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广东工业大学
通信电路与系统
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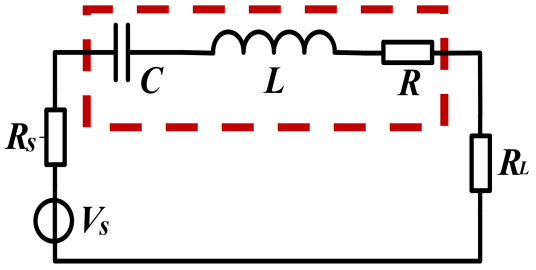
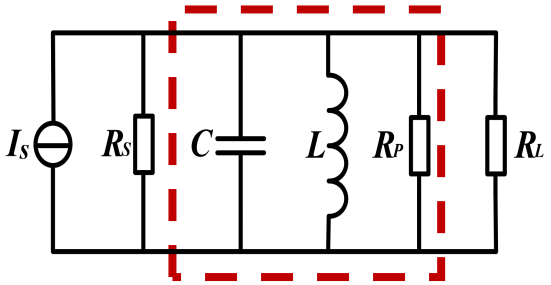
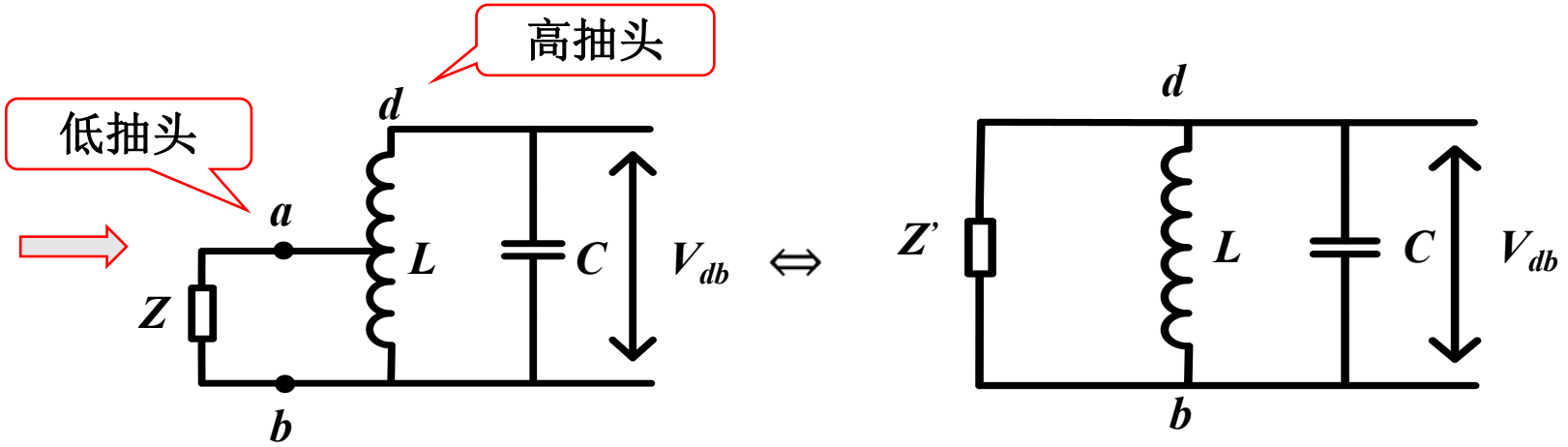




2.2 阻抗变换

抽头（部分接入）



接入系数：$p=\dfrac{V_{ab}}{V_{db}}\le 1$

$p=\dfrac{\text{接入部分的电压}}{\text{回路两端总电压}}$

功率等效：$\dfrac{V_{ab}^2}{z}=\dfrac{V_{ab}^2}{z'}\Rightarrow Z'=(\dfrac{V_{db}}{V_{ab}})^2 Z=(\dfrac{1}{p^2})Z$

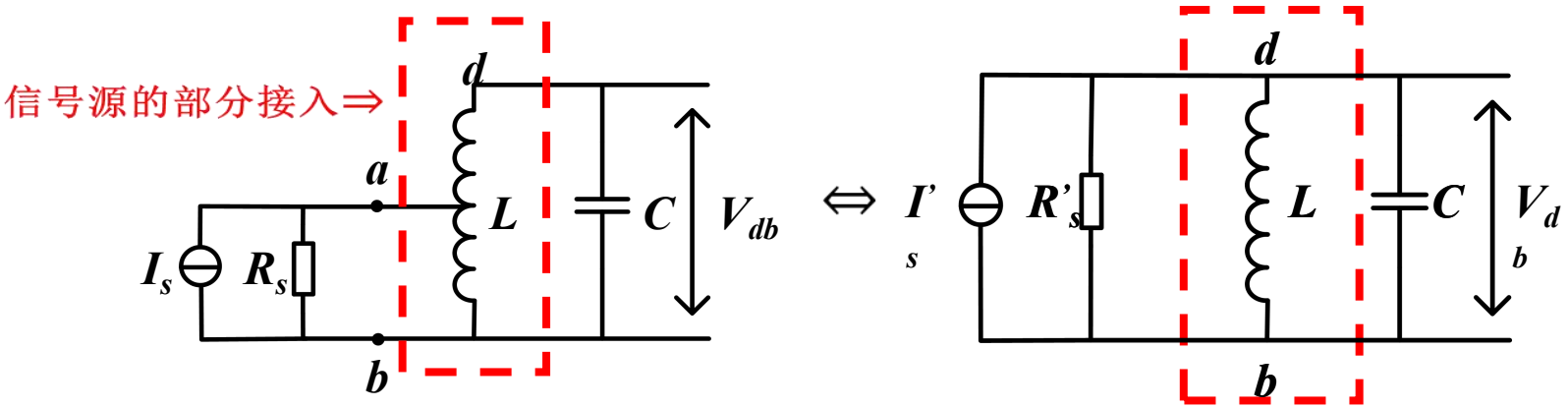
表明：低抽头→高抽头，等效电阻/电抗提高 $\dfrac{1}{p^2}$ 倍

电压提高 $\dfrac{1}{p}$ 倍

电流降低 p 倍

2.2 阻抗变换

抽头（部分接入）



低抽头→高抽头：

$R_s^{'} = \frac{1}{p^2} R_s \Leftrightarrow$ 等效信号源内阻 $R_s^{'}$ 提高 $\frac{1}{p}$ 倍

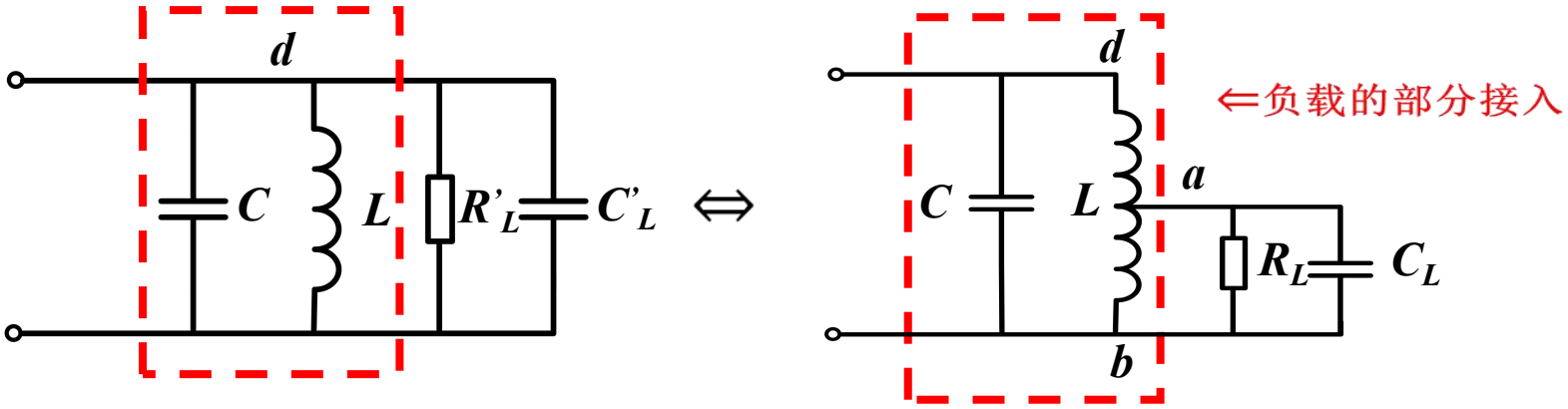
$I_s^{'} = p \bullet I_s \Leftrightarrow$ 等效信号源电流 $I_s^{'}$ 降低 p 倍

功率等效：

$I_s \bullet V_{db} = I_s^{'} \bullet V_{db}$

2.2 阻抗变换

抽头（部分接入）



低抽头→高抽头：

$R_L^{'} = \frac{1}{p^2} R_L \Leftrightarrow$ 等效负载点阻 $R_L^{'}$ 提高 $\frac{1}{p^2}$ 倍

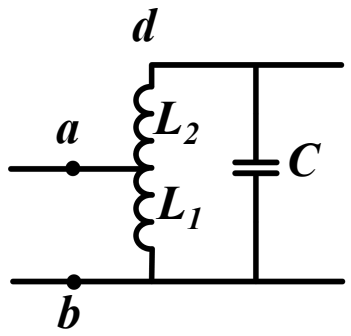
$\frac{1}{\omega C_L^{'}} = \frac{1}{p^2} \bullet \frac{1}{\omega C_L} \Leftrightarrow$ 等效容抗 $\frac{1}{\omega C_L^{'}}$ 提高 $\frac{1}{p^2}$ 倍

$\Rightarrow C_L^{'} = p^2 \bullet C_L \Leftrightarrow$ 等效负载电容 $C_L^{'}$ 降低 p^2 倍

2.2 阻抗变换

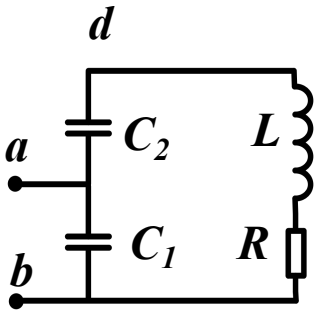
抽头（部分接入）

电感抽头



不考虑L_1和L_2之间的互感　$M: p=\dfrac{N_1}{N_1+N_2}$

$$C=\frac{C_1C_2}{C_1+C_2}$$



$$p=\frac{C}{C_1}=\frac{C_1}{C_1+C_2}$$

电容抽头

注：当外接在*ab*端的阻抗远大于ωL_1或$\dfrac{1}{\omega C_1}$时才成立

定义接入系数：$p=\dfrac{\text{转换前的圈数（或容抗）}}{\text{转换后的圈数（或容抗）}}$

变换关系：$R_L'=\dfrac{R_L}{p^2},X_L'=\dfrac{X_L}{p^2},U_g'=\dfrac{U_g}{p};$

$g_L'=p^2g_L,C_L'=p^2C_L,I_g'=pI_g$

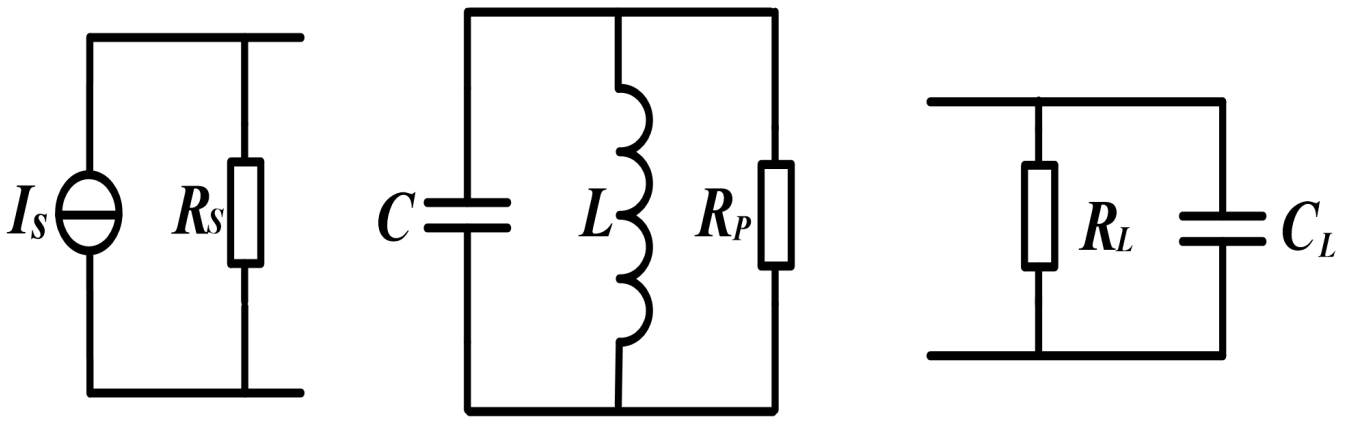
2.2 阻抗变换

抽头（部分接入）

抽头本质　阻抗转换

低抽头⟶高抽头　⇔　等效阻抗提高$\frac{1}{p^2}$倍

抽头目的　减小信号源内阻和负载对回路的影响



2.2 阻抗变换

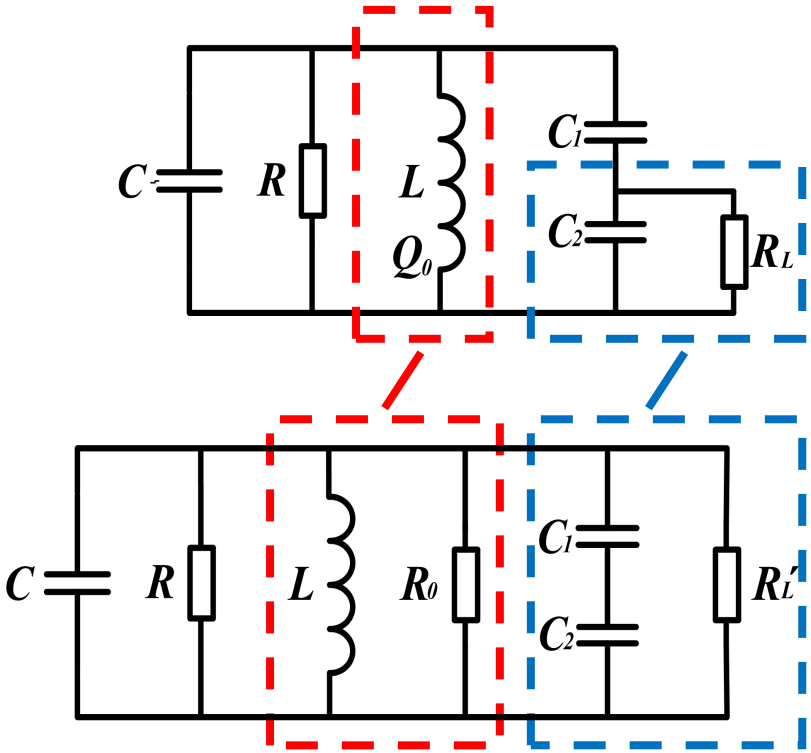
例1： 右图等效电路中 $L=0.8uH$,

$Q_0=100, C=5pF, C_1=20pF,$

$C_2=20pF, R=10k\Omega, R_L=5k\Omega$

计算回路的谐振频率、谐振电阻。

解： 画出等效电路如右图：



接入系数：$p=\dfrac{\dfrac{1}{\omega C_2}}{\dfrac{1}{\omega C_1}+\dfrac{1}{\omega C_2}}=\dfrac{C_1}{C_1+C_2}=\dfrac{1}{2},$

$R_L'=\dfrac{R_L}{p^2}=20k\Omega \qquad R_0=\omega_0 L Q_0$

2.2 阻抗变换

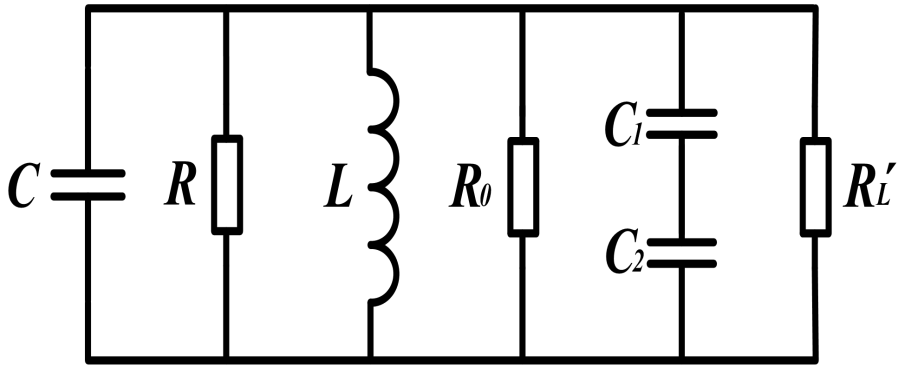
回路总电容：$C_\Sigma = C + \dfrac{C_1 C_2}{C_1 + C_2} = 5 + \dfrac{20 \times 20}{20 + 20} = 15(pF)$

求谐振频率：$f_0 = \dfrac{1}{2\pi\sqrt{LC_\Sigma}} = \dfrac{1}{2\pi\sqrt{0.8 \times 10^{-6} \times 15 \times 10^{-12}}} = 45.97(MHz)$

求谐振电阻：

$$R_0 = \omega_0 L Q_0$$
$$= 2\pi \times 45.97 \times 10^6 \times 0.8 \times 10^{-6} \times 100$$
$$= 23.09(k\Omega)$$

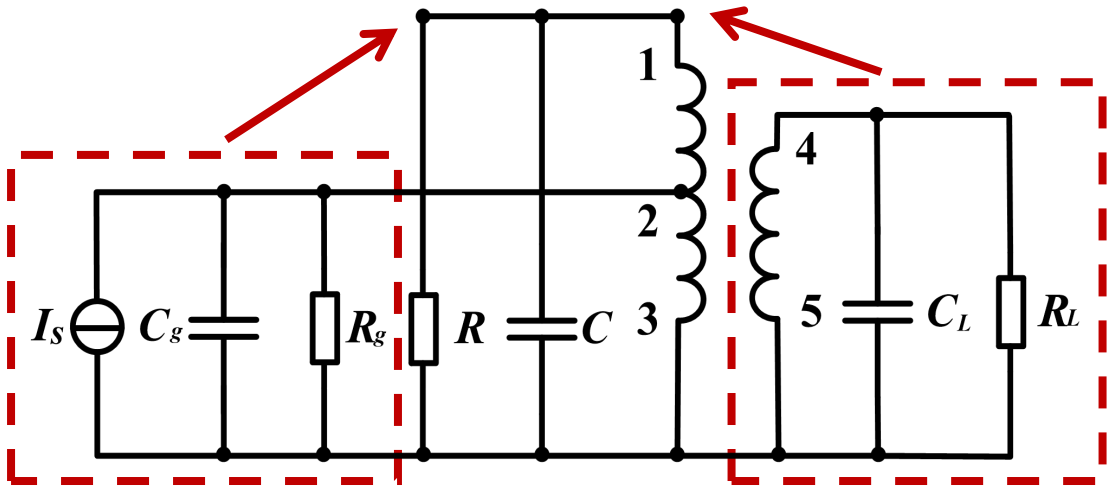
$$R_p = \frac{1}{\dfrac{1}{R} + \dfrac{1}{R_0} + \dfrac{1}{R_L'}} = 5.17(k\Omega)$$



2.2 阻抗变换

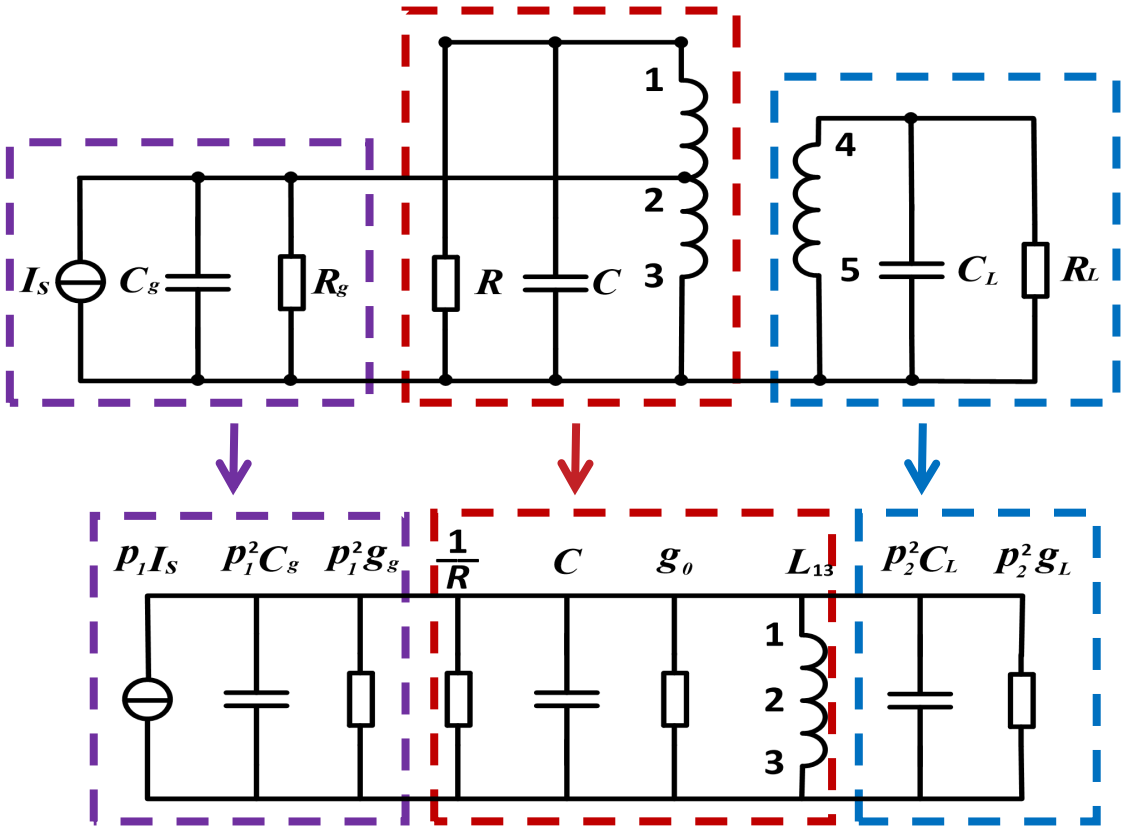
例2：电路如图所示，给定参数为

$$f_0 = 30MHz, C = 20\,pF, \text{线圈} L_{13} \text{的} Q_0 = 60,$$
$$N_{12} = 6, N_{23} = 4, N_{45} = 3, R_g = 10k\Omega, R = 2.5k\Omega,$$
$$R_L = 830k\Omega, C_g = 9\,pF, C_L = 12\,pF, \text{求} L_{13}, Q_L$$



2.2 阻抗变换

分析：计算之前要画等效电路，画等效电路时要注意两点:(1)L为有损电感要补充损耗电阻(2)L要进行等效电路变换

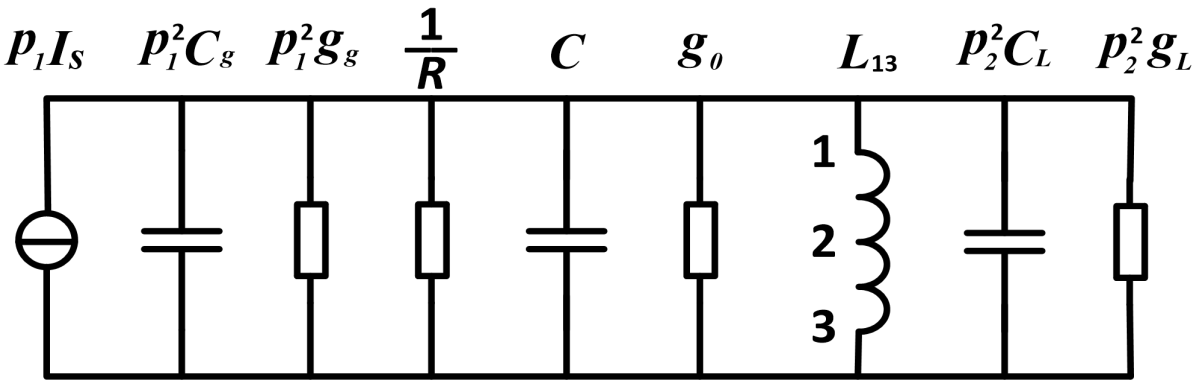


$$p_1 = \frac{N_{23}}{N_{13}}$$

$$p_2 = \frac{N_{45}}{N_{13}}$$

2.2 阻抗变换

解：等效电路如下：



$$p_1 = \frac{N_{23}}{N_{13}} = 0.4,\ p_2 = \frac{N_{45}}{N_{13}} = 0.3,\ g_g = \frac{1}{R_g},\ g_L = \frac{1}{R_L},\ g_0 = \frac{1}{R_0}$$

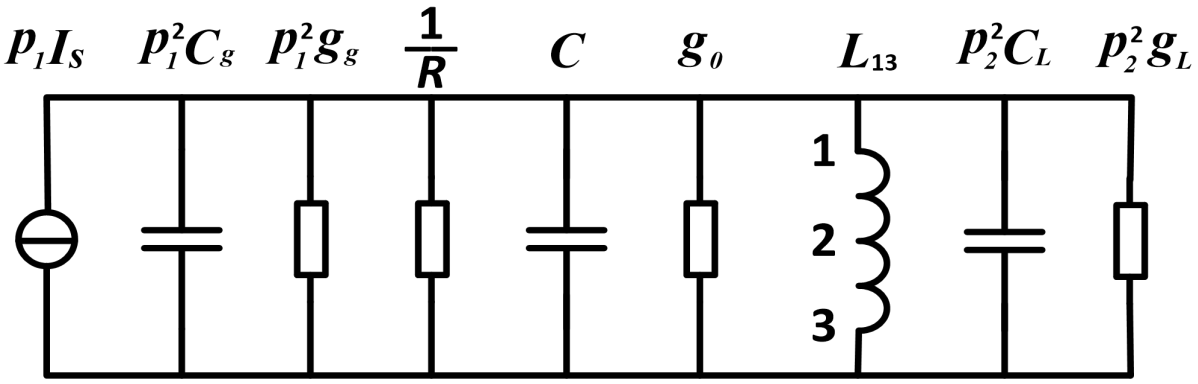
(1) 求 L_{13}

$$C_\Sigma = p_1^{\ 2} C_g + C + p_2^{\ 2} C_L = 0.4^2 \times 9 + 20 + 0.3^2 \times 12 = 22.52(pF)$$

$$L_{13} = \frac{1}{(2\pi f_0)^2 C_\Sigma} = \frac{1}{(2\pi \times 30 \times 10^6)^2 \times 22.52 \times 10^{-12}} = 1.25(uH)$$

2.2 阻抗变换

(2) 求 Q_L



$$g_0 = \frac{1}{R_0} = \frac{1}{\omega_0 L_{13} Q_0} = \frac{1}{2\pi \times 30 \times 10^6 \times 1.25 \times 10^{-6} \times 60} = 70.7(uS)$$

$$g_\Sigma = p_1^{\,2} g_g + \frac{1}{R} + g_0 + p_2^{\,2} g_L$$

$$= 0.4^2 \frac{1}{2.5 \times 10^3} + \frac{1}{10 \times 10^3} + 70.7 \times 10^{-6} + 0.3^2 \frac{1}{830 \times 10^3}$$

$$= 343.1(uS)$$

$$Q_L = \frac{1}{\omega_0 L_{13} g_\Sigma} = \frac{1}{2\pi \times 30 \times 10^6 \times 1.25 \times 10^{-6} \times 343.1 \times 10^{-6}} = 12.37$$