> #The equations are as follows. PAR is a function for the parallel impedance of two components.

> $$\frac{V_1 - V_i}{Z_S + \frac{1}{j\cdot\omega\cdot C_1}} + \frac{V_1}{PAR(3600, 20E3)} + \frac{V_1}{PAR\left(220, \frac{1}{j\cdot\omega\cdot C_E}\right)} - \beta\cdot i_b = 0,\ \frac{V_2}{1200} + \frac{V_2 - V_o}{\frac{1}{j\cdot\omega\cdot C_2}} + \beta\cdot i_b,\ \frac{V_o - V_2}{\frac{1}{j\cdot\omega\cdot C_2}} + \frac{V_o}{Z_L} = 0,\ i_b = \frac{V_i - V_1}{Z_S + \frac{1}{j\cdot\omega\cdot C_1}} - \frac{V_1}{PAR(3600, 20E3)}$$

> #The transfer function follows from the above equations.

> $$\frac{V_o}{V_i} = -\left(6.000000000\ 10^{14}\ \beta\ C_2\ Z_L\ \omega^2\ C_1\ \left(Z_S\ \omega\ C_1 - 1.\ j + 220.\ j\ \omega^2\ C_E\ Z_S\ C_1 + 220.\ \omega\ C_E\right)\right) \Big/ \left(1.100000000\ 10^{14}\ \omega^3\ C_1^2\ Z_S\ C_2\ Z_L - 6.432666667\ 10^{14}\ \omega\ C_2 + 1.100000000\ 10^{14}\ j\ \omega^4\ C_E\ Z_S^2\ C_1^2\ C_2\ Z_L - 7.211111109\ 10^{10}\ j\ \beta\ Z_S\ \omega^2\ C_1\ C_2\ Z_L - 7.211111109\ 10^{10}\ \beta\ Z_S\ \omega\ C_1 - 3.605555555\ 10^{10}\ \beta\ \omega\ C_2\ Z_L + 1.320000000\ 10^{17}\ \omega^3\ C_1^2\ Z_S\ C_2 + 6.432666667\ 10^{14}\ Z_S^2\ \omega^3\ C_1^2\ C_2 + 1.100000000\ 10^{14}\ \omega^3\ C_E\ Z_S^2\ C_1^2 - 1.100000000\ 10^{14}\ \omega\ C_1 - 1.100000000\ 10^{14}\ \omega\ C_E + 3.605555555\ 10^{10}\ j\ \beta + 3.605555555\ 10^{10}\ \beta\ Z_S^2\ \omega^3\ C_1^2\ C_2\ Z_L + 1.100000000\ 10^{14}\ \beta\ Z_S\ \omega^3\ C_1^2\ C_2\ Z_L + 2.200000000\ 10^{14}\ \omega^3\ C_E\ Z_S\ C_1\ C_2\ Z_L - 1.072111111\ 10^{12}\ j\ Z_S\ \omega^2\ C_1\ C_2\ Z_L + 1.320000000\ 10^{17}\ j\ \omega^4\ C_E\ Z_S^2\ C_1^2\ C_2 - 1.100000000\ 10^{14}\ j\ \beta\ \omega^2\ C_1\ C_2\ Z_L - 8.653333331\ 10^{13}\ j\ \beta\ Z_S\ \omega^2\ C_1\ C_2 - 5.360555555\ 10^{11}\ \omega\ C_2\ Z_L - 1.072111111\ 10^{12}\ Z_S\ \omega\ C_1 - 1.100000000\ 10^{14}\ \beta\ \omega\ C_1 - 4.326666666\ 10^{13}\ \beta\ \omega\ C_2 + 5.360555555\ 10^{11}\ j + 5.360555555\ 10^{11}\ Z_S^2\ \omega^3\ C_1^2\ C_2\ Z_L + 4.326666666\ 10^{13}\ \beta\ Z_S^2\ \omega^3\ C_1^2\ C_2 + 1.320000000\ 10^{17}\ \beta\ Z_S\ \omega^3\ C_1^2\ C_2 + 2.640000000\ 10^{17}\ \omega^3\ C_E\ Z_S\ C_1\ C_2 - 2.200000000\ 10^{14}\ j\ \omega^2\ C_E\ Z_S\ C_1 - 1.100000000\ 10^{14}\ j\ \omega^2\ C_1\ C_2\ Z_L - 1.286533333\ 10^{15}\ j\ Z_S\ \omega^2\ C_1\ C_2 - 1.100000000\ 10^{14}\ j\ \omega^2\ C_E\ C_2\ Z_L - 3.605555555\ 10^{10}\ j\ \beta\ Z_S^2\ \omega^2\ C_1^2 - 1.100000000\ 10^{14}\ j\ \beta\ \omega^2\ C_1^2\ Z_S - 1.320000000\ 10^{17}\ j\ \beta\ \omega^2\ C_1\ C_2 - 1.100000000\ 10^{14}\ j\ \omega^2\ C_1^2\ Z_S - 1.320000000\ 10^{17}\ j\ \omega^2\ C_1\ C_2 - 5.360555555\ 10^{11}\ j\ Z_S^2\ \omega^2\ C_1^2 - 1.320000000\ 10^{17}\ j\ \omega^2\ C_E\ C_2\right)$$

> #The denominator of this transfer function is

> $$-1.100000000\ 10^{14}\ \omega^3\ C_1^2\ Z_S\ C_2\ Z_L + 6.432666667\ 10^{14}\ \omega\ C_2 + 7.211111109\ 10^{10}\ \beta\ Z_S\ \omega\ C_1 + 3.605555555\ 10^{10}\ \beta\ \omega\ C_2\ Z_L - 1.320000000\ 10^{17}\ \omega^3\ C_1^2\ Z_S\ C_2 - 6.432666667\ 10^{14}\ Z_S^2\ \omega^3\ C_1^2\ C_2 - 1.100000000\ 10^{14}\ \omega^3\ C_E\ Z_S^2\ C_1^2 + 1.100000000\ 10^{14}\ \omega\ C_1$$

$$+ 1.100000000\ 10^{14}\ \omega\ C_E - 3.605555555\ 10^{10}\ \beta\ Z_S^2\ \omega^3\ C_1^2\ C_2\ Z_L$$
$$- 1.100000000\ 10^{14}\ \beta\ Z_S\ \omega^3\ C_1^2\ C_2\ Z_L - 2.200000000\ 10^{14}\ \omega^3\ C_E\ Z_S\ C_1\ C_2\ Z_L$$
$$+ 5.360555555\ 10^{11}\ \omega\ C_2\ Z_L + 1.072111111\ 10^{12}\ Z_S\ \omega\ C_1 + 1.100000000\ 10^{14}\ \beta\ \omega\ C_1$$
$$+ 4.326666666\ 10^{13}\ \beta\ \omega\ C_2 - 5.360555555\ 10^{11}\ j - 5.360555555\ 10^{11}\ Z_S^2\ \omega^3\ C_1^2\ C_2\ Z_L$$
$$- 4.326666666\ 10^{13}\ \beta\ Z_S^2\ \omega^3\ C_1^2\ C_2 - 1.320000000\ 10^{17}\ \beta\ Z_S\ \omega^3\ C_1^2\ C_2$$
$$- 2.640000000\ 10^{17}\ \omega^3\ C_E\ Z_S\ C_1\ C_2 + 1.100000000\ 10^{14}\ j\ \omega^2\ C_1^2\ Z_S$$
$$+ 1.320000000\ 10^{17}\ j\ \omega^2\ C_1\ C_2 + 5.360555555\ 10^{11}\ j\ Z_S^2\ \omega^2\ C_1^2$$
$$+ 1.320000000\ 10^{17}\ j\ \omega^2\ C_E\ C_2 + 1.100000000\ 10^{14}\ j\ \beta\ \omega^2\ C_1\ C_2\ Z_L$$
$$+ 1.072111111\ 10^{12}\ j\ Z_S\ \omega^2\ C_1\ C_2\ Z_L + 8.653333331\ 10^{13}\ j\ \beta\ Z_S\ \omega^2\ C_1\ C_2$$
$$+ 2.200000000\ 10^{14}\ j\ \omega^2\ C_E\ Z_S\ C_1 + 1.100000000\ 10^{14}\ j\ \omega^2\ C_1\ C_2\ Z_L$$
$$+ 1.286533333\ 10^{15}\ j\ Z_S\ \omega^2\ C_1\ C_2 + 1.100000000\ 10^{14}\ j\ \omega^2\ C_E\ C_2\ Z_L$$
$$+ 3.605555555\ 10^{10}\ j\ \beta\ Z_S^2\ \omega^2\ C_1^2 + 1.100000000\ 10^{14}\ j\ \beta\ \omega^2\ C_1^2\ Z_S$$
$$+ 1.320000000\ 10^{17}\ j\ \beta\ \omega^2\ C_1\ C_2 - 1.320000000\ 10^{17}\ j\ \omega^4\ C_E\ Z_S^2\ C_1^2\ C_2$$
$$+ 7.211111109\ 10^{10}\ j\ \beta\ Z_S\ \omega^2\ C_1\ C_2\ Z_L - 3.605555555\ 10^{10}\ j\ \beta$$
$$- 1.100000000\ 10^{14}\ j\ \omega^4\ C_E\ Z_S^2\ C_1^2\ C_2\ Z_L$$

> *#The input impedance is -$Z_S$*

$$> -Z_S = -\left(0.1000000000\left(-1.100000000\ 10^{13}\ \omega\ C_1 - 1.100000000\ 10^{13}\ j\ \beta\ \omega^2\ C_1\ C_2\ Z_L\right.\right.$$
$$- 1.072111111\ 10^{11}\ \omega\ C_2\ Z_L - 2.640000000\ 10^{16}\ j\ \omega^2\ C_E\ C_2$$
$$- 1.320000000\ 10^{16}\ j\ \omega^2\ C_1\ C_2 - 1.100000000\ 10^{13}\ j\ \omega^2\ C_1\ C_2\ Z_L + 1.072111111\ 10^{11}\ j$$
$$- 8.653333331\ 10^{12}\ \beta\ \omega\ C_2 + 7.211111109\ 10^{9}\ j\ \beta - 1.320000000\ 10^{16}\ j\ \beta\ \omega^2\ C_1\ C_2$$
$$- 1.100000000\ 10^{13}\ \beta\ \omega\ C_1 - 2.200000000\ 10^{13}\ \omega\ C_E - 7.211111109\ 10^{9}\ \beta\ \omega\ C_2\ Z_L$$
$$- 2.200000000\ 10^{13}\ j\ \omega^2\ C_E\ C_2\ Z_L - 1.286533333\ 10^{14}\ \omega\ C_2$$
$$+ \left(-1.442222222\ 10^{10}\ \beta^2\ \omega^2\ C_2^2\ Z_L^2 - 1.742400000\ 10^{32}\ \beta^2\ \omega^4\ C_1^2\ C_2^2\right.$$
$$- 8.800000000\ 10^{13}\ \omega^2\ C_E\ \beta\ C_2\ Z_L - 2.420000000\ 10^{26}\ \omega^4\ C_1^2\ C_2^2\ Z_L^2\ \beta$$
$$- 5.808000000\ 10^{29}\ \omega^4\ C_1^2\ C_2^2\ Z_L\ \beta - 1.210000000\ 10^{26}\ \beta^2\ \omega^4\ C_1^2\ C_2^2\ Z_L^2$$
$$- 2.904000000\ 10^{29}\ \beta^2\ \omega^4\ C_1^2\ C_2^2\ Z_L - 1.730666666\ 10^{16}\ \beta^2\ \omega^2\ C_2^2$$
$$+ 1.210000000\ 10^{26}\ \beta^2\ \omega^2\ C_1^2 - 1.742400000\ 10^{32}\ \omega^4\ C_1^2\ C_2^2 - 1.029226667\ 10^{19}\ \omega^2\ C_2^2$$
$$\left.\left.+ 2.144222222\ 10^{11}\ \beta - 8.576888888\ 10^{15}\ \omega^2\ C_2^2\ Z_L - 3.484800000\ 10^{32}\ \omega^4\ C_1^2\ C_2^2\ \beta\right.\right.$$

$$
\begin{aligned}
&- 1.210000000\ 10^{26}\ \omega^4\ C_1^2\ C_2^2\ Z_L^2 - 2.904000000\ 10^{29}\ \omega^4\ C_1^2\ C_2^2\ Z_L \\
&- 4.840000000\ 10^{16}\ \beta^2\ \omega^2\ C_2\ C_1 - 9.680000000\ 10^{16}\ \beta\ \omega^2\ C_2\ C_E \\
&- 3.172888888\ 10^{13}\ \beta^2\ \omega^2\ C_2^2\ Z_L + 8.576888888\ 10^{15}\ \mathrm{j}\ \omega\ C_2 + 4.840000000\ 10^{26}\ \mathrm{j}\ \beta\ \omega^3 \\
&C_1^2\ C_2\ Z_L - 9.284000000\ 10^{17}\ \mathrm{j}\ \omega^3\ C_1\ C_2^2\ Z_L\ \beta - 2.200000000\ 10^{13}\ \mathrm{j}\ \omega^3\ C_1\ C_2^2\ Z_L^2\ \beta \\
&- 9.680000000\ 10^{16}\ \mathrm{j}\ \omega^3\ C_E\ C_2^2\ Z_L\ \beta - 4.400000000\ 10^{13}\ \mathrm{j}\ \omega^3\ C_E\ C_2^2\ Z_L^2\ \beta \\
&- 4.840000000\ 10^{16}\ \mathrm{j}\ \beta^2\ \omega^3\ C_1\ C_2^2\ Z_L + 2.420000000\ 10^{26}\ \mathrm{j}\ \beta^2\ \omega^3\ C_1^2\ C_2\ Z_L \\
&- 2.200000000\ 10^{13}\ \mathrm{j}\ \beta^2\ \omega^3\ C_1\ C_2^2\ Z_L^2 - 9.284000000\ 10^{17}\ \beta\ \omega^2\ C_1\ C_2 \\
&- 8.800000000\ 10^{17}\ \omega^2\ C_1\ C_2 - 1.760000000\ 10^{18}\ \omega^2\ C_E\ C_2 \\
&- 4.400000000\ 10^{13}\ \beta\ \omega^2\ C_1\ C_2\ Z_L + 4.288444444\ 10^{11}\ \mathrm{j}\ \beta\ \omega\ C_2\ Z_L \\
&+ 5.808000000\ 10^{29}\ \mathrm{j}\ \beta\ \omega^3\ C_1^2\ C_2 + 2.420000000\ 10^{26}\ \mathrm{j}\ \omega^3\ C_1^2\ C_2\ Z_L \\
&+ 2.904000000\ 10^{29}\ \mathrm{j}\ \beta^2\ \omega^3\ C_1^2\ C_2 - 8.800000000\ 10^{17}\ \mathrm{j}\ \omega^3\ C_1\ C_2^2\ Z_L \\
&- 1.760000000\ 10^{18}\ \mathrm{j}\ \omega^3\ C_2^2\ Z_L\ C_E - 5.280000000\ 10^{19}\ \mathrm{j}\ \omega^3\ C_E\ C_2^2\ \beta \\
&- 1.082400000\ 10^{21}\ \mathrm{j}\ \beta\ \omega^3\ C_2^2\ C_1 - 2.640000000\ 10^{19}\ \mathrm{j}\ \beta^2\ \omega^3\ C_2^2\ C_1 \\
&+ 2.884444444\ 10^{10}\ \mathrm{j}\ \beta^2\ \omega\ C_2\ Z_L - 4.400000000\ 10^{13}\ \beta^2\ \omega^2\ C_1\ C_2\ Z_L \\
&- 2.144222222\ 10^{11}\ \omega^2\ C_2^2\ Z_L^2\ \beta - 1.048617778\ 10^{15}\ \omega^2\ C_2^2\ Z_L\ \beta - 9.495733332\ 10^{17}\ \omega^2 \\
&C_2^2\ \beta - 2.112000000\ 10^{21}\ \mathrm{j}\ \omega^3\ C_E\ C_2^2 + 3.172888888\ 10^{13}\ \mathrm{j}\ \beta^2\ \omega\ C_2 \\
&+ 2.200000000\ 10^{13}\ \mathrm{j}\ \beta^2\ \omega\ C_1 + 4.400000000\ 10^{13}\ \mathrm{j}\ \beta\ \omega\ C_E - 1.056000000\ 10^{21}\ \mathrm{j}\ \omega^3\ C_1 \\
&C_2^2 + 1.048617778\ 10^{15}\ \mathrm{j}\ \beta\ \omega\ C_2 + 2.200000000\ 10^{13}\ \mathrm{j}\ \beta\ \omega\ C_1 + 2.904000000\ 10^{29}\ \mathrm{j}\ \omega^3 \\
&C_1^2\ C_2 + 1.210000000\ 10^{26}\ \omega^2\ C_1^2 + 2.420000000\ 10^{26}\ \beta\ \omega^2\ C_1^2 + 1.442222222\ 10^{10}\ \beta^2\Big) \\
&{}^{1/2}\Big)\Big)\Big/\Big(\Big(7.21111111\ 10^{8}\ \mathrm{j}\ \beta\ \omega\ C_2\ Z_L + 2.200000000\ 10^{12}\ \mathrm{j}\ \omega\ C_E \\
&- 2.200000000\ 10^{12}\ \omega^2\ C_E\ C_2\ Z_L + 1.072111111\ 10^{10} + 1.072111111\ 10^{10}\ \mathrm{j}\ \omega\ C_2\ Z_L \\
&+ 8.653333332\ 10^{11}\ \mathrm{j}\ \beta\ \omega\ C_2 + 7.21111111\ 10^{8}\ \beta - 2.640000000\ 10^{15}\ \omega^2\ C_E\ C_2 \\
&+ 1.286533333\ 10^{13}\ \mathrm{j}\ \omega\ C_2\Big)\ C_1\ \omega\Big)
\end{aligned}
$$

*#Find the input impedance when $Z_L$ is $\infty$*

$$-Z_S = \left(1.100000000\ 10^{13}\ j\ \omega^2\ C_1\ C_2 + 1.100000000\ 10^{13}\ j\ \beta\ \omega^2\ C_1\ C_2 \right. \tag{1}$$
$$+ 4.472135954\ \left(-1.100000000\ 10^{12}\ j\ \omega^3\ C_2^2\ \beta\ C_1 - 1.100000000\ 10^{12}\ j\ \beta^2\ \omega^3\ C_2^2\ C_1\right.$$
$$- 2.200000000\ 10^{12}\ j\ \beta\ \omega^3\ C_2^2\ C_E - 7.21111111\ 10^8\ \beta^2\ \omega^2\ C_2^2 - 6.050000000\ 10^{24}\ \omega^4\ C_1^2\ C_2^2$$
$$- 1.210000000\ 10^{25}\ \beta\ \omega^4\ C_1^2\ C_2^2 - 1.072111111\ 10^{10}\ \omega^2\ C_2^2\ \beta - 6.050000000\ 10^{24}\ \beta^2\ \omega^4\ C_1^2$$
$$\left. C_2^2\right)^{1/2} + 1.072111111\ 10^{11}\ \omega\ C_2 + 2.200000000\ 10^{13}\ j\ \omega^2\ C_E\ C_2$$
$$\left. + 7.211111109\ 10^9\ \beta\ \omega\ C_2\right) \Big/ \left(7.211111110\ 10^9\ j\ \omega^2\ C_1\ C_2\ \beta\right.$$
$$\left. - 2.200000000\ 10^{13}\ \omega^3\ C_E\ C_1\ C_2 + 1.072111111\ 10^{11}\ j\ \omega^2\ C_1\ C_2\right)$$

*#Now short* $C_1$

$$-Z_S = \left(1.100000000\ 10^{12}\ j\ \omega^2\ C_2 + 1.100000000\ 10^{12}\ j\ \omega^2\ \beta\ C_2 \right. \tag{2}$$
$$\left. + 4.919349549\ 10^{11}\ \sqrt{-5.\ \omega^4\ C_2^2\ (\beta + 1.)^2}\right) \Big/ \left(7.21111111\ 10^8\ j\ \omega^2\ C_2\ \beta\right.$$
$$\left. - 2.200000000\ 10^{12}\ \omega^3\ C_E\ C_2 + 1.072111111\ 10^{10}\ j\ \omega^2\ C_2\right)$$

*#Now open* $C_E$

$$-Z_S = \left(1.100000000\ 10^{12}\ \omega^2\ C_2 + 1.100000000\ 10^{12}\ \beta\ \omega^2\ C_2 \right. \tag{3}$$
$$\left. - 4.919349549\ 10^{11}\ j\ \sqrt{-5.\ \omega^4\ C_2^2\ (\beta + 1.)^2}\right) \Big/ \left(7.21111111\ 10^8\ \beta\ \omega^2\ C_2\right.$$
$$\left. + 1.072111111\ 10^{10}\ \omega^2\ C_2\right)$$

*#Now short* $C_2$

$$-Z_S \tag{4}$$
$$= \frac{1}{7.21111111\ 10^8\ \beta\ \omega^2 + 1.072111111\ 10^{10}\ \omega^2}\left(1.100000000\ 10^{12}\ \omega^2\right.$$
$$\left. + 1.100000000\ 10^{12}\ \beta\ \omega^2 - 4.919349549\ 10^{11}\ j\ \sqrt{-5.\ \omega^4\ (\beta + 1.)^2}\right)$$

*#Simplify the expression*

$$-Z_S = \frac{2.199999999\ 10^{12} + 2.199999999\ 10^{12}\ \beta}{7.21111111\ 10^8\ \beta + 1.072111111\ 10^{10}} \tag{5}$$

*#Set* $\beta$ *to 100 and evaluate*

$$-Z_S = 2682.530952 \tag{6}$$

> *#which is the same as 3600||20000||220·101*

$$2682.530953 \tag{7}$$

*#The output impedance is* $-Z_L$ from *the transfer equation.*

> $$-Z_L = -\left(-6.432666667\,10^{14}\,\omega\,C_2 - 7.211111109\,10^{10}\,\beta\,Z_S\,\omega\,C_1 + 1.320000000\,10^{17}\,\omega^3\,C_1^2\,Z_S\,C_2 + 6.432666667\,10^{14}\,Z_S^2\,\omega^3\,C_1^2\,C_2 + 1.100000000\,10^{14}\,\omega^3\,C_E\,Z_S^2\,C_1^2 - 1.100000000\,10^{14}\,\omega\,C_1 - 1.100000000\,10^{14}\,\omega\,C_E + 3.605555555\,10^{10}\,j\,\beta + 1.320000000\,10^{17}\,j\,\omega^4\,C_E\,Z_S^2\,C_1^2\,C_2 - 8.653333331\,10^{13}\,j\,\beta\,Z_S\,\omega^2\,C_1\,C_2 - 1.072111111\,10^{12}\,Z_S\,\omega\,C_1 - 1.100000000\,10^{14}\,\beta\,\omega\,C_1 - 4.326666666\,10^{13}\,\beta\,\omega\,C_2 + 5.360555555\,10^{11}\,j + 4.326666666\,10^{13}\,\beta\,Z_S^2\,\omega^3\,C_1^2\,C_2 + 1.320000000\,10^{17}\,\beta\,Z_S\,\omega^3\,C_1^2\,C_2 + 2.640000000\,10^{17}\,\omega^3\,C_E\,Z_S\,C_1\,C_2 - 2.200000000\,10^{14}\,j\,\omega^2\,C_E\,Z_S\,C_1 - 1.286533333\,10^{15}\,j\,Z_S\,\omega^2\,C_1\,C_2 - 3.605555555\,10^{10}\,j\,\beta\,Z_S^2\,\omega^2\,C_1^2 - 1.100000000\,10^{14}\,j\,\beta\,\omega^2\,C_1^2\,Z_S - 1.320000000\,10^{17}\,j\,\beta\,\omega^2\,C_1\,C_2 - 1.100000000\,10^{14}\,j\,\omega^2\,C_1^2\,Z_S - 1.320000000\,10^{17}\,j\,\omega^2\,C_1\,C_2 - 5.360555555\,10^{11}\,j\,Z_S^2\,\omega^2\,C_1^2 - 1.320000000\,10^{17}\,j\,\omega^2\,C_E\,C_2\right) \Big/ \left(-1.100000000\,10^{14}\,\omega^3\,C_1^2\,Z_S\,C_2 - 5.360555555\,10^{11}\,Z_S^2\,\omega^3\,C_1^2\,C_2 + 1.100000000\,10^{14}\,j\,\omega^2\,C_1\,C_2 + 1.100000000\,10^{14}\,j\,\omega^2\,C_E\,C_2 - 1.100000000\,10^{14}\,\beta\,Z_S\,\omega^3\,C_1^2\,C_2 + 1.100000000\,10^{14}\,j\,\beta\,\omega^2\,C_1\,C_2 - 2.200000000\,10^{14}\,\omega^3\,C_E\,Z_S\,C_1\,C_2 + 1.072111111\,10^{12}\,j\,Z_S\,\omega^2\,C_1\,C_2 - 3.605555555\,10^{10}\,\beta\,Z_S^2\,\omega^3\,C_1^2\,C_2 + 3.605555555\,10^{10}\,\beta\,\omega\,C_2 + 7.211111109\,10^{10}\,j\,\beta\,Z_S\,\omega^2\,C_1\,C_2 - 1.100000000\,10^{14}\,j\,\omega^4\,C_E\,Z_S^2\,C_1^2\,C_2 + 5.360555555\,10^{11}\,\omega\,C_2\right)$$

#*Find the output impedance when* $Z_S = 0$

$$-Z_L = \left(-7.21111111\,10^{8}\,j\,\beta + 2.640000000\,10^{15}\,j\,\omega^2\,C_1\,C_2 + 2.640000000\,10^{15}\,j\,\omega^2\,C_E\,C_2 + 1.286533333\,10^{13}\,\omega\,C_2 + 2.200000000\,10^{12}\,\omega\,C_1 + 2.200000000\,10^{12}\,\omega\,C_E + 2.200000000\,10^{12}\,\beta\,\omega\,C_1 + 8.653333332\,10^{11}\,\beta\,\omega\,C_2 - 1.072111111\,10^{10}\,j + 2.640000000\,10^{15}\,j\,\beta\,\omega^2\,C_1\,C_2\right) \Big/ \left(1.072111111\,10^{10}\,\omega\,C_2 + 2.200000000\,10^{12}\,j\,\omega^2\,C_2\,\beta\,C_1 + 2.200000000\,10^{12}\,j\,\omega^2\,C_2\,C_1 + 2.200000000\,10^{12}\,j\,\omega^2\,C_E\,C_2 + 7.21111111\,10^{8}\,\beta\,\omega\,C_2\right) \quad \textbf{(8)}$$

> $\lim_{C_2 \to \infty} \textbf{(8)}$

$$-Z_L = \left(2.640000000\,10^{15}\,j\,\omega\,C_1 + 2.640000000\,10^{15}\,j\,\omega\,C_E + 1.286533333\,10^{13} + 2.640000000\,10^{15}\,j\,\beta\,\omega\,C_1 + 8.653333332\,10^{11}\,\beta\right) \Big/ \left(1.072111111\,10^{10} + 2.200000000\,10^{12}\,j\,\beta\,\omega\,C_1 + 2.200000000\,10^{12}\,j\,\omega\,C_1 + 2.200000000\,10^{12}\,j\,\omega\,C_E + 7.21111111\,10^{8}\,\beta\right)$$

> $\lim_{C_E \to 0}$ **??**

$$-Z_L = \left(2.640000000\ 10^{15}\ \mathrm{j}\ \omega\ C_1 + 1.286533333\ 10^{13} + 2.640000000\ 10^{15}\ \mathrm{j}\ \beta\ \omega\ C_1 + 8.653333332\ 10^{11}\ \beta\right) \Big/ \left(1.072111111\ 10^{10} + 2.200000000\ 10^{12}\ \mathrm{j}\ \beta\ \omega\ C_1 + 2.200000000\ 10^{12}\ \mathrm{j}\ \omega\ C_1 + 7.21111111\ 10^{8}\ \beta\right) \quad (9)$$

> $\lim_{C_1 \to \infty}$ (9)

$$-Z_L = 1200. \quad (10)$$

#*Short* $C_2$

$$-Z_L = \left(2.640000000\ 10^{15}\ \mathrm{j}\ \omega\ C_E + 1.286533333\ 10^{13} + 2.640000000\ 10^{15}\ \mathrm{j}\ \omega\ C_1 + 2.640000000\ 10^{15}\ \mathrm{j}\ \beta\ \omega\ C_1 + 8.653333332\ 10^{11}\ \beta\right) \Big/ \left(7.21111111\ 10^{8}\ \beta + 2.200000000\ 10^{12}\ \mathrm{j}\ \omega\ C_1 + 2.200000000\ 10^{12}\ \mathrm{j}\ \omega\ C_E + 2.200000000\ 10^{12}\ \mathrm{j}\ \beta\ \omega\ C_1 + 1.072111111\ 10^{10}\right) \quad (11)$$

#*Open* $C_E$

> $-Z_L = \left(2.640000000\ 10^{15}\ \mathrm{j}\ \omega\ C_1 + 1.286533333\ 10^{13} + 2.640000000\ 10^{15}\ \mathrm{j}\ \beta\ \omega\ C_1 + 8.653333332\ 10^{11}\ \beta\right) \Big/ \left(1.072111111\ 10^{10} + 2.200000000\ 10^{12}\ \mathrm{j}\ \beta\ \omega\ C_1 + 2.200000000\ 10^{12}\ \mathrm{j}\ \omega\ C_1 + 7.21111111\ 10^{8}\ \beta\right)$

#*Short* $C_1$

$$-Z_L = 1200. \quad (12)$$