $f_I = 465\text{kHz}$ $\therefore f_L = f_S + f_I = 1015\text{kHz}$

$pf_L + qf_n = f_I$ $\Rightarrow$ 当 $p=+1$, $q=1$ 时, $-f_L + 1480\text{kHz} = f_I$

故该现象属于寄生通道干扰, $f_n = 1480\text{kHz}$. $p=+1$, $q=1$

(13) $f_L = f_S + f_I = 1480\text{kHz} + 465\text{kHz} = 1945\text{kHz}$

$pf_L + qf_n = f_I$ 当 $p=1$, $q=-2$ 时, $f_L - 2 \times 740\text{kHz} = f_I$

故该现象属于寄生通道干扰, $f_n = 740\text{kHz}$. $p=1$, $q=-2$

7.19

$f_S = f_{LO} - f_{IF} = 23\text{MHz} - 3\text{MHz} = 20\text{MHz}$

当 $r=2$, $s=-1$ 时, $2f_{n1} - f_{n2} = 20\text{MHz} = f_S$

为二阶互调干扰