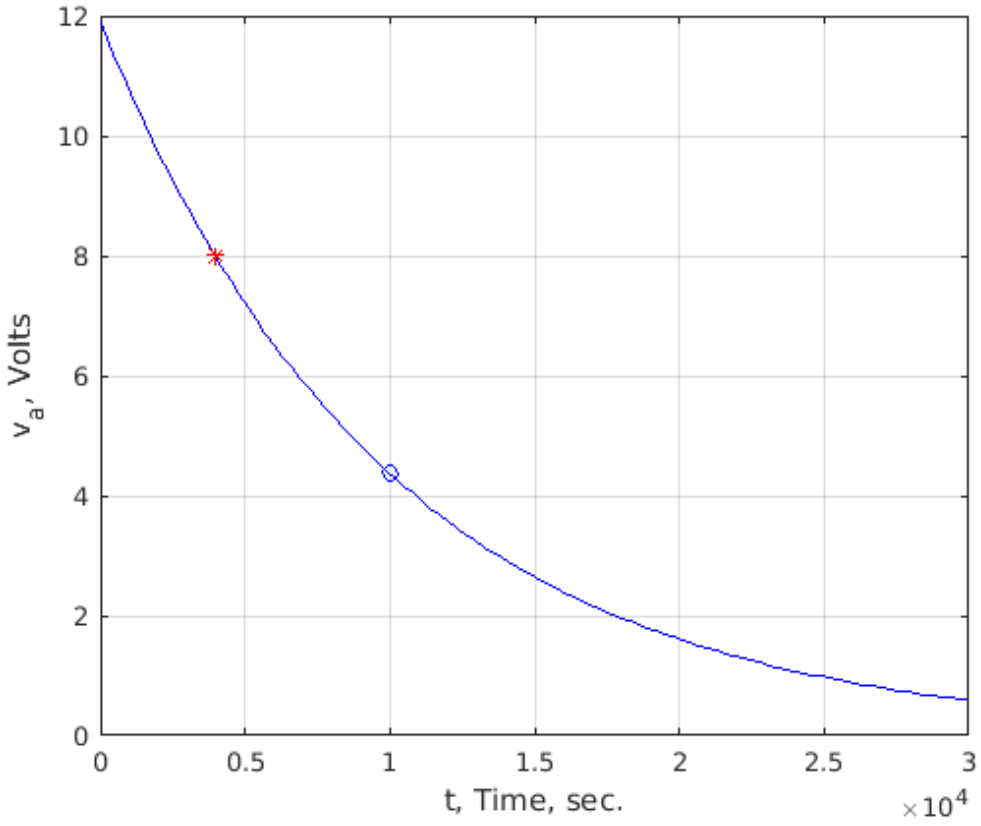
Table of Contents

Transient Problem

```
R1=1e5;R2=10e6;C=1e-3;L=150e-3;v_s=12;

% Charge V_A at 0^-
v_a0m=v_s*R2/(R1+R2) ;
disp(['***** a.',num2str(v_a0m),' Volts']);

% Discharge
s=-1/(R2*C);
tau=-1/s;

disp('***** b. v_a=v_a0m*exp(-t/tau)');
disp('***** b. Figure 1');
disp(['***** c.',num2str(tau),' Sec']);

t=[0:0.01:1]*3*tau;
v_a=v_a0m*exp(-t/tau);

% 8-volt time
v1=8;
T=tau*(-log(v1/v_a0m));
disp(['***** d.',num2str(T),' Sec']);


figure;plot(t,v_a,'b-',...
     tau,v_a0m*exp(-1),'bo',...
     T,v1,'r*');grid on;
xlabel('t, Time, sec.');
ylabel('v_a, Volts');


% Energy
w=C*v_a0m^2/2;
disp(['***** e.',num2str(w),' Joules']);

% Power
p_max=v_a0m^2/R2;
p_min=v1^2/R2;
disp(['***** f.',num2str(p_max),' Watts']);
disp(['***** f.',num2str(p_min),' Watts']);
disp('I accepted zero for the minmum too');
```

```
% Size
epsilon=7*8.85e-12;
d=10e-6;
A=C*d/epsilon;
Volume=d*A
side=(Volume/2)^(1/3);
disp(['***** g.',num2str(side),' meters']);

disp('Some had different assumptions and that was ok');
disp('Many missed epsilon_0 in the equation');
```

```
***** a.11.8812 Volts
***** b. v_a=v_a0m*exp(-t/tau)
***** b. Figure 1
***** c.10000 Sec
***** d.3955.1478 Sec
***** e.0.070581 Joules
***** f.1.4116e-05 Watts
***** f.6.4e-06 Watts
I accepted zero for the minmum too
Volume =
    0.0016
***** g.0.093106 meters
Some had different assumptions and that was ok
Many missed epsilon_0 in the equation
```

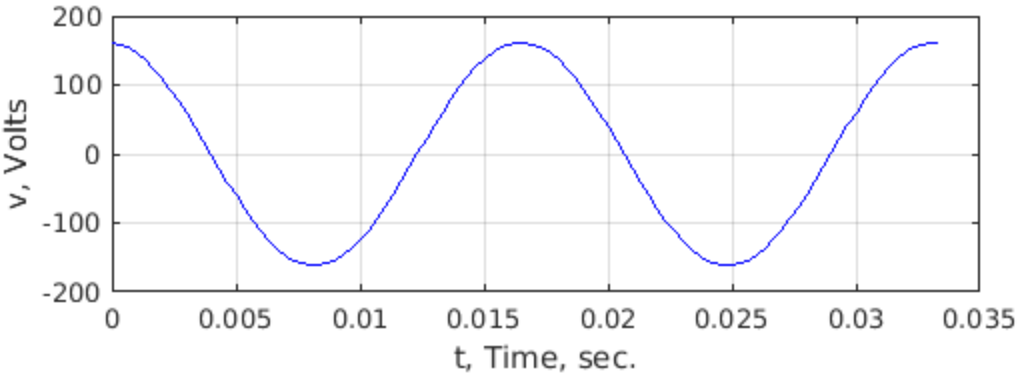


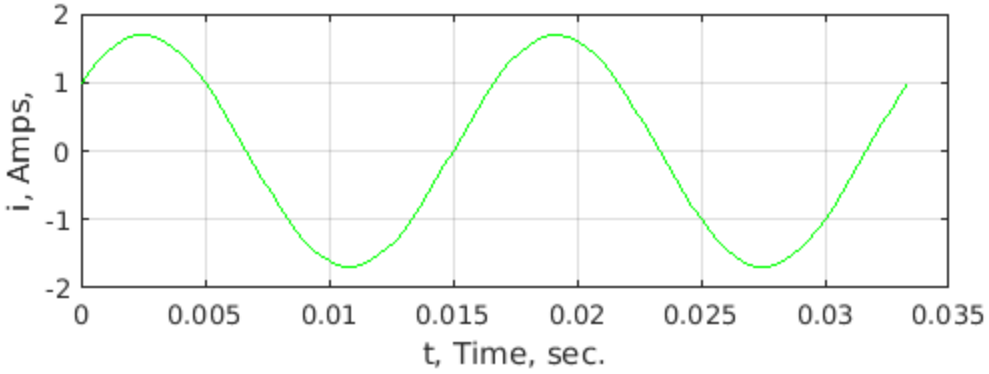
Power problem

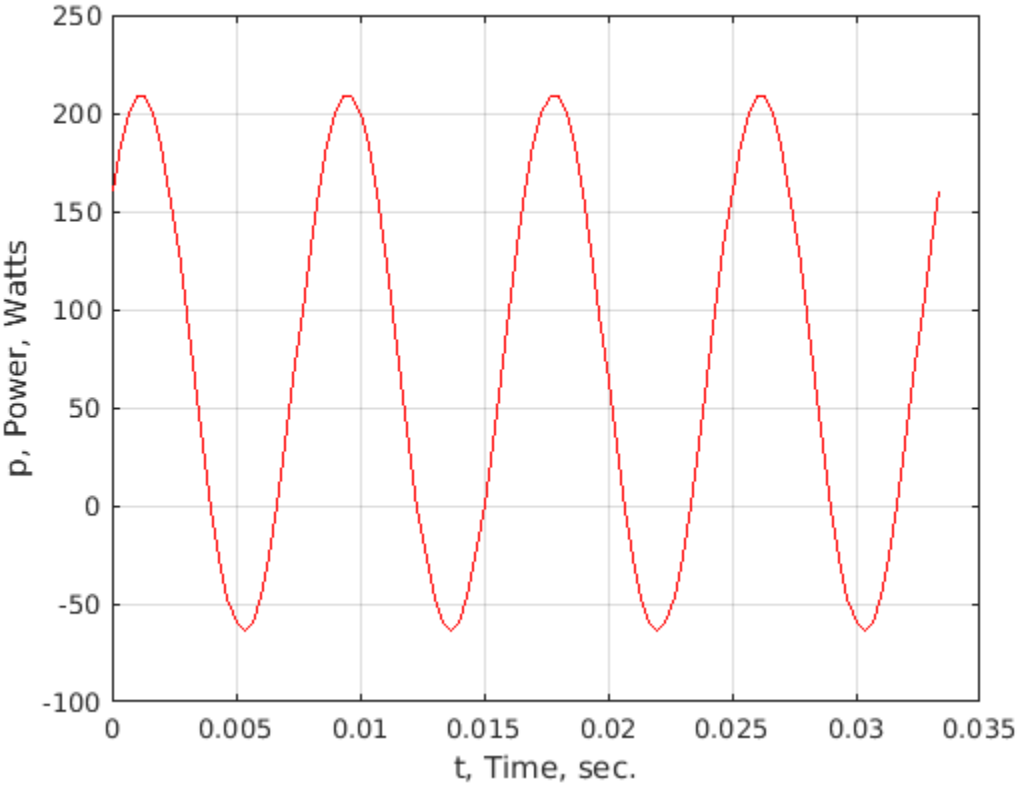
```
VSRMS=120;VS=VSRMS*sqrt(2); % Voltage Source Phasor
RT=8;  % Transmission loss along the way
f=60;

% Motor ratings
VRMS=120;IRMS=1.25;P=80;


% Motor parameters
VA=VRMS*IRMS
VAR=sqrt(VA^2-P^2)
phi=acos(P/VA);
phidegrees=acos(P/VA)*180/pi

disp(['***** a, power factor = ',num2str(P/VA)]);

V=VRMS*sqrt(2)
I=IRMS*sqrt(2)*exp(-1j*phi) %  Use the sign that makes the
                            %  reactance positive.  We can't know
                            %  this from the power factor because
                            %  the cosine is an even function

ZLOAD=V/I

RLOAD=real(ZLOAD);
L=imag(ZLOAD)/(2*pi*f);

disp(['***** b, RLOAD = ',num2str(RLOAD),' Ohms']);
disp(['***** b, L = ',num2str(L),' Henries']);

% Operational parameters

IOP=VS/(RT+ZLOAD)

VOP=IOP*ZLOAD

% Time behavior

t=[0:0.01:1]*2/f;
vop=real(VOP*exp(1j*2*pi*f*t));
iop=real(IOP*exp(1j*2*pi*f*t));

disp('***** c. Plot');

pop=vop.*iop;

figure;
subplot(2,1,1);
plot(t,vop,'b-');grid on;
xlabel('t, Time, sec.');
ylabel('v, Volts');
```

```
subplot(2,1,2);
plot(t,iop,'g-');grid on;
xlabel('t, Time, sec.');
ylabel('i, Amps,');

disp('***** d. Plot');


figure;plot(t,pop,'r-');grid on;
xlabel('t, Time, sec.');
ylabel('p, Power, Watts');


averagepower=mean(pop);
disp(['***** e, averagepower = ',num2str(averagepower),' Watts']);
```

```
VA =
   150
VAR =
  126.8858
phidegrees =
   57.7690
***** a, power factor = 0.53333
V =
  169.7056
I =
   0.9428 - 1.4954i
ZLOAD =
  51.2000 +81.2069i
***** b, RLOAD = 51.2 Ohms
***** b, L = 0.21541 Henries
IOP =
   0.9948 - 1.3646i
VOP =
   1.6175e+02 + 1.0917e+01i
***** c. Plot
***** d. Plot
***** e, averagepower = 73.8741 Watts
```


200
100
0
-100
-200
v, Volts
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
t, Time, sec.

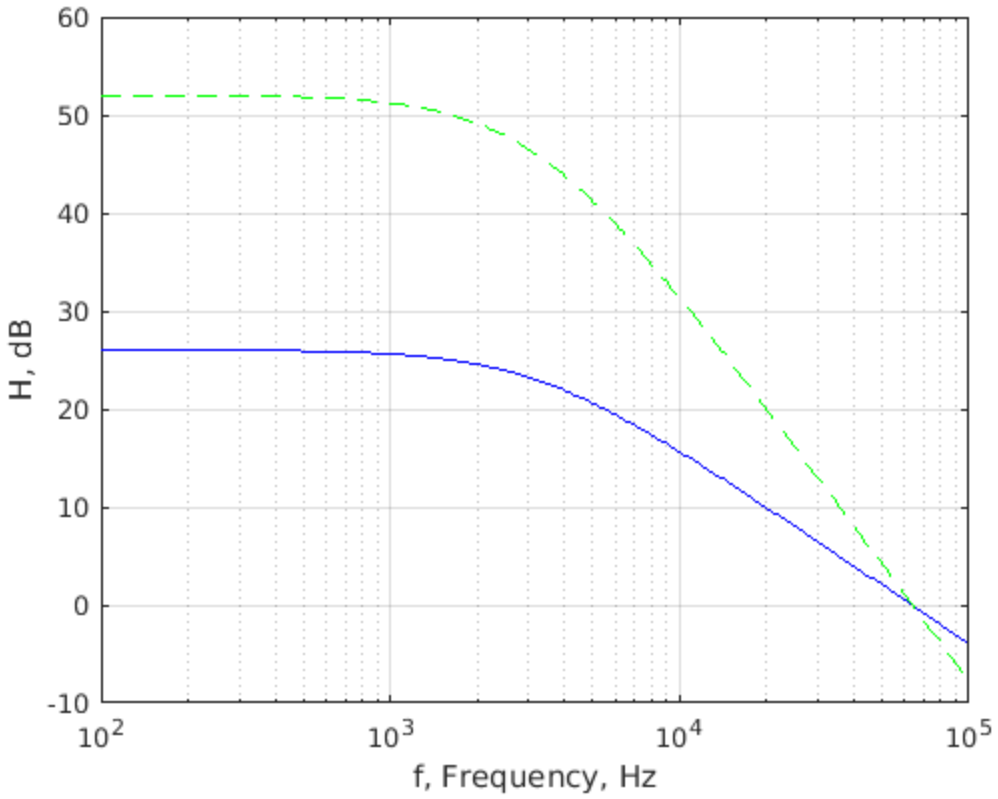

2
1
0
-1
-2
i, Amps,
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
t, Time, sec.

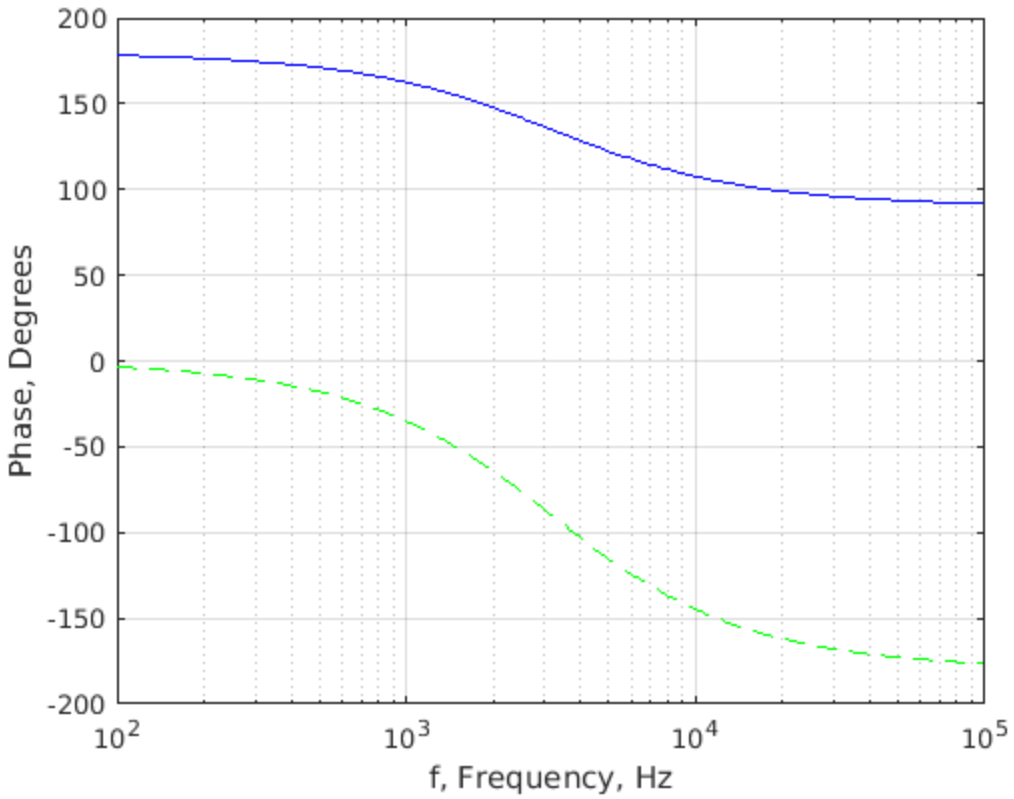

250
200
150
100
50
0
-50
-100
p, Power, Watts
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
t, Time, sec.

Transfer Function

```
R1=50;R2=1e3;C=50e-9;
f=10.^[2:0.01:5];


ZC=1./(1j*2*pi*f*C);

Z2=1./(1/R2+1./ZC);

H = -Z2./R1;

H2=H.^2;

disp('***** a Gain Equation ZC=1./(1j*2*pi*f*C)');
disp('                Z2=1./(1/R2+1./ZC)');
disp('                H = -Z2./R1;');

figure;semilogx(f,20*log10(abs(H)),'b-',...
  f,20*log10(abs(H2)),'g--');grid on;
xlabel('f, Frequency, Hz');
ylabel('H, dB');

figure;semilogx(f,angle(H)*180/pi,'b-',...
  f,angle(H2)*180/pi,'g--');grid on;
xlabel('f, Frequency, Hz');
ylabel('Phase, Degrees');

Hmax=R2/R1

disp(['***** b Hmax = ',num2str(Hmax)]);
disp(['b            ',num2str(20*log10(Hmax)),' dB']);

disp('***** c Plot');

test=find(abs(H)<max(abs(H))/sqrt(2),1);

disp('***** d. |H|/Hmax values bounding f_c');
abs(H([test-1,test]))/Hmax
disp('Frequencies: f_c is between these');
f([test-1,test])

H2max=Hmax^2;

disp('***** e Plot');

test=find(abs(H2)<max(abs(H2))/sqrt(2),1);

disp('***** f.  |H2|/H2max values bounding f_c');
abs(H2([test-1,test]))/H2max
disp('Frequencies: f_c is between these');
f([test-1,test])
```

```
***** a Gain Equation ZC=1./(1j*2*pi*f*C)
                Z2=1./(1/R2+1./ZC)
                H = -Z2./R1;
Hmax =
    20
***** b Hmax = 20
b            26.0206 dB
***** c Plot
***** d. |H|/Hmax values bounding f_c
ans =
    0.7094    0.7013
Frequencies: f_c is between these
ans =
   1.0e+03 *
    3.1623    3.2359
***** e Plot
***** f.  |H2|/H2max values bounding f_c
ans =
    0.7085    0.6989
Frequencies: f_c is between these
ans =
   1.0e+03 *
    2.0417    2.0893
```



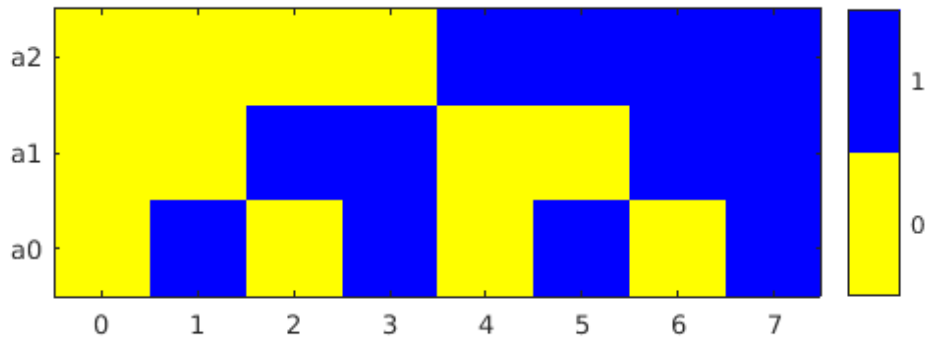


Amplifier Circuit

```
disp('Here is a complete solution for all values 0 to 7 Volts');
disp('This was not expected of the sutdents, but just to');
disp('show what the circuit does');
vin=[0:7];
a2=double(vin>3.99);
b=-vin;
c=-4*a2-b;
a1=double(c>1.99);
d=-2*a1-4*a2-b;
a0=double(d>0.99);
figure;imagesc([0:7],[1:3],[a2;a1;a0]);
colormap([1,1,0;0,0,1]);
z=colorbar;
z.Ticks=[0,1];
caxis([-0.5,1.5]);
xticks([0:7]);
yticks([1:3]);
axis([-0.5,7.5,0.5,3.5]);axis image;
yticklabels(['a2';'a1';'a0']);

disp('***** a');
n=4;disp([num2str(vin(n)),'
 ',num2str(a2(n)),num2str(a1(n)),num2str(a0(n))]);
```

```
n=5;disp([num2str(vin(n)),'
 ',num2str(a2(n)),num2str(a1(n)),num2str(a0(n))]);
n=8;disp([num2str(vin(n)),'
 ',num2str(a2(n)),num2str(a1(n)),num2str(a0(n))]);

disp('***** b  Decimal to binary converter');

disp('***** c.  For inverse, see slides5, page 16');
disp('and make the gains be 1, 2, and 4');

disp('There are 10 kinds of people in the world;');
disp('Those that understand binary numbers and those that do not');
```

```
Here is a complete solution for all values 0 to 7 Volts
This was not expected of the sutdents, but just to
show what the circuit does
***** a
3 011
4 100
7 111
***** b  Decimal to binary converter
***** c.  For inverse, see slides5, page 16
and make the gains be 1, 2, and 4
There are 10 kinds of people in the world;
Those that understand binary numbers and those that do not
```



Published with MATLAB® R2017a