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ECEN452 Ultra High Frequency
Lab1

Q1. Demonstrate the operation of Python installation by running the plotting program.

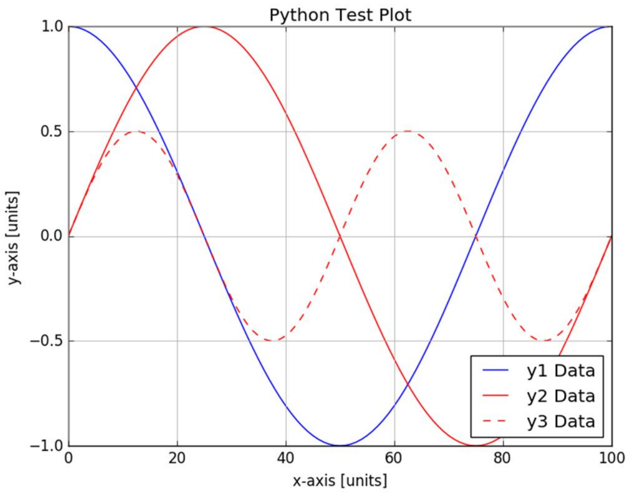

Figure 1. Python simulation result plotting

Q2. Already setup and email GitHub account (tim721w) to instructor.

Q3. Simulating the files provided in GitHub.

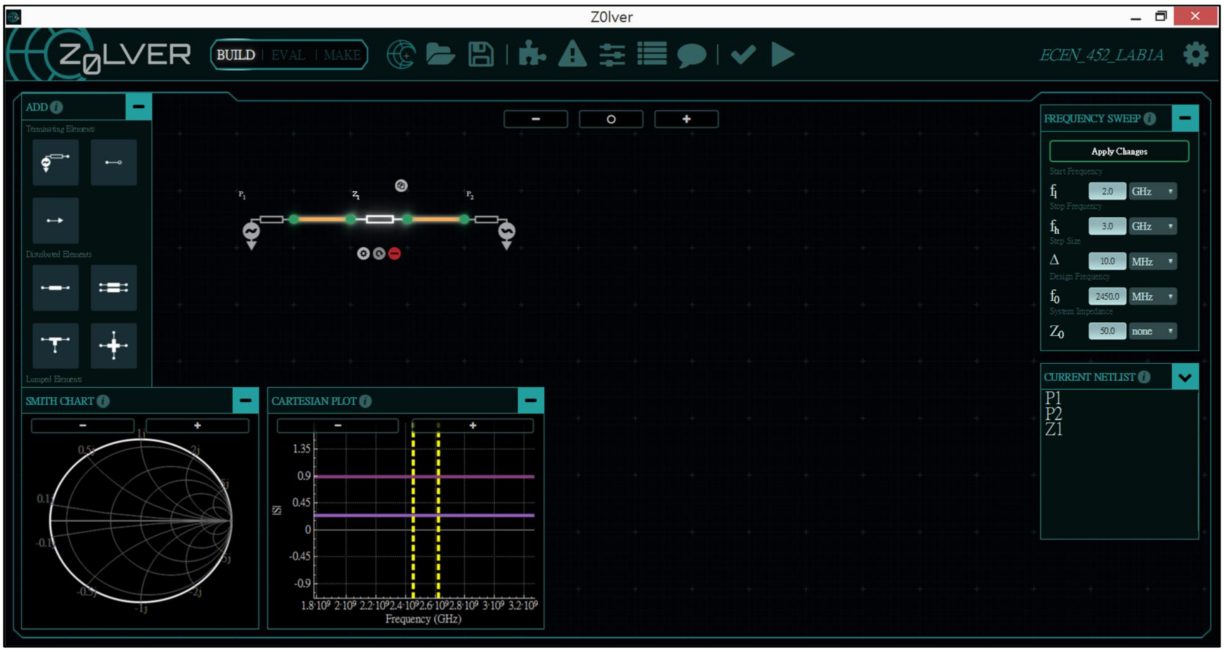

Figure 2. ECEN_452_Lab1a.zov simulation

Figure 3. ECEN_452_Lab1b.zov simulation

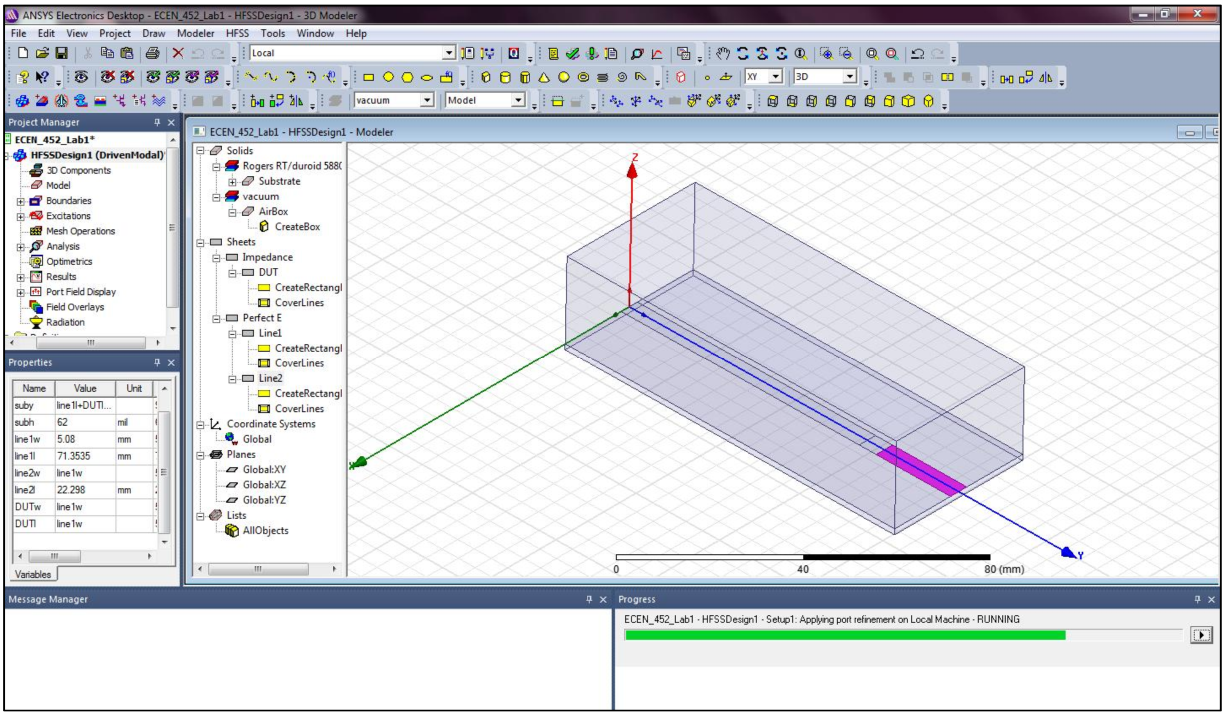

Figure 4. ECEN_452_Lab1.hfss simulation

Q4. Calculate the two-port S and ABCD matrices for a series impedance Z = 10 + j25 with system impedance 50 Ω and simulate in Z0lver. The circuit model is show in Figure 2. The S parameters are corresponded for both calculation and simulation results which is $|S_{11}| = |S_{22}| \cong 0.886$ and $|S_{12}| = |S_{21}| \cong 0.2386$

$$[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} = \begin{bmatrix} \frac{Z}{Z+2Z_0} & \frac{2Z_0}{Z+2Z_0} \\ \frac{2Z_0}{Z+2Z_0} & \frac{Z}{Z+2Z_0} \end{bmatrix}$$

$$= \begin{bmatrix} \frac{10+j25}{(10+j25)+2\times 50} & \frac{2\times 50}{(10+j25)+2\times 50} \\ \frac{2\times 50}{(10+j25)+2\times 50} & \frac{10+j25}{(10+j25)+2\times 50} \end{bmatrix}$$

$$= \begin{bmatrix} \frac{2+j5}{22+j5} & \frac{20}{22+j5} \\ \frac{20}{22+j5} & \frac{2+j5}{22+j5} \end{bmatrix} \cong \begin{bmatrix} 0.239e^{j55.39^\circ} & 0.886e^{-j12.8^\circ} \\ 0.886e^{-j12.8^\circ} & 0.239e^{j55.39^\circ} \end{bmatrix}$$

Since system impedance Z_0 is 50 Ω, therefore ABCD matrix can be written as:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & Z \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 10+j25 \\ 0 & 1 \end{bmatrix}$$

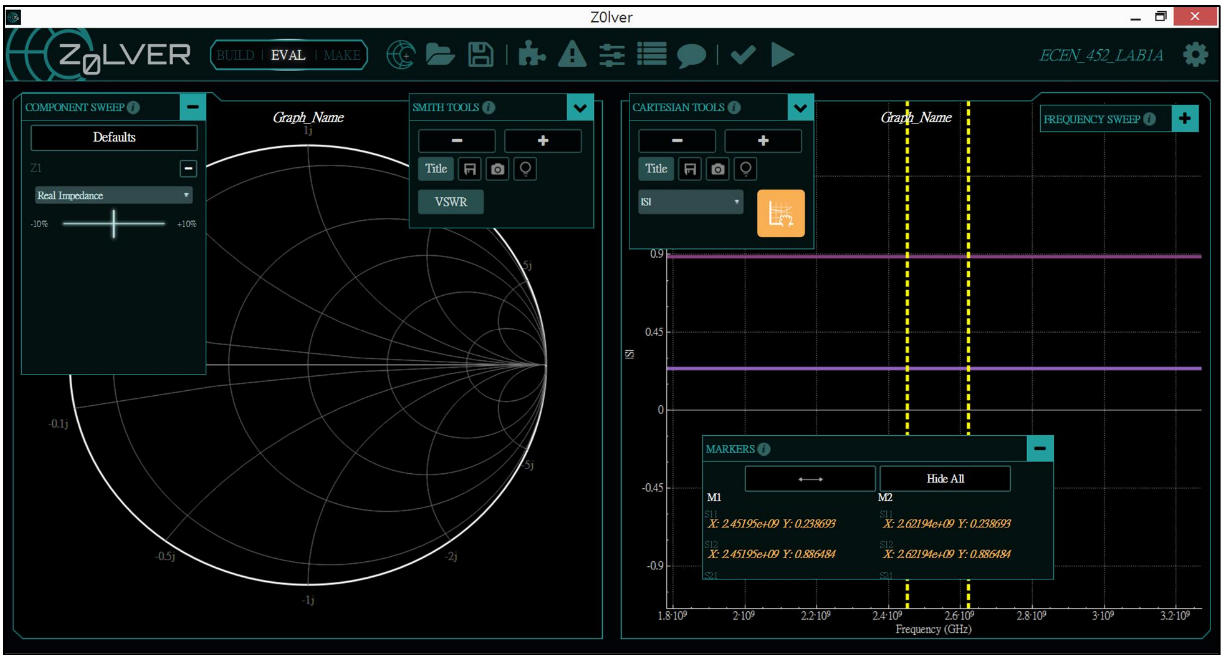

Figure 5. S_{11} simulation result plot in Z0lver

Q5. Shift the reference planes with a length 0.8 λ at Port 1 and 0.25 λ at Port 2.

$$[S'] = \begin{bmatrix} S_{11}' & S_{12}' \\ S_{21}' & S_{22}' \end{bmatrix} = \begin{bmatrix} S_{11}e^{-j2\theta_1} & S_{12}e^{-j(\theta_1+\theta_2)} \\ S_{21}e^{-j(\theta_1+\theta_2)} & S_{22}e^{-j2\theta_2} \end{bmatrix}$$

$$= \begin{bmatrix} 0.239e^{j55.39^\circ}e^{-j3.2\pi} & 0.886e^{-j12.8^\circ}e^{-j2.1\pi} \\ 0.886e^{-j12.8^\circ}e^{-j2.1\pi} & 0.239e^{j55.39^\circ}e^{-j\pi} \end{bmatrix}$$

$$= \begin{bmatrix} 0.239e^{-j16\ 06\ 1^\circ} & 0.886e^{j30.8^\circ} \\ 0.886e^{j30.8^\circ} & 0.239e^{-j124.6\ 1^\circ} \end{bmatrix}$$

The circuit model is shown in Figure 3.

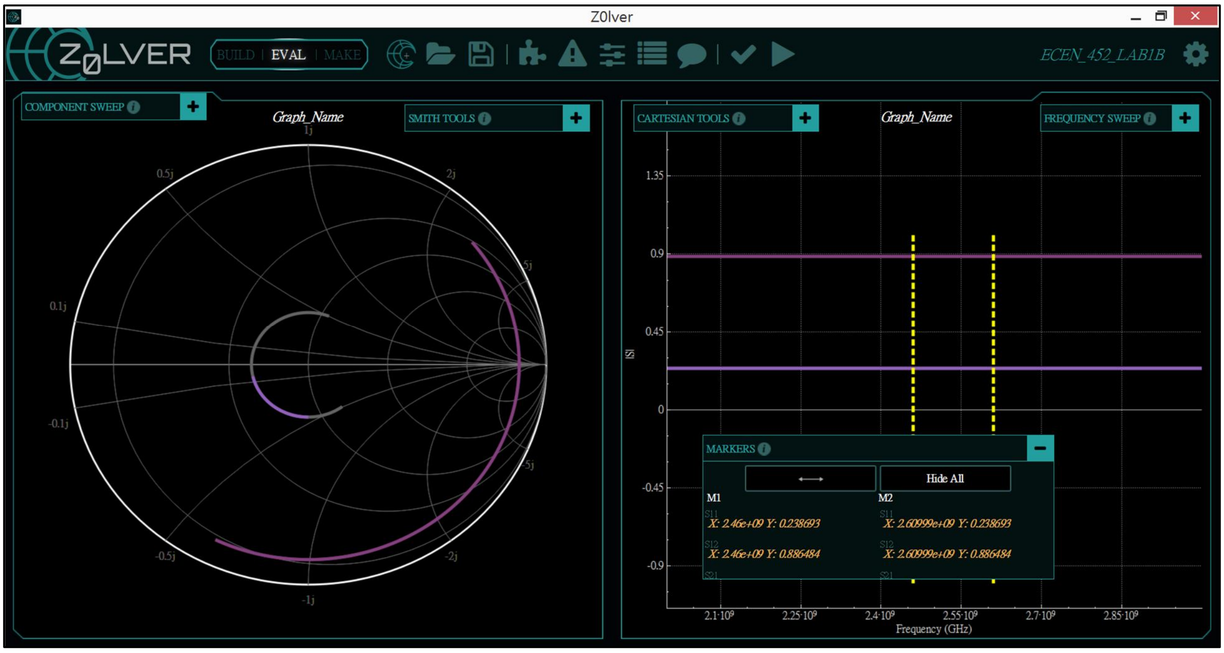

Figure 6. S_{11} simulation result plot in Z0lver

Q6. Create two separate plots comparing analytical, Z0lver and HFSS results.

The analytical results turn out that $|S_{11}| \cong 0.239 \cong -12.43\ dB$ and $|S_{21}| \cong 0.886 \cong -1.05\ dB$.

The Z0lver results turn out that $|S_{11}| \cong -14.3258\ dB$ and $|S_{21}| \cong -1.20492\ dB$.

The HFSS results turn out that $|S_{11}| \cong -12.1605\ dB$ and $|S_{21}| \cong -1.1961\ dB$.

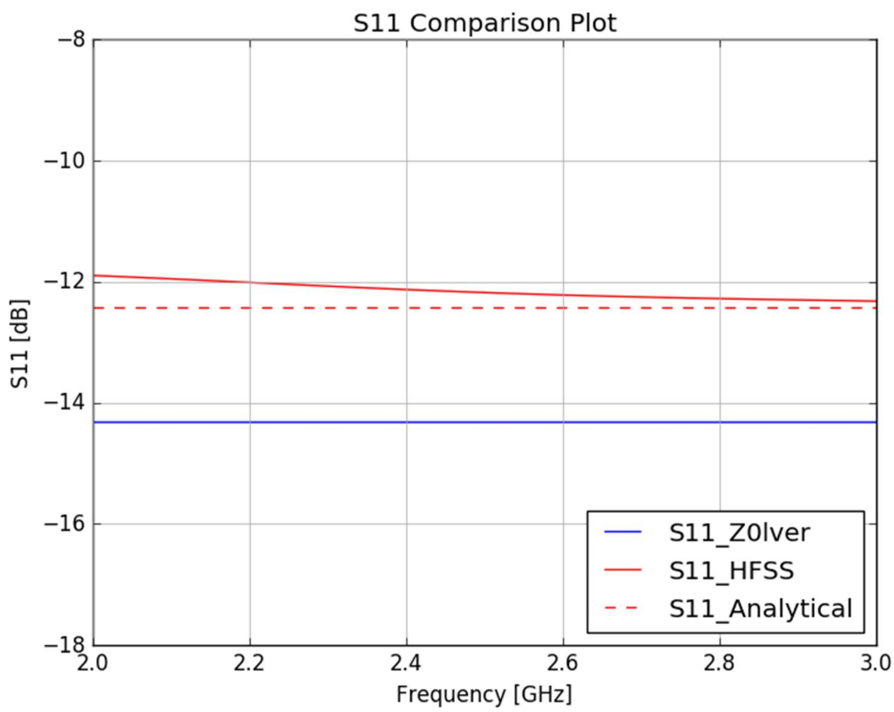

Figure 7. $|S_{11}|$ plotting

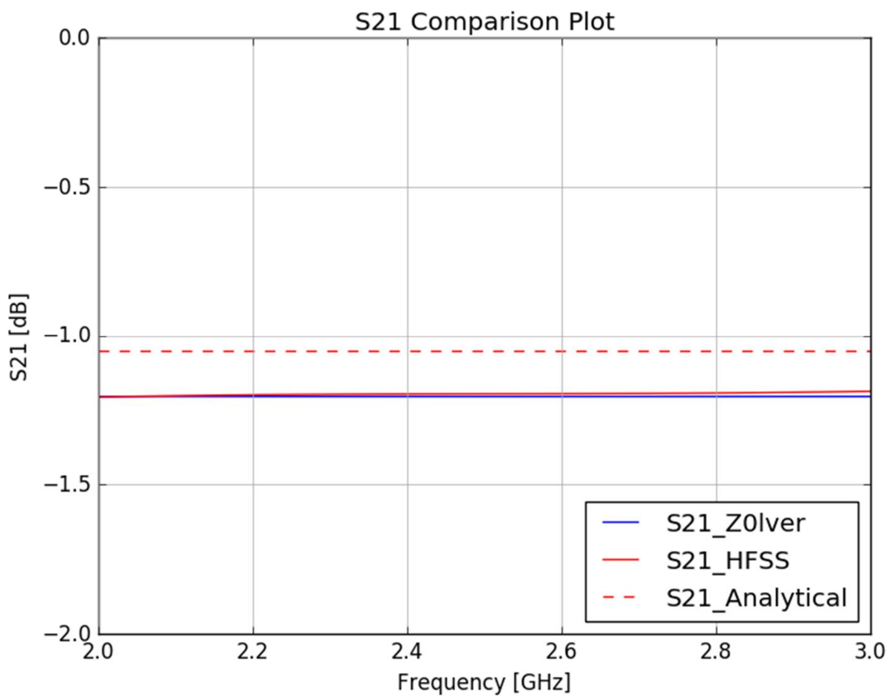

Figure 8. $|S_{21}|$ plotting

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Q7. Fill out the table below.

	FR4	Duroid 5880	Duroid 6006	Duroid 6010.2
ε_r	~4.4	~2.2	~6.15	~10.2
$Tan\ \delta$	0.018	0.0009	0.0027	0.0023

Q8. Fill out the table below.

	Type N	SMA	3.5 mm	2.92 mm	2.4 mm	1.85 mm
Type N	Y	N	N	N	N	N
SMA	N	Y	Y	Y	N	N
3.5 mm	N	Y	Y	Y	N	N
2.92 mm	N	Y	Y	Y	N	N
2.4 mm	N	N	N	N	Y	Y
1.85 mm	N	N	N	N	Y	Y