­­­­­­­­­­­­­­ **main.m**

%Q1----------------------------------;

%a);

clear;

t1 = 0:0.01:10; % 0<= t <=10

theta = pi/3; % 60 degrees

f = 2; % w = 2\*pi\*f

x1 = 0.1\*sin(t1) + 0.2\*cos( 2\*pi\*f\*t1 + theta);

plot(t1,x1);

xlabel('Time');

ylabel('x1(t) = 0.1sin(t) + 0.2cos(?t + ?)');

grid;

%b);

for theta = 0:pi/4:pi % ? from 0 to 180 degrees(pi rad) with increments of 45 degrees (pi/4 rad)

hold on;

t1 = 0:0.01:10; % 0<= t <=10

f = 2; % w = 2\*pi\*f

x2 = 0.1\*sin(t1) + 0.2\*cos( 2\*pi\*f\*t1 + theta);

plot(t1,x2);

end

legend('0.1sin(t)+0.2cos(wt+pi/3)','0.1sin(t)+0.2cos(wt+0)','0.1sin(t)+0.2cos(wt+pi/4)','0.1sin(t)+0.2cos(wt+pi/2)', '0.1sin(t)+0.2cos(wt+3pi/4)', '0.1sin(t)+0.2cos(wt+pi)' );

hold off;

%c);

% Periodic functions looking at the plot with period T = 1/f = 1/2 = 0.5;

%Q2 --------------------------;

%a);

t2 = 0:0.01:10; % 0 ? t ? 10

e = exp(-0.1\*pi\*t2);

plot(t2,e,'r:');

hold on;

x2 = e.\*cos(2\*pi\*t2);

plot(t2, x2)

hold off;

legend('e(t)= exp(-0.1?t)', 'x2(t)= exp(-0.1?t)Cos(2?t)');

xlabel('Time');

ylabel('CT signal x2(t) and the exponential component e(t)');

%b);

t3 = 0:0.01:10; % 0 ? t ? 10

u = heaviside(t3-2); % time-shifted unit-step function

x2b = x2.\*u;

plot(t3,x2b);

xlabel('Time');

ylabel('x2b(t) = x2(t)\*u(t-2)');

%Q3 ------------------------;

%a;

% zi = 1 - 3j + 70j/(10+7j);

% zi = 4.2886 + 1.6980i;

% polar form of a+jb -> re^j\*theta

% a = real(zi) = rx = 4.2886 , b = imag(zi) = ry = 1.6980

% r = sqrt(real(zi)^2 + imag(zi)^2) = 4.6125

% [phase\_angle, magnitude] = cart2pol(real(zi), imag(zi))

% phase\_angle = theta = 0.3770

% magnitude = r = 4.6125

% Therefore polar form is 4.6125e^(0.377j)

%b;

% sinosoidal function -> x(t) = A sin(2\*pi\*f\*t + theta) , T= 1/f

% Given A = 50, T = 0.2, f = 1/0.2

% Vs = 50\*sin(2\*pi/0.2);

% = -6.1232e-14

% polar form given Theta = 0, r = magnitude = 50 -> Vs = 50e^(0j) = 50

%

% V= IZ -> Is = Vs/Zi

% zi = 4.2886 + 1.6980i;

% Is = vs/zi;

% Is = vs/zi = 10.0788 - 3.9905i

% [phase\_angle, magnitude] = cart2pol(real(Is), imag(Is))

% phase\_angle =

% -0.3770

% magnitude =

% 10.8401

% Polar form of Is = 10.84e^(-0.377j)

% Plotting

t2 = 0:0.01:0.4;

Vs = 50\*sin(2\*pi\*t2/0.2);

plot(t2,Vs,'r:');

hold on;

Is = 10.84\*sin(2\*pi\*t2/0.2 - 0.377);

plot(t2, Is)

hold off;

legend('Vs', 'Is');

xlabel('Time');

ylabel('Vs and Is signals of the circuit');

%Q4 ------------------------;

%squarewave(f, V, n, t)

squarewave(2,10,150, 0:0.1:10);

squarewave(2,10,150, 0:0.01:5);

%%%%%

% maximum instantaneous power Px(t) = x(t)^2

% its fundamental component -> when k =1

%Q5 ------------------------;

%a;

t5 = -5:0.01:5; %-5 to 5 with a time step of 0.01

f = -3\*sign(t5).\*exp(1j\*2\*pi\*t5 + 0.25\*t5); % sgn() => sign()

realf = real(f); % real component

imagf = imag(f); % imaginary component

subplot(2,1,1); % 2 rows, 1 column, 1st spot

plot(t5,real(f));

xlabel('Time');

ylabel('Real');

title('Real Component of CT signal');

subplot(2,1,2); % 2 rows, 1 column, 2nd spot

plot(t5,imag(f));

xlabel('Time');

ylabel('Imaginary');

title('Imaginary Component of CT signal');

%b;

t5 = -5:0.01:5; %-5 to 5 with a time step of 0.01

f = -3\*sign(t5).\*exp(1j\*2\*pi\*t5 + 0.25\*t5); % sgn() => sign()

%fnew = f.\*(-2<t5 & t5<2); % multiply by rectangular pulse signal rect(t/T), where T = 4

fnew = f.\*(-2<t5 & t5<2);

% rect(t/T), T=4

% rect(t/4) = f -> |t5| <= T/2 =2 and otherwise 0 -> |t5| > 2

realf = real(fnew);% real component

imagf = imag(fnew);% imaginary component

subplot(2,1,1); % 2 rows, 1 column, 1st spot

plot(t5,real(fnew));

xlabel('Time');

ylabel('Real');

title('Real Component of new CT signal');

subplot(2,1,2); % 2 rows, 1 column, 2nd spot

plot(t5,imag(fnew));

xlabel('Time');

ylabel('Imaginary');

title('Imaginary Component of new CT signal');

clf;

%Q6 ------------------------;

% ref: https://www.mathworks.com/help/symbolic/piecewise.html

syms x(t)

x(t)=piecewise(-2<=t<0, 0.25\*t, 0<=t<0.5, 1.5, 0.5<=t<=2, -t+2); % plotting x(t)

fplot(x(t));

hold on;

fplot(2\*x(t+1)); % plotting transformed x(t) into 2\*x(t+1)

hold off;

legend('x(t)', '2x(t+1)');

xlabel('Time');

ylabel('x(t) and 2x(t+1)');

%Extra

syms x(t)

x(t)=piecewise(-2<=t<0, 0.25\*t, 0<=t<0.5, 1.5, 0.5<=t<=2, -t+2); % plotting x(t)

fplot(x(t));

hold on;

fplot(x(2\*t-3)); % plotting transformed x(t) into x(2t-3)

hold off;

legend('x(t)', 'x(2t-3)');

xlabel('Time');

ylabel('x(t) and x(2t-3)');

%Q7 ------------------------;

% 1

n = [0:100];

x = (1-exp(-0.01\*n)).\*cos(pi\*n/10);

subplot(4,2,1);

stem(n,x,'filled'), grid

title('x(n)')

xlabel('n');

ylabel('x(n)');

% 2

n2\_1 = [0:100]./2; % x(n/2)

x2\_1 = (1-exp(-0.01\*n2\_1)).\*cos(pi\*n2\_1/10);

% subplot(4,2,3);

stem(n2\_1,x2\_1,'filled'), grid

title('x(n/2)');

xlabel('n');

ylabel('x(n/2)');

n2\_2 = [0:100].\*4; % x(4n)

x2\_2 = (1-exp(-0.01\*n2\_2)).\*cos(pi\*n2\_2/10);

% subplot(4,2,4);

stem(n2\_2,x2\_2,'filled'), grid

title('x(4n)')

xlabel('n');

ylabel('x(4n)');

% 3

n3\_1 = [0:100]./4; % x(n/4) = y(n)

y = (1-exp(-0.01\*n3\_1)).\*cos(pi\*n3\_1/10);

% subplot(4,2,5);

stem(n3\_1,y,'filled'), grid

title('x(n/4)')

xlabel('n');

ylabel('x(n/4)');

n3\_2 = n3\_1.\*4; % y(4n)

z = (1-exp(-0.01\*n3\_2)).\*cos(pi\*n3\_2/10);

% subplot(4,2,6);

stem(n3\_2,z,'filled'), grid

title('y(4n)=z(n)')

xlabel('n');

ylabel('z(n)');

% x(n) and z(n) are equal

% 4

n4\_1 = [0:100].\*4;

y = (1-exp(-0.01\*n4\_1)).\*cos(pi\*n4\_1/10);

% subplot(4,2,7);

stem(n4\_1,y,'filled'), grid

title('x(4n)')

xlabel('n');

ylabel('x(4n)');

n4\_2 = n4\_1./4;

z = (1-exp(-0.01\*n4\_2)).\*cos(pi\*n4\_2/10);

% subplot(4,2,8);

stem(n4\_2,z,'filled'), grid

title('y(n/4)=z(n)')

xlabel('n');

ylabel('z(n)');

% x(n) and z(n) are equal

**squarewave.m**

function [out, power] = squarewave(f, V, n, t)

% Frequency[f], Amplitude[v], Number of Terms[n], Time Array[t]

max\_array = 1:n\*2; %1:double the number required(because we only need odd #s)

odd\_terms = max\_array(rem(max\_array,2)==1); % getting n odd numbers

out = zeros(1,length(t)); % empty array of all zeros

for i=1:length(odd\_terms) % summation of all the terms

tmp= 1/odd\_terms(i) \* sin(odd\_terms(i)\*2\*pi\*f\*t); % a term of a n at a time

out=out+tmp; % adding terms

end

%e= sin(1\*2\*pi\*f.\*t);

out = out\*4\*V/pi; % complete xsq(t) function

plot(t,out);

hold on;

fundamental = 4\*V/pi \* 1/1 \* sin(1\*2\*pi\*f\*t); % Fundamental component n =1 of xsq(t)

plot(t,fundamental);

% maximum instantaneous power of the fundamental component of xsq(t)

fundamental\_power = fundamental.^2;

power = fundamental\_power;

fprintf('maximum instantaneous power of the fundamental component of xsq(t) is %s.\n',max(power));

plot(t, power);

hold off;

legend('SquareWave Form', 'Fundamental Component', 'instantaneous power of the fundamental component');

xlabel('Time');

ylabel({'Square waveform, its fundamental component(fc),';'and instantaneous power of fc'})

end