I had no Partner on this project

Graham Robinson

Question 1 Project 1

1). $V_1 = 150\angle -5°\ V$ $Z = 4+j8\ \Omega$

$V_2 = 120\angle 0°\ V$

$R + jx = 1+j8\ \Omega$

$-5° < 0°$

$$I_{z_1} = \frac{V_2 - V_1}{Z} = \frac{(120+j0) - (149.43 - j13.07)}{(4+j8)}$$

$I_{z_1} = -0.16 + j3.8 = 3.8\angle -87.48°\ A$

a). $S = V - I_{z_1}^* \rightarrow S_1 = V_1 - I_{z_1}^* = (150\angle -5°)(-3.6 < 87.96°)$

$S_1 = -540\angle 82.96°\ VA = -70.86 - j535.33\ VA$

$P_1 = -70.86\ W$ $Q_1 = -535.33\ VAR$

$S_2 = V_2 I^* = (120\angle 0°)(3.6 < 87.96°)$

$S_2 = 432\angle 87.96°\ VA = 17.14 + j431.58\ VA$

$P_2 = 19.14\ W$ $Q_2 = 431.58\ VAR$

b). $P_{loss} = R|I_{z_1}|^2 = 4|3.6|^2 = 51.84\ W$

$Q_{loss} = X|I_{z_1}|^2 = 8|3.6|^2 = 103.68\ VAR$

c). Matlab 3 Graphs Images Below

d). Matlab 1 Graph

As well as Zip File

MATLAB R2020b - academic use

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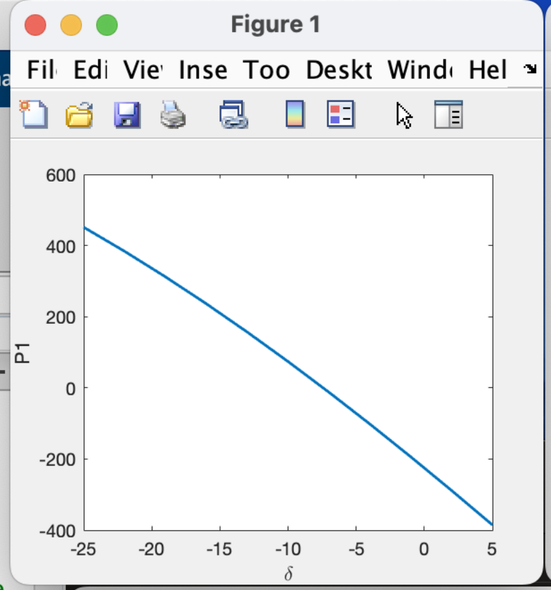
Command Window

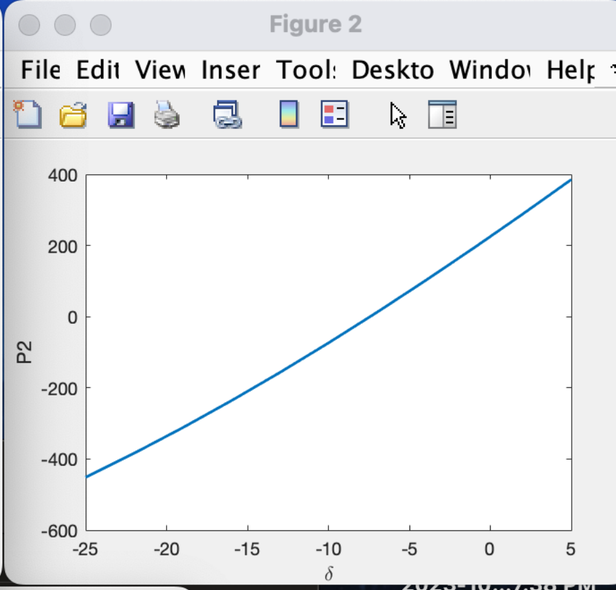
```
varNames =

  1×4 cell array

  Columns 1 through 3

    {'delta'}    {'P1'}    {'P2'}

  Column 4

    {'Ploss'}


ans =

  11×4 table

    delta      P1         P2
    _____    _______    _______

      -25      451.39    -451.39
      -22      383.76    -383.76
      -19      311.99    -311.99
      -16      236.28    -236.28
      -13      156.84    -156.84
      -10      73.894    -73.894
       -7     -12.344     12.344
       -4     -101.63     101.63
       -1     -193.72     193.72
        2     -288.37     288.37
        5     -385.31     385.31
```

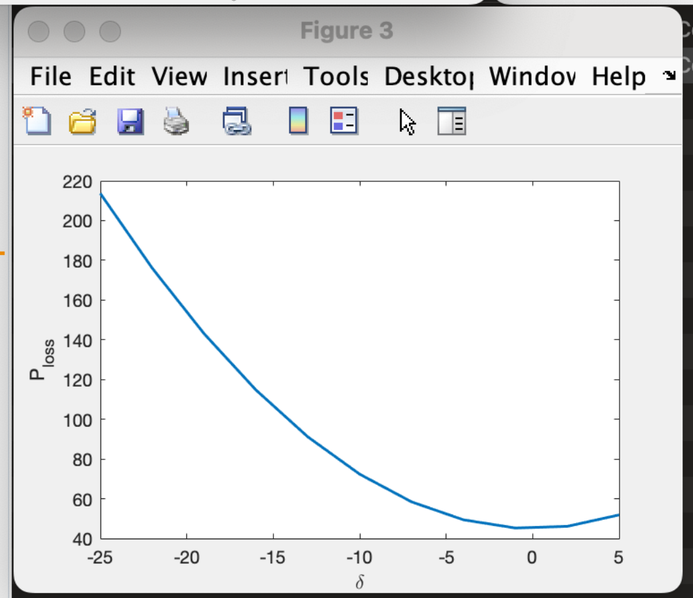
Editor - /Users/grahamrobinson/Downloads/PowerProject1...

PowerProject1Problem1.m | PowerProject1Problem1Part2.m

```
close all; % it will close previous open figure
clear all; % it will clear workspace variable
clc; % clear the command window
R=4; % Resistance R
X=8; % Reactance of Line
del=-25:3:5; % Change in Delta angle
V1=150*exp(1j*del*pi/180); % Given V1 voltage source
V2=120*exp(1j*0); % Given V2 Voltage source
I=(V2-V1)/(R+1j*X); % Current from V1 to V2
S1=V1.*conj(I); % Complex power of source 1
S2=V1.*(-conj(I)); % Complex power of source 2
P1=real(S1); % Active or Real power of S1
P2=real(S2); % Real power of S2
Ploss=R*abs(I.^2); % Power loss in transmission line
varNames={'delta','P1','P2','Ploss'} % Variable names
table(del',P1',P2',Ploss','VariableNames',varNames) %
figure(1)
plot(del,P1,'LineWidth',1.5);
xlabel('\delta');
ylabel('P1');
figure(2)
plot(del,P2,'LineWidth',1.5);
xlabel('\delta');
ylabel('P2')
figure(3)
plot(del,Ploss,'LineWidth',1.5);
xlabel('\delta');
ylabel('P_{loss}')
```







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Command Window

```
>> E1 = input('Source # 1 Voltage Mag. = ');
a1 = input('Source # 1 Phase Angle = ');     %
E2 = input('Source # 2 Voltage Mag. = ');    %
a2 = input('Source # 2 Phase Angle = ');     %
R = input('Line Resistance = ');             %
X = input('Line Reactance = ');              %
Z = R + j*X; % Line impedance
E1 = (0.60*E1:1:E1)'; % Change E1 form 60% to
a1r = a1*pi/180; % Convert degree to radian
k = length(E1);
E2 = ones(k,1)*E2;%create col. Array of same
a2r = a2*pi/180; % Convert degree to radian
V1=E1.*cos(a1r) + j*E1.*sin(a1r);
V2=E2.*cos(a2r) + j*E2.*sin(a2r);
I12 = (V1 - V2)./Z; I21=-I12;
S1= V1.*conj(I12); P1 = real(S1); Q1 = imag(S
S2= V2.*conj(I21); P2 = real(S2); Q2 = imag(S
SL= S1+S2; PL = real(SL); QL = imag(SL);
Result1=[E1, Q1, Q2, QL];
disp(' E1 Q-1 Q-2 Q-L ')
disp(Result1)
plot(E1, Q1, E1, Q2, E1, QL), grid
xlabel(' Source #1 Voltage Magnitude')
ylabel(' Q, var')
text(112.5, -180, 'Q2')
text(112.5, 5,'QL'), text(112.5, 197, 'Q1')
Source # 1 Voltage Mag. = 150
Source # 1 Phase Angle = -5
Source # 2 Voltage Mag. = 120
Source # 2 Phase Angle = 0
Line Resistance = 4
Line Reactance = 8
 E1 Q-1 Q-2 Q-L
   90.0000 -218.8262  317.0456   98.2195
```

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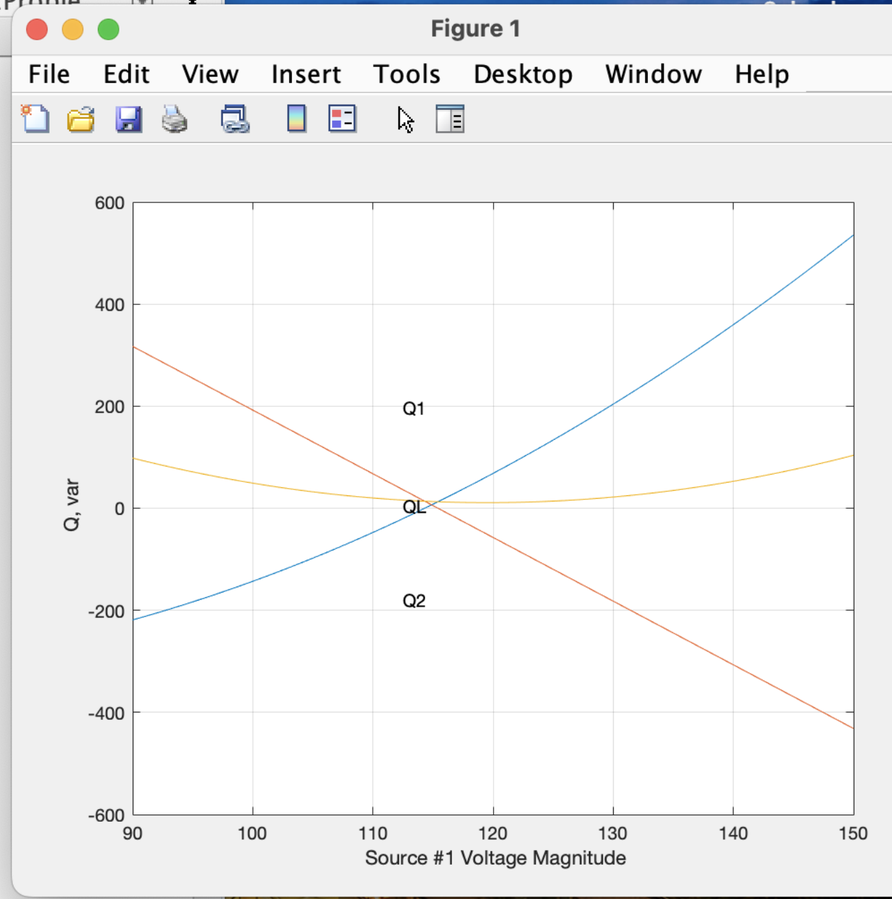
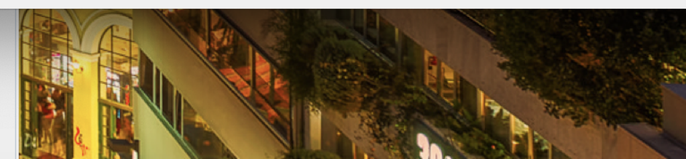
PowerProject1Problem1.m | PowerProject1Problem1Part2.m

```
1  - E1 = input('Source # 1 Voltage Mag. = ');   % 150
2  - a1 = input('Source # 1 Phase Angle = ');    % -5
3  - E2 = input('Source # 2 Voltage Mag. = ');   % 120
4  - a2 = input('Source # 2 Phase Angle = ');    % 0
5  - R = input('Line Resistance = ');            % 4
6  - X = input('Line Reactance = ');             % 8
7  - Z = R + j*X; % Line impedance
8  - E1 = (0.60*E1:1:E1)'; % Change E1 form 60% to 100% E1
9  - a1r = a1*pi/180; % Convert degree to radian
10 - k = length(E1);
11 - E2 = ones(k,1)*E2;%create col. Array of same length for E2
12 - a2r = a2*pi/180; % Convert degree to radian
13 - V1=E1.*cos(a1r) + j*E1.*sin(a1r);
14 - V2=E2.*cos(a2r) + j*E2.*sin(a2r);
15 - I12 = (V1 - V2)./Z; I21=-I12;
16 - S1= V1.*conj(I12); P1 = real(S1); Q1 = imag(S1);
17 - S2= V2.*conj(I21); P2 = real(S2); Q2 = imag(S2);
18 - SL= S1+S2; PL = real(SL); QL = imag(SL);
19 - Result1=[E1, Q1, Q2, QL];
20 - disp(' E1 Q-1 Q-2 Q-L ')
21 - disp(Result1)
22 - plot(E1, Q1, E1, Q2, E1, QL), grid
23 - xlabel(' Source #1 Voltage Magnitude')
24 - ylabel(' Q, var')
25 - text(112.5, -180, 'Q2')
26 - text(112.5, 5,'QL'), text(112.5, 197, 'Q1')
```





Question 2

2). $V_{an} = 1414\cos(120\pi t)\,V$

$V_{bn} = 1414\cos(120\pi t - 120°)\,V$

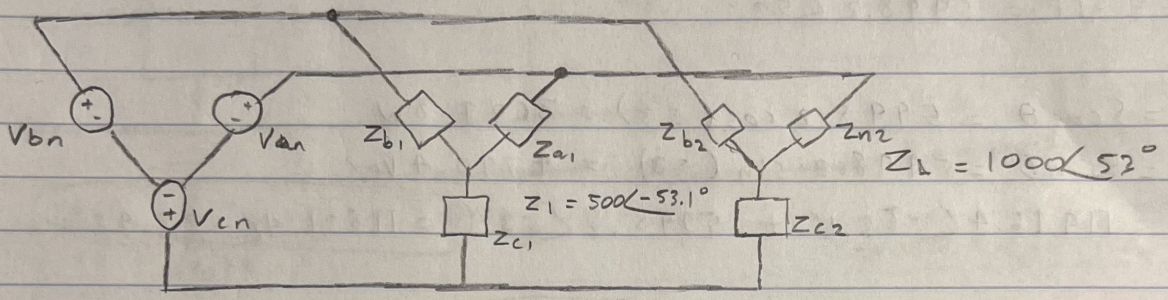
$V_{cn} = 1414\cos(120\pi t - 240°)\,V$

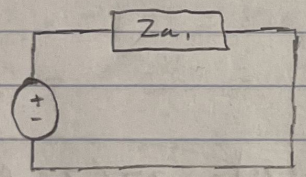
$Z_Y = 300 - j400$

$Z_\Delta = 3000\angle 53°$

$Z_\Delta = \frac{Z_Y}{3} = 1000\angle 53°\ \Omega$

a).





$Z = \frac{V}{I} \qquad I = \frac{V}{Z}$

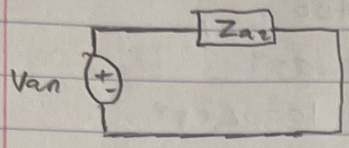
$I_{a1} = 2.83\angle 53.1 \qquad I_{a1} = \frac{1414\angle 0°}{500\angle -53.1°}$

$S_p = VI^* = (1414\angle 0°)(2.83\angle -53.1°) = 3998.8\angle -53.1°$

$S_T = 3S_p = 11996.4\angle -53.1°$

$P = S\cos\theta = 11996.4\cos(-53.1) = 7202.9\ W$

$Q = S\sin\theta = 11996.4\sin(-53.1°) = -9593.3\ Var$



$$I_{az} = \frac{1414\angle 0^\circ}{1000\angle 53^\circ} = 1.414\angle -53^\circ \text{ A}$$

$S = VI^* = (1414\angle 0^\circ)(1.414\angle 53^\circ) = 1999.4\angle 53^\circ$ VA

$ST = 3SP = 5998.2\angle 53^\circ$

$P = S\cos\theta = 5998.2\cos(53) = 3609.8$ W

$Q = S\sin\theta = 5998.2\sin(53) = 4790.4$ var

$ST = 11996.4\angle -53.1^\circ + 5998.2\angle 53^\circ = 11831.4\angle -23.95^\circ$

$PT = 7202.9 + 3609.8 = 10812.7$ W

$QT = -9593.3 + 4790.4 = -4803.0$ W

b). $I_T = 3(I_{a1} + I_{a2}) = 3(2.83\angle 53.1^\circ + 1.414\angle -53^\circ) = 8.37\angle 23.97^\circ$ A

$I_{L1} = 3I_{a1} = 3(2.83\angle 53.1^\circ) = 7.00\angle 75.95^\circ$ A

$I_{L2} = 3I_{a2} = 3(1.414\angle -53^\circ) = 4.24\angle -53^\circ$ A

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Command Window

```
>>
```

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+2 | PowerProject1Problem1.m | PowerProject1Problem1Part2.m | untitled6*

```
Van = 1414;
Z_wye1 = 500 * exp(53.1i * pi/180);
Z_delta = 3000 * exp(53i * pi/180);
Z_wye2 = Z_delta / 3;

Ia1 = Van / Z_wye1;
S1_p = Van * conj(Ia1);
S1_total = 3 * S1_p

Ia2 = Van / Z_wye2;
S2_p = Van * conj(Ia1);
S2_total = 3 * S2_p

S_total = S1_total + S2_total

Q_total = imag(S_total)

P_total = real(S_total)

% Step 2
I_total = 3 * (Ia1 + Ia2)

% Step 3
clear
clc
x = 0:0.05:2 * pi;
Van = 1414 .* cosd((120 * pi) .* (x));
```

Figure 1

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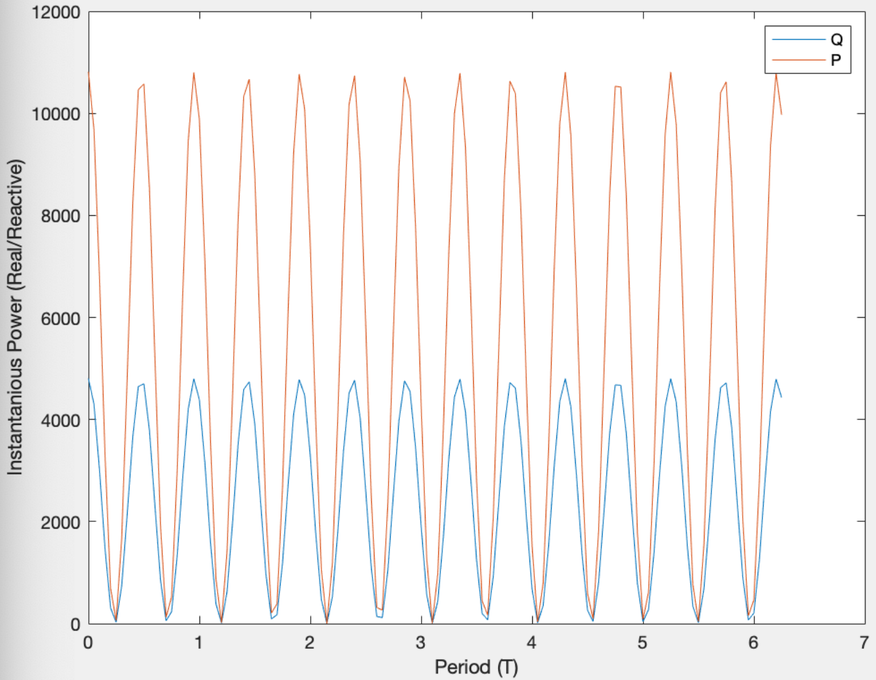


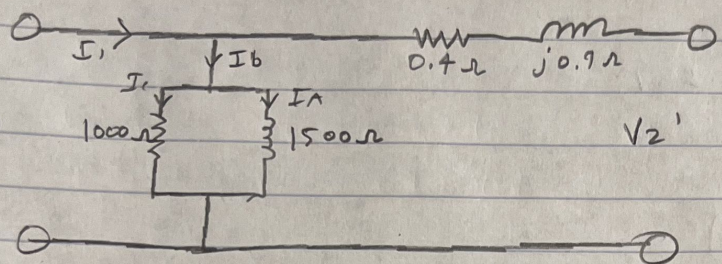
Question 3

3). $a = \frac{2400}{240} = 10 \quad S = 150\,kVA$

a). $Z_{eq} = (0.2 + j0.45) + (10)^2 (0.002 + j0.0045) = 0.4 + j0.9\,\Omega$

$S = (150 \times 10^3) \angle \cos^{-1}(0.8) = (150 \times 10^{-3}) \angle 36.87°\,VA$

$P = 119,999.84\,W \quad Q = 90,000.21\,VAR$



$R_{eq} = 0.2 + 0.2$

$= 0.4\,\Omega$

$X_{eq} = 0.45 + 0.45\,\Omega$

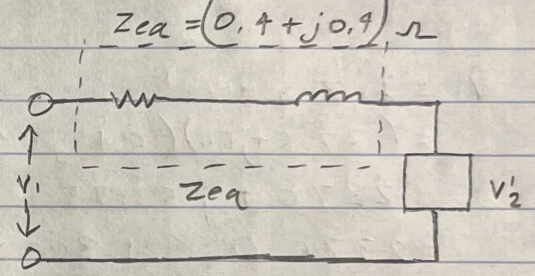
$= j0.9$

b). $Z_{eq} = \frac{(0.2 + j0.45)}{(10)^2} + (0.002 + j0.0045)$

$= 0.004 + j0.009\,\Omega$

$R_c' = \frac{1000}{10^2} = 10\,\Omega$

$X_m' = \frac{1500}{10^2} = 15\,\Omega$



c). $\cos\Phi = 0.8 \quad \Phi = \cos^{-1}(0.8) = 36.87°$

$V_2' = 10 \times 240 = 2400V$

$S = P\cos\Phi + jQ\sin\Phi$

$= 150\cos 36.87 + j150 \sin 36.87$

$= (120 + j90)\,kVA$

$I_1 = \frac{S^*}{V_2'} = \frac{(120 - j90)}{2400} = (50 - j37.5)A$

$V_1 = I_1^* Z_{eq} + V_2'$

$= (50 - j37.5)(0.4 + j0.9) + 2400$

$= 53.75 + j30 + 2400$

$= 2453.75 + j30$

$= 2454 \angle 0.7°\,V$

$V_{reg} = \frac{|V_1| - |V_2'|}{|V_2'|} = \frac{2454 - 2400}{2400} \times 100 = 2.25\%$

d). $\cos\phi = 0.6$

$\phi = \cos^{-1}(0.6)$

$= 53.13^\circ$

$S = P\cos\phi - jQ\sin\phi$

$= 150\cos 53.13 - j150\sin 53.13$

$= (90 - j120)\,kVA$

$I_1 = \frac{S^*}{V_2'} = \frac{(40 + j120)}{2400}$

$= (37.5 + j50)\,A$

$V_1 = I_1 Z_{eq} + V_2'$

$= (37.5 + j50)(0.4 + j0.9) + 2400$

$= 2370 + j53.75$

$= 2370.60 \angle 1.30^\circ\,V$

$V_{reg} = \frac{|V_1| - |V_2'|}{|V_2'|}$

$= \frac{2371 - 2400}{2400} \times 100$

$= -1.21\,\%$

e). Matlab

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Command Window

```
I3 = exp(1i*0*pi/180);
VNL2 = 2400;
ZE = 0.4 + 1i*0.9;
VL1 = 0;

for i = 1:length(I1_vals)
    VFL1 = (i*I1)*ZE + VNL2;
    VR = 100*(abs(VFL1) - VNL2)/
    VR_vals(i) = VR;

end

for j = 1:length(I1_vals)
    VFL12 = (j*I2)*ZE + VNL2;
    VR2 = 100*((abs(VFL12) - VNL
    VR2_vals(j) = VR2;

end

for k = 1:length(I1_vals)
    VFL13 = (k*I3)*ZE + VNL2;
    VR3 = 100*(abs(VFL13) - VNL2
    VR3_vals(k) = VR3;

end

plot(I1_vals,VR_vals);
hold on;
plot(I1_vals,VR2_vals);
plot(I1_vals,VR3_vals);
xlabel('Zero Load to Full Load (
ylabel('Vr (%)');
legend('VR 0.8 lag', 'VR 0.8 lea
>>
```

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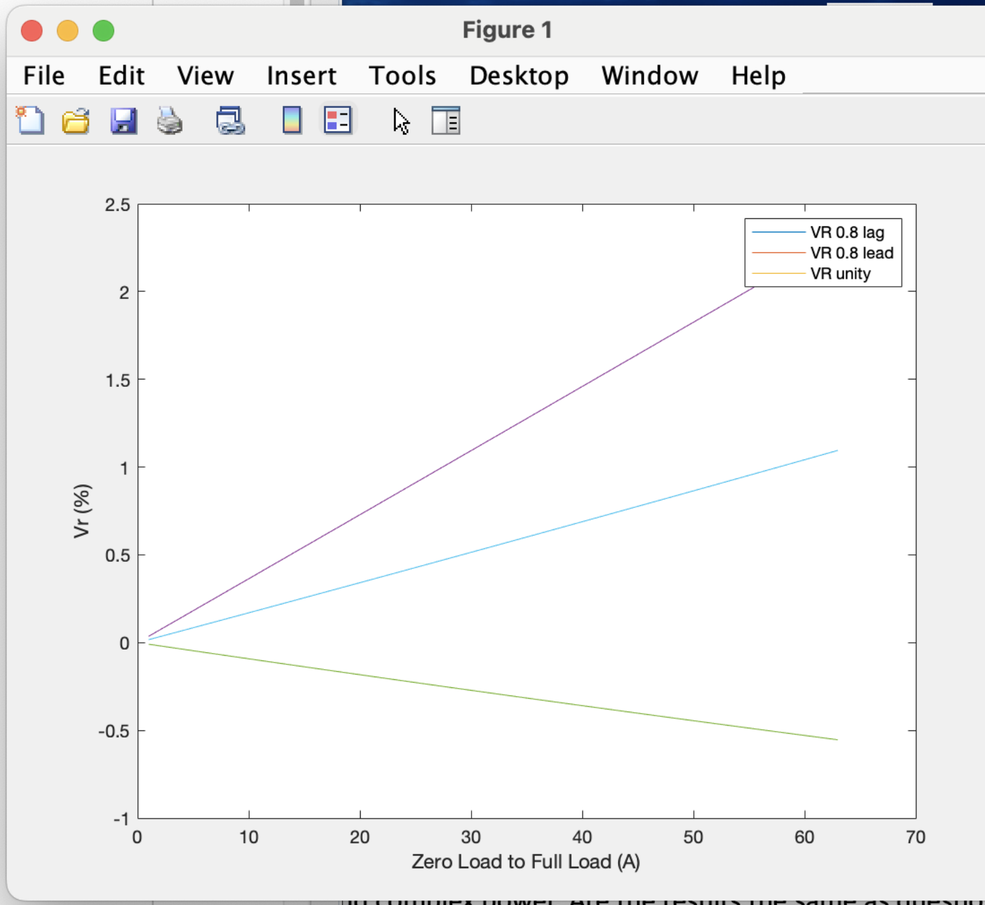
+1 | PowerProject1Problem1.m | PowerProject1Problem1Part2.m | untitled3* | untitled4*

```
1   I1_vals = linspace(1,63,64);
2   I1_zeros = zeros(size(I1_vals));
3   VR_vals = zeros(size(I1_vals));
4   VR2_vals = zeros(size(I1_vals));
5   VR3_vals = zeros(size(I1_vals));
6   I1 = exp(1i*-36.87*pi/180); % 0.8 lag
7   I2 = exp(1i*36.87*pi/180); % 0.8 lead
8   I3 = exp(1i*0*pi/180);
9   VNL2 = 2400;
10  ZE = 0.4 + 1i*0.9;
11  VL1 = 0;
12
13  for i = 1:length(I1_vals)
14      VFL1 = (i*I1)*ZE + VNL2;
15      VR = 100*(abs(VFL1) - VNL2)/(VNL2);
16      VR_vals(i) = VR;
17
18  end
19
20  for j = 1:length(I1_vals)
21      VFL12 = (j*I2)*ZE + VNL2;
22      VR2 = 100*((abs(VFL12) - VNL2)/(VNL2));
23      VR2_vals(j) = VR2;
24
25  end
26
27  for k = 1:length(I1_vals)
28      VFL13 = (k*I3)*ZE + VNL2;
29      VR3 = 100*(abs(VFL13) - VNL2)/(VNL2);
30      VR3_vals(k) = VR3;
31
32  end
33
```



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ge source. Is the result the same as question b)?

and reactive power of each load over the range of 0: 0