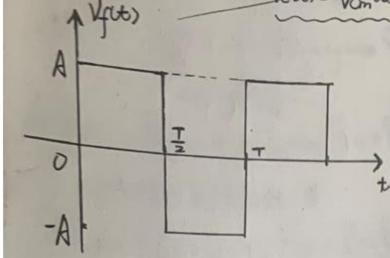
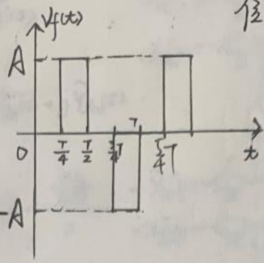
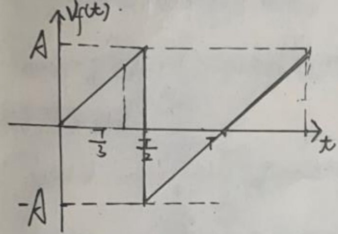
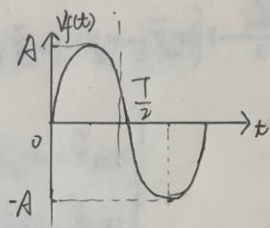
调频波波形研究　$V_c(t)=V_{cm}\cos\omega_c t$.

由此可得其调频波形、瞬时频率与瞬时相位曲线。请看 Matlab 文件 HomeWork 8.









调频波数学表达式為：

$$V_{FM}(t)=V_{cm}\cos\left(\omega_c t+K_F\int_0^t V_f(t)\,dt\right).$$

$\frac{T}{3}$ 瞬时频率有：$\omega\Big|_{t=\frac{T}{3}}=\frac{\partial\phi}{\partial t}\Big|_{t=\frac{T}{3}}=\omega_c+V_f(\frac{T}{3})\cdot K_F$.

$$\omega=\omega_c+V_f(t)K_F,\quad \phi\Big|_{t=\frac{T}{3}}=\omega_c\cdot\frac{T}{3}+K_F\int_0^{\frac{T}{3}}V_f(t)\,dt.$$

由调频波形可以立即得到 $t=\frac{T}{3}$ 时全相角：

$$\begin{cases}\phi_1(\frac{T}{3})=\frac{T}{3}\omega_c+K_F\cdot\frac{A}{3}T & \phi_3(\frac{T}{3})=\frac{T}{3}\omega_c+K_F\frac{1}{9}AT\\ \phi_2(\frac{T}{3})=\frac{T}{3}\omega_c+K_F\frac{A}{12}T & \phi_4(\frac{T}{3})=\frac{T}{3}\omega_c+K_F\int_0^{\frac{T}{3}}\sin\frac{2\pi}{T}t\,dt\end{cases}$$

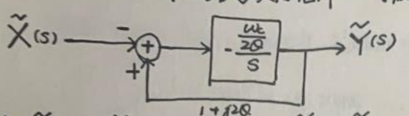
得：$\phi_4(\frac{T}{3})=\frac{T}{3}\omega_c+K_F\cdot\left(-\cos\frac{2\pi}{T}t\Big|_0^{\frac{T}{3}}\right)\cdot\frac{T}{2\pi}\cdot\frac{2\pi}{T}$

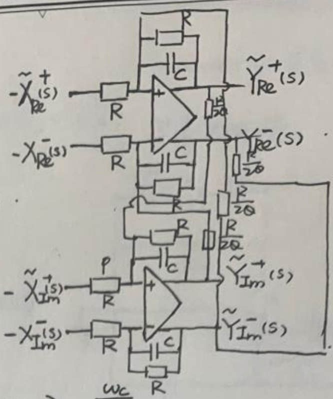
$$=\frac{T}{3}\omega_c+K_F\left(-\cos\phi\Big|_0^{\frac{2}{3}\pi}\right)\cdot\frac{T}{2\pi}$$

$$=\frac{T}{3}\omega_c+K_F\cdot\frac{3}{2}\cdot\frac{T}{2\pi}=\frac{T}{3}\omega_c+\frac{3T}{4\pi}K_F.$$

班级: 姓名: 刘升济 编号: 8 科目: 通信电路

Homework I: 将电路与实际元件一一对應:





与原式设计一致.

由 $\tilde{X}(s) = \tilde{X}_{Re}(s) + j\tilde{X}_{Im}(s)$, $\tilde{Y}(s) = \tilde{Y}_{Re}(s) + j\tilde{Y}_{Im}(s)$.

对于上述反馈系统,有:

$$\tilde{Y}(s) = \left\{[1+j2Q]\tilde{Y}(s) - \tilde{X}(s)\right\} - \frac{\frac{\omega_c}{2Q}}{s}$$

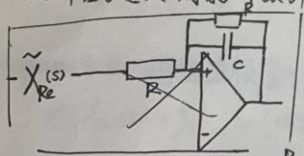
将 $\tilde{Y}(s)$ 按实、虚部展开,则有:

$$\tilde{Y}_{Re}(s) + j\tilde{Y}_{Im}(s) = \left\{[1+j2Q](\tilde{Y}_{Re}(s) + j\tilde{Y}_{Im}(s)) - (\tilde{X}_{Re}(s) + j\tilde{X}_{Im}(s))\right\}\left(-\frac{\frac{\omega_c}{2Q}}{s}\right).$$

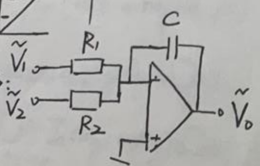
于是其实部与虚部有:

$$\begin{cases} \tilde{Y}_{Re}(s) = -\dfrac{\frac{\omega_c}{2Q}}{s}\left[\tilde{Y}_{Re}(s) - 2Q\tilde{Y}_{Im}(s) - \tilde{X}_{Re}(s)\right]. \\ \tilde{Y}_{Im}(s) = -\dfrac{\frac{\omega_c}{2Q}}{s}\left[2Q\tilde{Y}_{Re}(s) + \tilde{Y}_{Im}(s) - \tilde{X}_{Im}(s)\right]. \end{cases}$$

設計差分运放,则有如下設計:



对于积分电路如右:



有:

$$\tilde{V}_o = -\frac{1}{sC}\left[\frac{\tilde{V}_1}{R_1} + \frac{\tilde{V}_2}{R_2}\right]$$, 于是可以設計差分运放如上

清華大学 TSINGHUA UNIVERSITY　数学作业纸

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Homework Ⅱ：调频与调相：

$V_f(t) = \cos(2\pi \times 400t)$，$V_c(t) = 4\cos(2\pi \times 25 \times 10^6 t)$

$\Delta f = 15\,kHz$.

(1)：已调波是调频波

$V_{FM}(t) = 4\cos(2\pi \times 25 \times 10^6 t + m_F \sin(2\pi \times 400t))$

$m_F = \dfrac{\Delta f}{f_f} = \dfrac{15\,kHz}{400\,Hz} = \dfrac{75}{2}$

$\Rightarrow V_{FM}(t) = 4\cos(2\pi \times 25 \times 10^6 t + 37.5\sin(2\pi \times 400t))$.

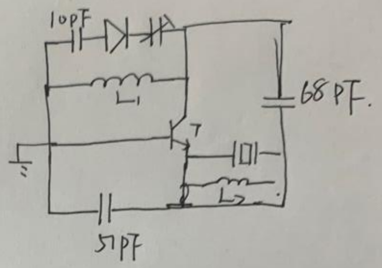
(2)：已调波是调相波.

$V_{PM}(t) = 4\cos\left(2\pi \times 25 \times 10^6 t + \dfrac{\Delta f}{f_f}\cos(2\pi \times 400t)\right)$

$= 4\cos(2\pi \times 25 \times 10^6 t + 37.5\cos(2\pi \times 400t))$.

Homework Ⅴ：变容直接调频：.

其高频电路：.



L_1：3点振荡器振荡电感，提供直流通路.

L_2：去除石英并联电容 C_0 影响，提高频率稳定度

$L_3.L_4$：高频扼流圈，防止高频信号窜入低频和直流回路.

Homework Ⅲ：调相波频谱分析：.

由 $V_{PM}(t) = V_{Cm}\cos(\omega_c t + m_p\cos\Omega t)$

$\Rightarrow \tilde{V}_{PM}(t) = V_{Cm}\exp(j\omega_c t)\exp(jm_p\cos\Omega t)$.

由 $\exp(jm_p\sin\Omega t) = \sum\limits_{n=-\infty}^{\infty} J_n(m_p)\exp(jn\Omega t)$

由 ~~对~~ $\exp(jm_p\cos\Omega t) = \exp\left(jm_p\sin\left(\Omega\left(t + \dfrac{\frac{\pi}{2}}{\Omega}\right)\right)\right)$.

$\Rightarrow F[\exp(jm_p\cos\Omega t)] = \sum\limits_{n=-\infty}^{\infty} J_n(m_p)\exp(jn\Omega t)\exp\left(j\dfrac{\frac{\pi}{2}}{\Omega}\cdot(\Omega n)\right)$.

$= \sum\limits_{n=-\infty}^{\infty} J_n(m_p)\exp(jn\Omega t)\exp\left(jn\dfrac{\pi}{2}\right)$.

其与调频波类似，但其在n为~~偶~~奇数时 $\boxed{\text{实部为0}}$

~~n为偶~~ n=4k时其为-1，n=4k+2时其为1