```
»x=1                                %scalar  (% signs are comments and aren't evaluated)
x =
    1

»y=[1 2 3 4 5 6]                    % sequence vector (row)
y =
    1    2    3    4    5    6

»z=[1;2;3;4;5;6]                    % list vector (column)
z =
    1
    2
    3
    4
    5
    6


»a=[1 2 3;4 5 6;7 8 9]          % matrix
a =
    1    2    3
    4    5    6
    7    8    9

»b=[y;y;y]                          %matrix (list of sequences)
b =
    1    2    3    4    5    6
    1    2    3    4    5    6
    1    2    3    4    5    6

»c=[z z z]                          %matrix (sequences of lists)
c =
    1    1    1
    2    2    2
    3    3    3
    4    4    4
    5    5    5
    6    6    6

»y'                                 %conjugate transpose
ans =
    1
    2
    3
    4
    5
    6

»y=[j*1, j*2, j*3, j*4, j*5, j*6]
y =
  Columns 1 through 2
            0 + 1.00000000000000i            0 + 2.00000000000000i
  Columns 3 through 4
            0 + 3.00000000000000i            0 + 4.00000000000000i
  Columns 5 through 6
            0 + 5.00000000000000i            0 + 6.00000000000000i

»y'                                 %conjugate transpose  (watch out, it switches sign of the complex part!)  (converts col to row, row to col)
ans =
            0 - 1.00000000000000i
            0 - 2.00000000000000i
            0 - 3.00000000000000i
            0 - 4.00000000000000i
            0 - 5.00000000000000i
            0 - 6.00000000000000i

»y(:)                                   %makes column  (this is another way -- this always makes it a column)
ans =
            0 + 1.00000000000000i
            0 + 2.00000000000000i
            0 + 3.00000000000000i
            0 + 4.00000000000000i
            0 + 5.00000000000000i
            0 + 6.00000000000000i


»d=0:1/10:1                         %sequence  (beg: step: end)
d =
  Columns 1 through 4
            0   0.10000000000000   0.20000000000000   0.30000000000000
  Columns 5 through 8
   0.40000000000000   0.50000000000000   0.60000000000000   0.70000000000000
  Columns 9 through 11
   0.80000000000000   0.90000000000000   1.00000000000000

»e=sin(2*pi*d)                      %operation on sequence  (operation on each element of sequence)
e =
  Columns 1 through 4
            0   0.58778525229247   0.95105651629515   0.95105651629515
  Columns 5 through 8
   0.58778525229247                  0  -0.58778525229247  -0.95105651629515
  Columns 9 through 11
  -0.95105651629515  -0.58778525229247                  0

»f=[0:1/8:1;0:1/16:.5;0:1/32:.25]  %list of sequences
f =
  Columns 1 through 4
            0   0.12500000000000   0.25000000000000   0.37500000000000
            0   0.06250000000000   0.12500000000000   0.18750000000000
            0   0.03125000000000   0.06250000000000   0.09375000000000
  Columns 5 through 8
   0.50000000000000   0.62500000000000   0.75000000000000   0.87500000000000
   0.25000000000000   0.31250000000000   0.37500000000000   0.43750000000000
```

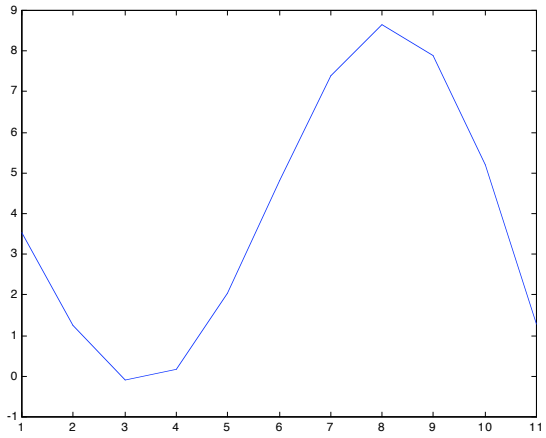
```
   0.12500000000000   0.15625000000000   0.18750000000000   0.21875000000000
  Column 9
   1.00000000000000
   0.50000000000000
   0.25000000000000

»g=sin(2*pi*f)                  %operation on list of sequences  (ex.could have a list of sines sequences with different frequencies)
g =
  Columns 1 through 4
                0   0.70710678118655   1.00000000000000   0.70710678118655
                0   0.38268343236509   0.70710678118655   0.92387953251129
                0   0.19509032201613   0.38268343236509   0.55557023301960
  Columns 5 through 8
                0  -0.70710678118655  -1.00000000000000  -0.70710678118655
   1.00000000000000   0.92387953251129   0.70710678118655   0.38268343236509
   0.70710678118655   0.83146961230255   0.92387953251129   0.98078528040323
  Column 9
                0
                0
   1.00000000000000

»whos                                   %variable list and sizes  ( helpful when doing vector multiplication)
  Name      Size         Bytes  Class

  a         3x3             72  double array
  ans       1x10          4192  struct array
  b         3x6            144  double array
  c         6x3            144  double array
  d         1x11            88  double array
  e         1x11            88  double array
  f         3x9            216  double array
  g         3x9            216  double array
  x         1x1              8  double array
  y         1x6             48  double array
  z         6x1             48  double array

Grand total is 276 elements using 5264 bytes

leaving 307693008 bytes of memory free.

»
»y-1                                    %addition
ans =
     0     1     2     3     4     5

»z
z =
     1
     2
     3
     4
     5
     6

»z*(y-1)                                %outer product  6x1 x 1x6  =  6x6  (makes a list of sequences, each sequence y multiplied by corresponding element of list in z)
ans =
     0     1     2     3     4     5
     0     2     4     6     8    10
     0     3     6     9    12    15
     0     4     8    12    16    20
     0     5    10    15    20    25
     0     6    12    18    24    30

»(y-1)*z                                %inner product 1x6 x 6x1 = 1x1  (multiplies each corresponding element of y and z, then adds the resulting elements together)
ans =
    70
»0*1+1*2+2*3+3*4+4*5+5*6    inner product
ans =
    70

»[1 2 3]*g                              %vector x matrix  (sequence of inner products)
ans =
  Columns 1 through 4
                0   2.05774461196511   3.56226385946836   4.22157654526793
  Columns 5 through 8
   4.12132034355964   3.63506112074366   3.18585215990695   3.00061592475332
  Column 9
   3.00000000000000

»%g was the list of sine sequences;
»% but you can also think of it as a sequence of lists
»%with each list being the values for the three sinewaves at different times in the sequence.
»%you are doing an inner product between [1 2 3] and each column (list) of the sine sequence.
»%at each time in the sequence, you are scaling each sine wave by a different amount then adding them together.

»%g = [sine1(t0) sine1(t1) sine1(t2)...
          sine2(t0) sine2(t1) sine2(t2)..
         sine3(t0) sine3(t1) sine3(t2)...]

»%[1 2 3]*g=[1*sin1(t0)+2*sin2(t0)+3*sine(t0), 1*sin1(t1)+2*sine2(t1)+3*sine3(t1), ...



=====
Function:
input: f (row),X(row),fs(scalar),dur(scalar)
output: xx(row)

function xx=sumcos(f,X,fs,dur)
.
.
.
xx =?
```

save as sumcos.m

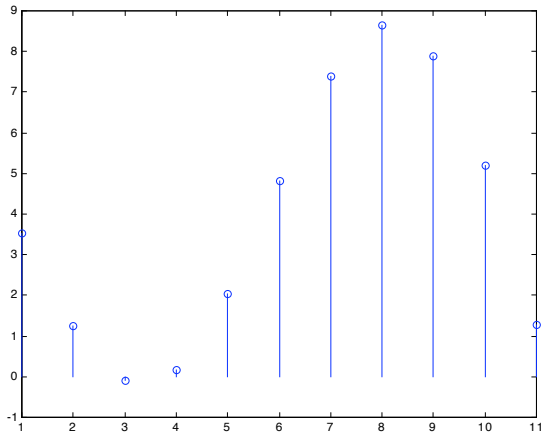
======

```
»z1=5*exp(j*0.5*pi);
»z2=5*exp(j*-0.25*pi);
»zp=sumcos([1, 1/3],[z1,z2],10,1)
zp =
  Columns 1 through 4
   3.53553390593274   1.25442657826475  -0.08738044898976   0.18315912149992
  Columns 5 through 8
   2.05422141231050   4.82962913144534   7.39395888240421   8.64101238876062
  Columns 9 through 11
   7.90188453672496   5.20887876016010   1.29409522551261
```

»plot(zp)



»stem(zp)



=======

output xx and t

function [xx,t]=sumcos(f,X,fs,dur)

%make time sequence from fs & dur

t=?

% use outer product to make a list of complex exponential sequences using f and t

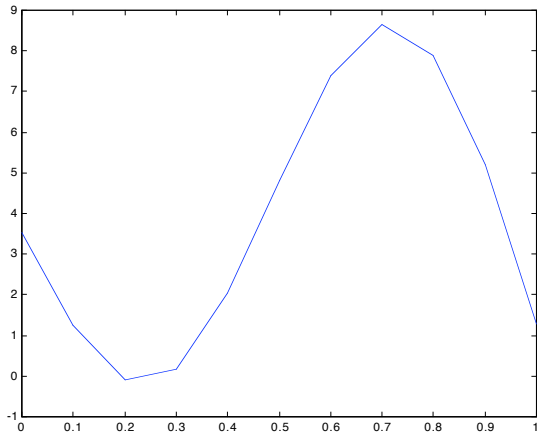
% use the inner product to multiply list of phasors X with list of complex exponential sequences

xx=?

=====

```
»[zp,t]=sumcos([1, 1/3],[z1,z2],10,1)
zp =
  Columns 1 through 4
   3.53553390593274   1.25442657826475  -0.08738044898976   0.18315912149992
  Columns 5 through 8
   2.05422141231050   4.82962913144534   7.39395888240421   8.64101238876062
  Columns 9 through 11
   7.90188453672496   5.20887876016010   1.29409522551261
t =
```

```
 Columns 1 through 4
         0   0.10000000000000   0.20000000000000   0.30000000000000
 Columns 5 through 8
  0.40000000000000   0.50000000000000   0.60000000000000   0.70000000000000
 Columns 9 through 11
  0.80000000000000   0.90000000000000   1.00000000000000

»plot(t,zp)
```

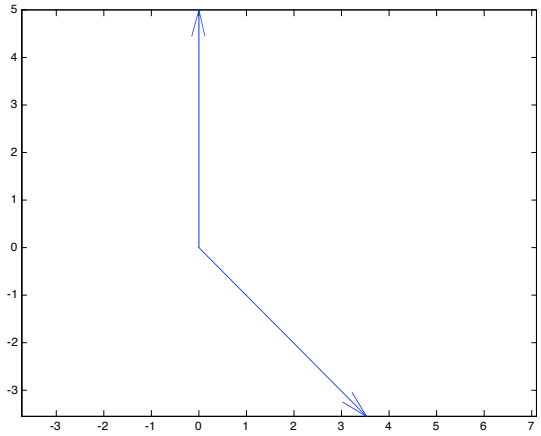



```
»cd dspfirst  % change directory  (you either must be in directory to use the functions, or add path of directory)
»ls  % list directory

Writing_Fast_MATLAB_Code.pdf pkinterp.m
alphacon.m                   pkpick.m
amdemod.m                    pretty_w.m
b5syn.mat                    pumpkin.m
baboon.mat                   replacez.m
beatcon.m                    rrecks.mat
beatconb.m                   show_img.m
clip.m                       showspec.m
cosgen.m                     sinedri
dspf.mat                     spectgr.m
dspf1.mat                    striplot.m
dspf2.mat                    sumprod.m
dspfirst.m                   tools.gif
dtmfchck.m                   tools.mat
dtmfmain.m                   trusize.m
echar512.mat                 ucplot.m
echart.mat                   vowel_d.m
expand.m                     wavesnds.m
fenotes.m                    wavwrisc.m
firfilt.m                    wngui.m
furelise.mat                 wngui.mat
imsample.m                   woodwenv.m
inout.m                      wreck.mat
lab6dat.mat                  wrinotes.m
lab7dat.mat                  zcat.m
lenna.mat                    zcoords.m
lenna512.mat                 zdrill
lenna_bl.mat                 zone.mat
manipsin.m                   zone512.mat
mattostr.m                   zone_mak.m
musiclab                     zprint.m
mysound.m                    zvect.m
nveloper.m
pez_31

»help zprint  % if you don't know what the command does, use help

 ZPRINT   printout complex # in rect and polar form
 ------
   usage:   zprint(z)
     z = vector of complex numbers; each one will be printed
         in a format showing real, imag, mag and phase


»zprint([z1 z2])
 Z =     X    +     jY     Magnitude    Phase    Ph/pi   Ph(deg)
        -0          5           5    1.571    0.500    90.00
     3.536     -3.536           5   -0.785   -0.250   -45.00

»help zvect

 ZVECT   Plot vectors in complex z-plane from zFrom to zTo

  usage:   HV = zvect(zFrom, <zTo>, <LTYPE>, <SCALE>)

        Z:  is a vector of compplex numbers; each one will be
            displayed as an arrow emanating from the origin.
    LTYPE: string containing any valid line type (see PLOT)
    SCALE: controls size of arrowhead (default = 1.0)
           (order of LTYPE and SCALE args doesn't matter)
       HV: output handle from graphics of vector plot
```

** With only one input vector: zvect(Z)
displays Z as arrows emanating from the origin.
** If either zFrom or zTo is a scalar all vectors will
start or end at that point.

See also ZCAT, PLOT, COMPASS, ROSE, FEATHER, QUIVER.

»zvect([z1, z2])



»help zcat

ZCAT   Plot vectors in z-plane end-to-end

usage: hv = zcat(Z, <LTYPE>, <SCALE>)

Z = vector of complex numbers; each complex # is displayed
as a vector, with the arrows placed end-to-end
LTYPE: string containing any valid line type (see PLOT)
SCALE: varies size of arrowhead (default = 1.0)
(order of LTYPE and SCALE args doesn't matter)
hv: output handle from graphics of vector plot

See also ZVECT, COMPASS, ROSE, FEATHER, QUIVER.

»zcat([z1,z2])