Cairo University Faculty of Engineering
Computer Engineering Department
CMPN202

PHYN212
Electromagnetics for Computer Engineers

Project

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Analytic formula & Result values:

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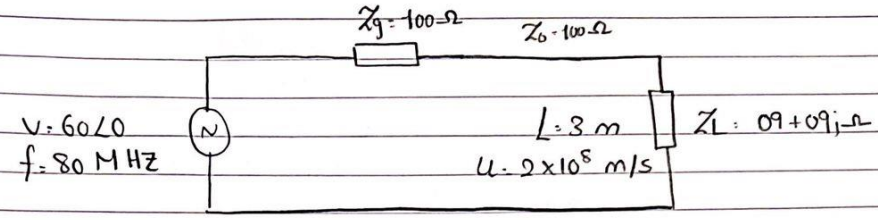
Project 1 EM



1) $\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{9+9j-100}{9+9j+100} = 0.83609\angle 169.6316$ ↳ degrees

$= -\frac{4919}{5981} + \frac{900}{5981}j = 0.83609\angle 2.96063$ ↳ radians

2) $VSWR = \frac{1+|\Gamma_L|}{1-|\Gamma_L|} = \frac{1+0.83609}{1-0.83609} = 11.20181$

3) $Z_{in}(0) = Z_0 \frac{Z_L + jZ_0\tan(\beta L)}{Z_0 + jZ_L\tan(\beta L)}$

to get $\beta = \frac{\omega}{u} = \frac{2\pi \times 80\times10^6}{2\times10^8} = 0.8\pi = 144°$ $\quad \beta l = 144\times3 = 432$
$432 - 360 = 72$ degrees

$Z_{in}(0) = 100 \times \frac{(9+9j)+j\times100\times\tan(0.8\pi\times3)}{100+j(9+9j)\tan(0.8\pi\times3)}$ → radians

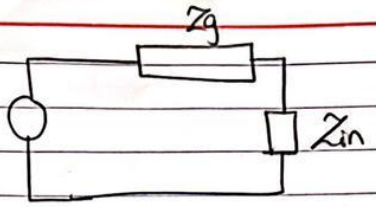
$900 + 31676.83537j$

$72.30084817 + 27.69915183j$

$= 409.2935\angle 1.17653$ → radians

$= 409.2935\angle 67.41$ → degrees

4)



$$I_{S(c)} = \frac{V_g}{Z_g + Z_{in}}$$

$$= \frac{60}{100 + 409.2935 \angle 67.41}$$

$$= 0.131254 \angle -55.7576 \rightarrow \text{degrees}$$
$$= 0.131254 \angle -0.97315 \rightarrow \text{radians}$$

5) $P_{avg} = \frac{1}{2} Re\left[V_{S(c)} \times I_{S(c)}^*\right]$

$$V_{S(c)} = \frac{V_g}{Z_g + Z_{in}} = I_{S(c)} * Z_{in}$$

$$= 53.7214 \angle 11.6524 \rightarrow \text{degrees}$$
$$= 53.7214 \angle 0.20337 \rightarrow \text{Radrans}$$

$$P_{avg} = \frac{1}{2} Re\left[53.7214 \angle 11.6524 * 0.131254 \angle 55.7576\right]$$

$$P_{avg} = \frac{1}{2} Re\left[2.70858 + 6.510j\right]$$

$$\frac{1}{2}\left[2.70858\right] = 1.35429 \text{ Watt}$$

6) $$P_{avg} = \frac{1}{2} \frac{|V_{0^+}|^2}{Z_0} \left[1 - |\Gamma_L|^2\right]$$

$$1.35429 = \frac{1}{2} \frac{|V_{0^+}|^2}{100} \left[1 - (0.83609)^2\right]$$

$$|V_{0^+}| = 29.99 \simeq 30$$

$$V_{max} = |V_{0^+}| \left[1 + |\Gamma_L|\right] = 30\left[1 + 0.83609\right] = 55.0827$$
$$V_{min} = |V_{0^+}| \left[1 - |\Gamma_L|\right] = 30\left[1 - 0.83609\right] = 4.9173$$
$$I_{max} = \frac{V_{max}}{Z_0} = \frac{55.0827}{100} = 0.550827 \text{ A}$$
$$I_{min} = \frac{V_{min}}{Z_0} = \frac{4.9173}{100} = 0.049173 \text{ A}$$

$$Z_{inmax} = \frac{V_{max}}{I_{min}} = 1120.18187 \qquad Z_{inmin} = \frac{V_{min}}{I_{max}} = 8.92712$$

7) $|V_{max}| = V_0^+ e^{-j\beta z}\left[1 + \Gamma_L e^{-j2\beta\ell}\right]$

$$55.0827 = 30\, e^{-j0.8\pi z}\left[1 + 0.83609\angle 169.6316 \times e^{-j2\times 0.8\pi(3-z)}\right]$$

$$Z = 0.10463966 + 0.1473407\,i = 0.18071729\angle 54.618 \rightarrow \text{Degrees}$$

$\ell = l - z$

8) $V_S(z) = V_0^+ e^{-j\beta z}\left[1 + \Gamma_L e^{-j2\beta\ell}\right]$

$$= 30\, e^{-j\times 0.8\pi z}\left[1 + (0.83609\angle 169.6316)e^{-j2\times 0.8\pi(l-z)}\right]$$

9) $$I_S(z) = \frac{30}{100} e^{-j\times 0.8\pi z}\left[1 - (0.83609\angle 169.6316)e^{-j2\times 0.8\pi(l-z)}\right]$$

10) $$Z_{in}(z) = 100 \times \frac{9 + 9j + j\times 100\tan(0.8\pi(3-z))}{100 + j(9+9j)\tan(0.8\pi(3-z))}$$

from Z_0 $\dfrac{Z_L + jZ_0\tan\beta(l-z)}{Z_0 + jZ_L\tan\beta(l-z)}$


```
3;

Vs(Z) according to the equation
* exp(-0.8j*pi*Z) .* (1 + 0.83609 .* exp(2.960629j*pi) .* exp(-1.6j*pi*(3-Z)));

s(Vs));
s(Vs));

Index]=max(abs(Vs));
ndex);
```

	1	2	3	4	5
1	2.4000				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

EM.m

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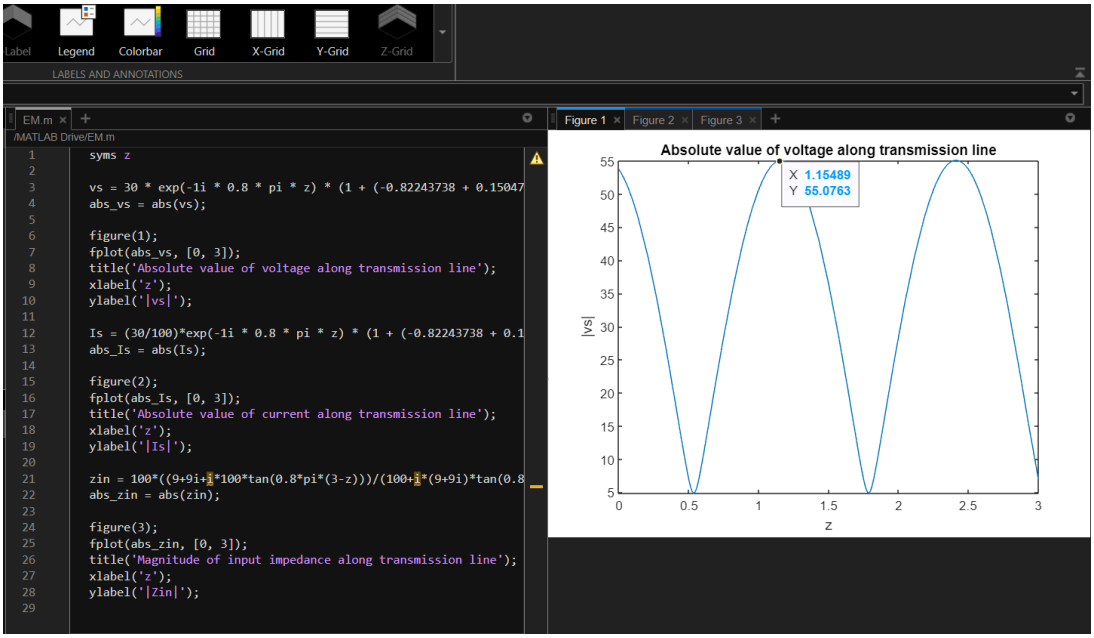
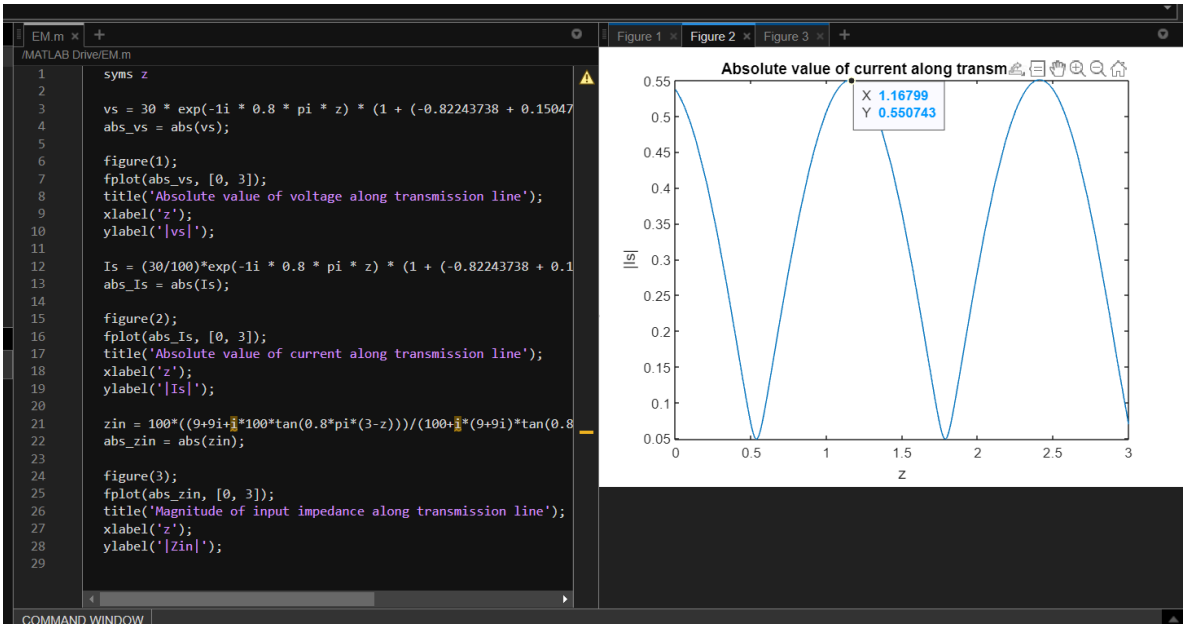
```
syms z

vs = 30 * exp(-1i * 0.8 * pi * z) * (1 + (-0.82243738 + 0.15047668i) * exp(-2i * 0.8 * pi * (3 - z)));
abs_vs = abs(vs);

figure(1);
fplot(abs_vs, [0, 3]);
title('Absolute value of voltage along transmission line');
xlabel('z');
ylabel('|vs|');

Is = (30/100)*exp(-1i * 0.8 * pi * z) * (1 + (-0.82243738 + 0.15047668i) * exp(-2i * 0.8 * pi * (3 - z)));
abs_Is = abs(Is);

figure(2);
fplot(abs_Is, [0, 3]);
title('Absolute value of current along transmission line');
xlabel('z');
ylabel('|Is|');

zin = 100*((9+9i+i*100*tan(0.8*pi*(3-z)))/(100+i*(9+9i)*tan(0.8*pi*(3-z))));
abs_zin = abs(zin);

figure(3);
fplot(abs_zin, [0, 3]);
title('Magnitude of input impedance along transmission line');
xlabel('z');
ylabel('|Zin|');
```




EM.m
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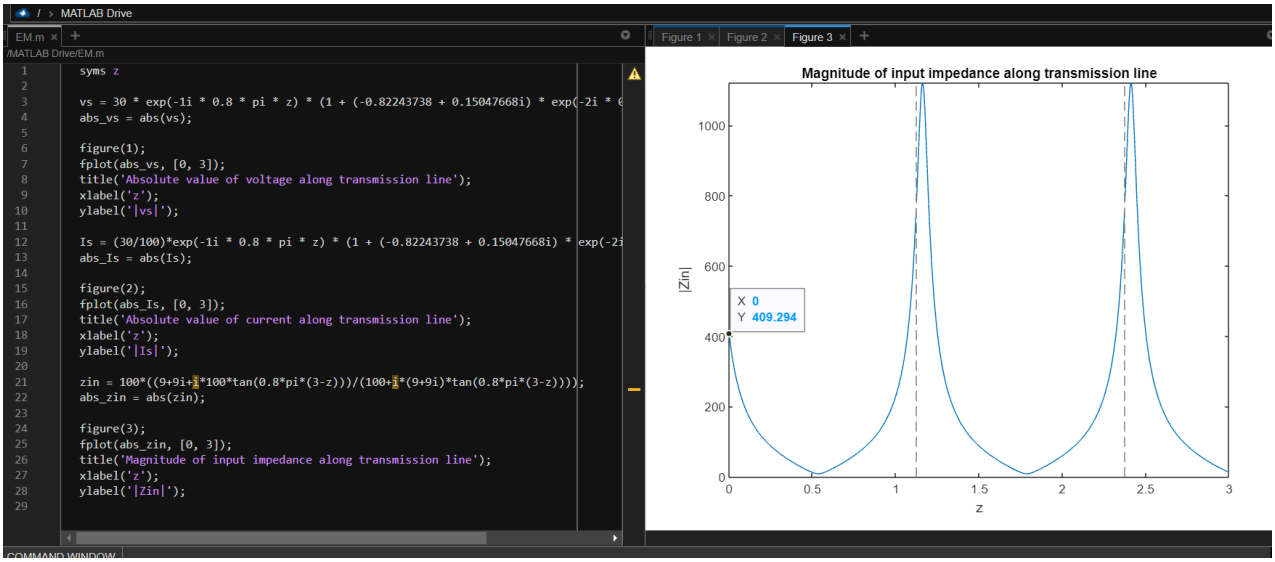
syms z
vs = 30 * exp(-1i * 0.8 * pi * z) * (1 + (-0.82243738 + 0.15047
abs_vs = abs(vs);
figure(1);
fplot(abs_vs, [0, 3]);
title('Absolute value of voltage along transmission line');
xlabel('z');
ylabel('|vs|');
Is = (30/100)*exp(-1i * 0.8 * pi * z) * (1 + (-0.82243738 + 0.1
abs_Is = abs(Is);
figure(2);
fplot(abs_Is, [0, 3]);
title('Absolute value of current along transmission line');
xlabel('z');
ylabel('|Is|');
zin = 100*((9+9i+i*100*tan(0.8*pi*(3-z)))/(100+i*(9+9i)*tan(0.8
abs_zin = abs(zin);
figure(3);
fplot(abs_zin, [0, 3]);
title('Magnitude of input impedance along transmission line');
xlabel('z');
ylabel('|Zin|');
COMMAND WINDOW
Figure 1
Figure 2
Figure 3
Absolute value of current along transm
X 1.16799
Y 0.550743
|Is|
z


MATLAB Drive
EM.m
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syms z
vs = 30 * exp(-1i * 0.8 * pi * z) * (1 + (-0.82243738 + 0.15047668i) * exp(-2i *
abs_vs = abs(vs);
figure(1);
fplot(abs_vs, [0, 3]);
title('Absolute value of voltage along transmission line');
xlabel('z');
ylabel('|vs|');
Is = (30/100)*exp(-1i * 0.8 * pi * z) * (1 + (-0.82243738 + 0.15047668i) * exp(-2i
abs_Is = abs(Is);
figure(2);
fplot(abs_Is, [0, 3]);
title('Absolute value of current along transmission line');
xlabel('z');
ylabel('|Is|');
zin = 100*((9+9i+i*100*tan(0.8*pi*(3-z)))/(100+i*(9+9i)*tan(0.8*pi*(3-z))));
abs_zin = abs(zin);
figure(3);
fplot(abs_zin, [0, 3]);
title('Magnitude of input impedance along transmission line');
xlabel('z');
ylabel('|Zin|');
COMMAND WINDOW
Figure 1
Figure 2
Figure 3
Magnitude of input impedance along transmission line
X 0
Y 409.294
|Zin|
z