یا لطیف

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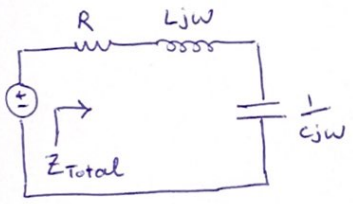
۹۸۱۴۳۰۴۳
تمرین سری ۱ مدار مخابراتی

2 a) $\omega_T = ?$, $Q = ?$ $BW = ?$



$$\Rightarrow Z_{Total} = R + LjW + \frac{1}{CjW} = R + j\frac{-1+LW^2C}{CW}$$

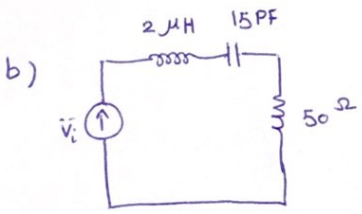
$$W_o = Im\left\{Z_{Total}\right\} = 0$$

$$\Rightarrow \frac{-1+LW^2C}{CW} = 0 \Rightarrow W_o^2 = \frac{1}{LC} \Rightarrow \boxed{W_o = \frac{1}{\sqrt{LC}}}$$

$$|Z_{Total}| = \sqrt{R^2 + \left(\frac{-1+LW^2C}{CW}\right)^2} = \frac{1}{CW}\cdot\left[1+R^2C^2W^2-2LW^2C+L^2W^4C^2\right]$$

$$BW = \frac{1}{CW}\cdot\left(1+R^2C^2W^2-2LW^2C+L^2W^4C^2\right) = \frac{1}{\sqrt{2}} \qquad Q = \frac{W_o}{BW}$$

b)



$$W_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times10^{-6}\times15\times10^{-12}}} = 182.57\times10^6 \left(\frac{Rad}{s}\right)$$

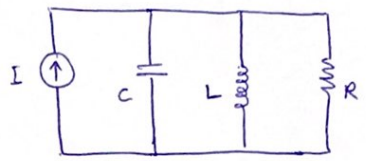
$$BW = \frac{1}{15\times10^{-12}W}\cdot\left(1+\left(50^2\times(15\times10^{-12})^2W^2-\cdots\right)\right) = \frac{1}{\sqrt{2}}$$

$$W_{1,2} = \frac{\pm1}{2LC}\cdot\left[\left(-2C^2R^2+4LC+C^2+\left(8LC^3+4C^4R^4-16LC^3R^2-4C^4R^2+C^4\right)^{1/2}\right)^{1/2}\right]$$

$$\begin{cases} W_1 = ? \\ W_2 = ? \end{cases}$$

#5

$$\begin{cases} Q_C = 100 \\ Q_L = 80 \\ \omega_o = 100\ MHz \\ C = 25\ pF \\ R = 100^K \end{cases} \qquad BW = ?$$



$$\Rightarrow \omega_o = \frac{1}{\sqrt{LC}} \Rightarrow L = \frac{1}{C\omega_o^2} = \frac{1}{25\times10^{-12}\times(100\times10^6)^2} = 4^{\mu H}$$

$$Q_L = \frac{R_{tL}}{L\omega_o} \Rightarrow R_{tL} = Q_L\omega_o L \quad OR \quad R_{tL} = \frac{Q_L}{C\omega_o} = \frac{80}{25\times10^{-12}\times100\times10^6} = 32^K$$

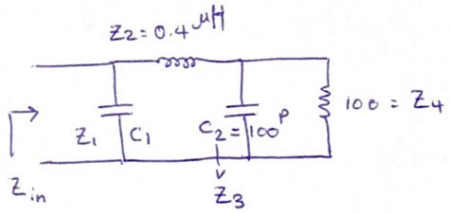
$$\Rightarrow R = 100^K \,||\, 32^K = \frac{3200}{132} = 24.24^K$$

$$\Rightarrow Q_T = RC\omega_o = 24.24^K \times 25^{pF} \times 100^{MHz} = 60.6$$

$$\Rightarrow BW = \frac{\omega_o}{Q} = \frac{100^{MHz}}{60.6} = 1.65^{MHz}$$

#6

$$\begin{cases} C_2 = 100\ pF \\ C_1 = ? \longrightarrow Im\{Z_{in}\}\big|_{f=20^{MHz}} = 0 \end{cases}$$



$$Z_{in} = Z_1 \,||\, \overbrace{\left[(Z_3||Z_4)+Z_2\right]}^{Z_H} \Rightarrow \begin{cases} Z_1 = \frac{1}{C_1 S} \\ Z_2 = LS = 0.4\times10^{-6}S \\ Z_3 = \frac{1}{C_2 S} = \frac{1}{100\times10^{-12}S}, \quad Z_4 = 100 \end{cases}$$

$$Z_3||Z_4 = \frac{Z_3Z_4}{Z_3+Z_4} = \frac{\frac{100}{100\times10^{-12}S}}{100+\frac{1}{100\times10^{-12}S}} = \frac{\frac{10^{12}}{S}}{100+\frac{10^{10}}{S}} = \frac{\frac{10^{12}}{S}}{\frac{1}{S}(10^{10}+100S)} = \frac{10^{12}}{10^{10}+100S}$$

$$Z_H = 0.4\times10^{-6}S + \frac{10^{12}}{10^{10}+100S} \Rightarrow Z_{in} = \frac{1}{C_1S} \,||\, \left[0.4\times10^{-6}S + \frac{10^{12}}{10^{10}+100S}\right]$$

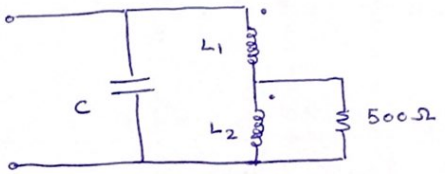
$$= \frac{C_1S\left[0.4S(S+10^8)+10^{16}\right]}{0.4S(S+10^8)+10^{16}+10^6C_1S(S+10^8)} \xrightarrow{S=j20\times10^6} \frac{1.88\times10^{22}C_1 + 4\times10^{44}C_1^2}{9.74\times10 + 4.16\times10^{42}C_1^2 - 4.67\times10^{36}C_1}$$

$$+ j\,\frac{1.94\times10^{39}C_1 - 4.67\times10^{43}C_1^2}{9.74\times10^{31} + 4.16\times10^{42}C_1^2 - 4.67\times10^{36}C} \Rightarrow \mathrm{Im}\{Z_{in}\} = 0$$

$$\Rightarrow \boxed{C_1 \cong 40\ \mu F}$$

#8

$$\begin{cases} C = ? \\ \omega_o = 1\ MHz \\ Q = ? \\ M = 8\ \mu H \\ L_1 = L_2 = 20\ \mu H \end{cases}$$



$$L = L_1 + L_2 = 2(20) = 40\ \mu H \Rightarrow \omega_o = \frac{1}{\sqrt{LC}} \Rightarrow C = \frac{1}{L\omega_o^2} = \frac{1}{40\times10^{-6}\times1\times10^{6}}$$

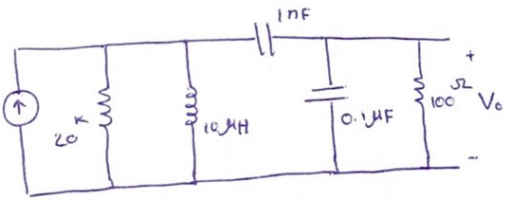
$$\Rightarrow C = 0.025\ F = 25\ mF$$

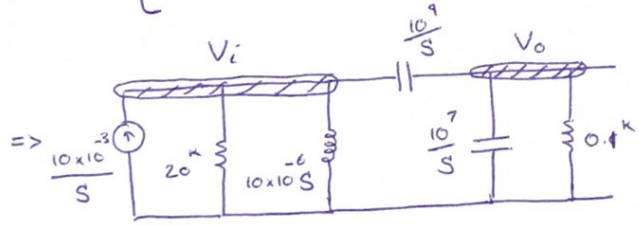
$$Q_E = \frac{L_1+L_2}{\omega_o + GL_1L_2} = \frac{20\ \mu H + 20\ \mu H}{1\ MHz + \frac{20\mu\times20\mu}{500}} = 4\times10^{-11}$$

$$Q'_T = \frac{\omega_o C}{n^2 G} = \frac{\omega_o C}{\left(\frac{L_2}{L_1+L_2}\right)^2 \cdot G} = \frac{25\times10^{-3}\times10^{6}}{\left(\frac{20\times10^{-6}}{40\times10^{-6}}\right)^2 \times \frac{1}{500}} = \boxed{50\times10^{6}}$$

#9

$$\begin{cases} A_{in} = 10\ mA \\ V_{out} = ? \end{cases}$$





KCL in Vi : $-\frac{1}{S}\times10\times10^{-3} + \frac{V_i}{20^K} + \frac{V_i - 0}{10\times10^{-6}S} + \frac{V_i - V_o}{\frac{10^9}{S}} = 0$

$$\Rightarrow \frac{-10^{-2}}{S} + 5V_i\times10^{-5} + \frac{10^5 V_i}{S} + 10^{-9}SV_i = 10^{-9}SV_o$$

$$\Rightarrow V_i\left(5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S\right) = 10^{-9}SV_o + \frac{10^{-2}}{S} \Rightarrow V_i = \frac{10^{-9}SV_o + \frac{10^{-2}}{S}}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S} \quad (I)$$

KCL in Vo : $\frac{V_o}{10^{-4}} + \frac{V_o}{\frac{10^7}{S}} + \frac{V_o - V_i}{\frac{10^9}{S}} = 0 \Rightarrow V_o\left(10^4 + 10^{-7}S + 10^{-9}S\right) = 10^{-9}SV_i \quad (II)$

(I) in (II) $\rightarrow$ $V_o\left(10^4 + 10^{-7}S\right) = 10^{-9}S\left[\dfrac{10^{-9}SV_o + \dfrac{10^{-2}}{S}}{5\times10^{-5} + \dfrac{10^5}{S} + 10^{-9}S}\right]$

$$\Rightarrow V_o\left(10^4 + 10^{-7}S\right) = \frac{10^{-18}S^2V_o + 10^{-11}}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S} =$$

$$= \frac{10^{-18}S^2V_o}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S} + \frac{10^{-11}}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S}$$

$$\Rightarrow V_o\left[10^4 + 10^{-7}S - \frac{10^{-18}S^2}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S}\right] = \frac{10^{-11}}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S}$$

$$\Rightarrow V_o(S) = \frac{\dfrac{10^{-11}}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S}}{10^4 + 10^{-7}S - \dfrac{10^{-18}S^2}{5\times10^{-5} + \frac{10^5}{S} + 10^{-9}S}} \qquad \Rightarrow V_o(t) = L^{-1}\left\{V_o(S)\right\}$$