Hayden Fuller

Homework # 2

Due: Monday, June 12th

Question 1. (30 points) Show that only 1-phase circuits have the double frequency component of power but not the balanced 3-phase circuits. Include detailed steps. Also implement this in Matlab environment and plot the relevant power components (include Matlab code as a part of answers).

Question 2. (30 points) A 440-V, 3-phase voltage feeds a balanced delta-connected 3-phase load with an impedance of (25 + j10) Ω/phase

(a) Calculate the line current and represent in phasor form
(b) Calculate the power absorbed per phase and
(c) Calculate the sum of all phase currents. Explain why this sum has such a value

Question 3. (40 points) A three-phase, star connected load with a resistance of 30Ω and a reactance of 25Ω per phase, is fed by a 230 V, three-phase, 60 Hz source. Calculate

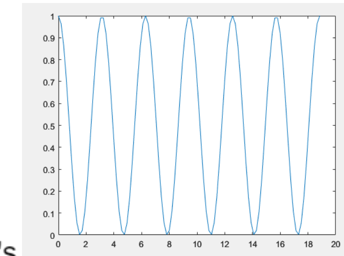
(a) all line currents
(b) power consumed and
(c) power factor.

If a delta connected, balanced 3-phase capacitor bank, is added to the same supply in parallel to the given load, with the 15 micro Farad capacitance/phase, then calculate the new overall power factor of the circuit.

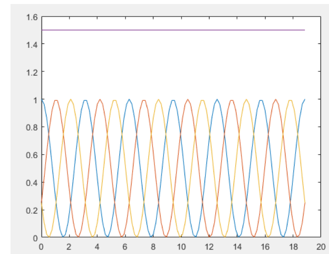
```
>> ya = cos(x).^2;
>> yb = cos(x+2*pi/3).^2;
>> yc = cos(x+4*pi/3).^2;
>> yt=ya+yb+yc
>> figure
>> plot(x,ya,x,yb,x,yc,x,yt)
```

```
>> ya = cos(x).^2;
>> figure
>> plot(x,ya)
```

1)
Single phase:
v(t)=V_m*cos(wt+theta_v)
i(t)=I_m*cos(wt+theta_i)
P(t)=v(t)i(t)=V_m*I_m*cos(wt+theta)*cos(wt+theta)
since cos^2(x)=1/2*[1+cos(2x)], this shows that P(t) will have twice the frequency of v(t) and i(t)
this is because we have positive power twice per period, one with positive voltage, and one with negative voltage.



Three phase:
P(t)=v_an*i_a+v_bn*i_b+v_cn*i_c
P(t)=V_m*I_m*[[cos(theta_v-theta_i)+cos(2wt+theta_v+theta_i+0)] +
[cos(theta_v-theta_i)+cos(2wt+theta_v+theta_i-240)] +
[cos(theta_v-theta_i)+cos(2wt+theta_v+theta_i+240)]]
P(t)=3*V_m*I_m*cos(theta)
all the individual powers have twice the frequency still, but when you sum equally spaced cos's together, they all cancel out, giving us constant power.



2)
Va=440<0
Vb=440<120
Vc=440<-120
a)
I_ph-a=V_line/Z_ph=(440+j0)/(25+j10)=15.17-j6.07 A =
I_ph-a=16.34<-21.79
I_ph-b=16.34<98.21
I_ph-c=16.34<218.21
I_line=I_ph-a - I_ph-b = 16.34<-21.79 - 16.34<98.21
I_line=28.3<-51.8
b)
S=V*I^*=440*(16.34<21.79)
P=440*16.34=7190 W
c)
I=M(cos(t)+cos(t-120)+cos(t+120)=0
Zero. Same as mentioned at the end of the previous question. Since it's a balanced system, they all cancel out, and are always at a net 0.

3)
V_ph=230/sqrt(3)=132.79 V
Z_ph=30+j25=39<39.8 ohms
a)
Iph=Vph/Zph=132.79/(39<39.8)=3.36<-39.8 A
b)
power consumed = sqrt(3)*V_L*I_L*cos(phi)=1028.3W
reactive power = sqrt(3)*V_L*I_L*sin(phi)=856.8 VAR
c)
power factor = cos(39.8)=.77 lagging
c.2)
3*V_L*I_ph*sin(phi)=897 VAR
close to 856.8, this will mostly cancel it out
856.8-1028.3*tan(phi2)=897
tan(phi2)=(-40.3)/1028=-.039
cos(phi2)=.999
new power factor =.999, much better