```
G_u = 27.6 * (0.01^2/0.1);
G_al = 205 * (0.01^2/0.1);
G_fe = 16 * (0.01^2/0.1);
G_inf = 150 * 0.01^2;

G = [2*G_u -G_u 0 0 0 0 0 0 0 0;
    -G_u 2*G_u -G_u 0 0 0 0 0 0 0;
    0 -G_u 2*G_u -G_u 0 0 0 0 0 0;
    0 0 -G_u (G_u+G_al) -G_al 0 0 0 0 0;
    0 0 0 -G_al 2*G_al -G_al 0 0 0 0;
    0 0 0 0 -G_al 2*G_al -G_al 0 0 0;
    0 0 0 0 0 -G_al (G_al+G_fe) -G_fe 0 0;
    0 0 0 0 0 0 -G_fe 2*G_fe -G_fe 0;
    0 0 0 0 0 0 0 -G_fe 2*G_fe -G_fe;
    0 0 0 0 0 0 0 0 -G_fe (G_fe+G_inf)];

b = [G_u*373.15 0 0 0 0 0 0 0 0 G_inf*298]';

sparse(G);

T_total  = G \ b;

T_final = [373.15 T_total' 298]';

x = 0:0.1:1.1;
f1 = figure('Name', 'Figure 1: Plot of T_final');
plot(x,T_final');
xlabel('Position (m)');
ylabel('Temp (K)');
title('Plot of T(x) = T_{final}')

diary vj_problem1.txt
echo
G_u
G_fe
G_al
G_inf
sparse(G)
sparse(b)
T_total
T_final
echo off
diary off
```

```
G_u

G_u =

    0.0276

G_fe

G_fe =

    0.0160

G_al
```

```
G_al =

    0.2050

G_inf

G_inf =

    0.0150

sparse(G)

ans =

   (1,1)       0.0552
   (2,1)      -0.0276
   (1,2)      -0.0276
   (2,2)       0.0552
   (3,2)      -0.0276
   (2,3)      -0.0276
   (3,3)       0.0552
   (4,3)      -0.0276
   (3,4)      -0.0276
   (4,4)       0.2326
   (5,4)      -0.2050
   (4,5)      -0.2050
   (5,5)       0.4100
   (6,5)      -0.2050
   (5,6)      -0.2050
   (6,6)       0.4100
   (7,6)      -0.2050
   (6,7)      -0.2050
   (7,7)       0.2210
   (8,7)      -0.0160
   (7,8)      -0.0160
   (8,8)       0.0320
   (9,8)      -0.0160
   (8,9)      -0.0160
   (9,9)       0.0320
  (10,9)      -0.0160
   (9,10)     -0.0160
  (10,10)      0.0310

sparse(b)

ans =

   (1,1)      10.2989
  (10,1)       4.4700

T_total

T_total =

  366.5688
  359.9876
  353.4064
  346.8252
  345.9392
  345.0531
```

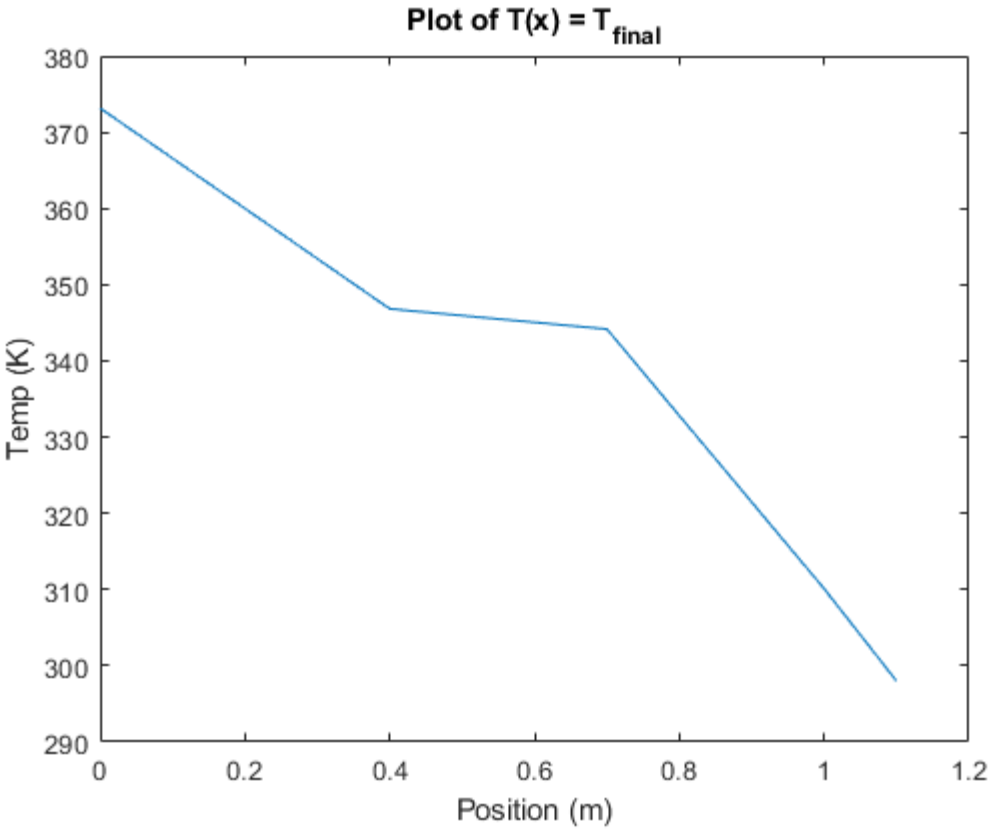
```
   344.1671
   332.8145
   321.4620
   310.1094

T_final

T_final =

   373.1500
   366.5688
   359.9876
   353.4064
   346.8252
   345.9392
   345.0531
   344.1671
   332.8145
   321.4620
   310.1094
   298.0000

echo off
```



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```
close all
%All in um^3/sec
G_cell = 100 * 35;
G_out = 800 * 35;
G_infy = 40 * 5 * 35;

G_raw = [4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    -G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,-G_out,4*G_out,0,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    -G_out,0,0,0,0,0,0,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,0,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,-G_out,0,0,0,0,0,0,3.5 * G_out,-G_out,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,3*G_out + G_cell,-G_out,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_out,-G_out,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,2 * G_out + 1.5 * G_cell,0,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,0,3*G_cell,-G_cell,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_cell,3*G_cell,-G_cell,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-(0.5*G_out + 0.5*G_cell),0,0,0,0,0,-G_cell,2*G_cell + 2*G_out,-
(0.5*G_cell + 0.5*G_out),0,0,0,0,0,-G_out,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-0.5*(G_cell + G_out),3*G_out + G_cell,-0.5 *
(G_cell + G_out),0,0,0,0,0,-G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-(0.5*G_out + 0.5*G_cell),0,0,0,0,0,-(0.5*G_out +
0.5*G_cell),4,-G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_out,4*G_cell,-G_cell,0,0,0,0,0,-
```

```
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_out,0,0,0,0,0,-G_cell,3*G_cell,0,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,0,3*G_cell,-G_cell,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,4*G_cell,-
G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,4*G_cell,-
G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,4*G_cell,-
G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,4*G_cell,-
G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,3 *
G_cell,0,0,0,0,0,0,-G_cell,0,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,0,3 * G_cell,-
G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,4 * G_cell,-
G_cell,0,0,0,0,0,-G_cell,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,4 *
G_cell,-G_cell,0,0,0,0,0,-G_cell,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-
G_cell,4*G_cell,-G_cell,0,0,0,0,0,-G_cell,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-
G_cell,4*G_cell,-G_cell,0,0,0,0,0,-G_cell,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-
G_cell,4*G_cell,-G_cell,0,0,0,0,0,-G_cell,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-G_cell,3
* G_cell,0,0,0,0,0,0,-G_cell;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-
G_cell,0,0,0,0,0,0,2*G_cell + G_infy,-G_cell,0,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-
G_cell,3*G_cell + G_infy,-G_cell,0,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-
G_cell,3*G_cell + G_infy,-G_cell,0,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-G_cell,0,0,0,0,0,-
G_cell,3*G_cell + G_infy,-G_cell,0,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-
G_cell,0,0,0,0,0,-G_cell,3*G_cell + G_infy,-G_cell,0;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-
G_cell,0,0,0,0,0,-G_cell,3*G_cell + G_infy,-G_cell;
    0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-
G_cell,0,0,0,0,0,-0.5*(G_cell + G_infy),2*G_cell + G_infy];

b = [200 100 100 100 100 100 200 100 100 100 100 100 100 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0];

[L, U, P] = lu(G_raw);

fig0 = figure('Name', 'Spy of G');
spy(G_raw)
hold on
title('Spy of G_{raw}')
fig1 = figure('Name', 'Spy of L');
spy(L)
hold on
title('Spy of L')
fig2 = figure('Name', 'Spy of U');
```

```
spy(U)
hold on
title('Spy of U')
fig3 = figure('Name', 'Spy of P');
spy(P)
hold on
title('Spy of P')

C_total = G_raw\b';



C_final = reshape(C_total, [7, 7]).';

conc_top = 0.1*ones(9,1)';
conc_side = 0.1*ones(9,1);
conc_side(5:8) = NaN;

C_int = padarray(C_final, [1,1], 0,'both');

C_int(:,9) = conc_side;
C_int(:,1) = conc_side;
C_int(1,:) = conc_top;
C_int(9,:) = [];
C_final2 = C_int;

x = 0:5:40;
y = 0:5:35;
[X,Y] = meshgrid(x,y);
fig4 = figure('Name', 'PseudoColor Plot');

h2 = pcolor(X,Y, C_final2);
title('Concentration Plot')
axis ij
h = colorbar;
ylabel({'Microns'});
xlabel({'Microns'});
ylabel(h, 'Concentration (mM)');



fig5 = figure('Name', 'Flux Vectors and Iso-Concentration Contours');
dx = diff(X(1,1:2));
dy = diff(Y(1:2,1));
[PX, PY] = gradient(C_final2, dx, dy);
quiver(X, Y, -PX, -PY, 1, 'blue');
hold on
contour(X, Y, C_final2,[0.05:0.05: 0.1])
h3 = colorbar;
axis ij
ylabel(h3, 'Concentration (M)');
ylabel({'Microns'});
xlabel({'Microns'});
title('Flux Vectors and Iso-Concentration Contours')
hold off

%Echoing all outputs
diary vj_problem2.txt
echo on
sparse(G_raw)
sparse(b)
```

```
C_total
C_final
C_final2
echo off
```

```
sparse(G_raw)

ans =

   (1,1)         112000
   (2,1)         -28000
   (8,1)         -28000
   (1,2)         -28000
   (2,2)         112000
   (3,2)         -28000
   (9,2)         -28000
   (2,3)         -28000
   (3,3)         112000
   (4,3)         -28000
  (10,3)         -28000
   (3,4)         -28000
   (4,4)         112000
   (5,4)         -28000
  (11,4)         -28000
   (4,5)         -28000
   (5,5)         112000
   (6,5)         -28000
  (12,5)         -28000
   (5,6)         -28000
   (6,6)         112000
   (7,6)         -28000
  (13,6)         -28000
   (6,7)         -28000
   (7,7)         112000
  (14,7)         -28000
   (1,8)         -28000
   (8,8)         112000
   (9,8)         -28000
  (15,8)         -28000
   (2,9)         -28000
   (8,9)         -28000
   (9,9)         112000
  (10,9)         -28000
  (16,9)         -28000
   (3,10)        -28000
   (9,10)        -28000
  (10,10)        112000
  (11,10)        -28000
  (17,10)        -28000
   (4,11)        -28000
  (10,11)        -28000
  (11,11)        112000
  (12,11)        -28000
  (18,11)        -28000
   (5,12)        -28000
  (11,12)        -28000
  (12,12)        112000
  (13,12)        -28000
  (19,12)        -28000
```

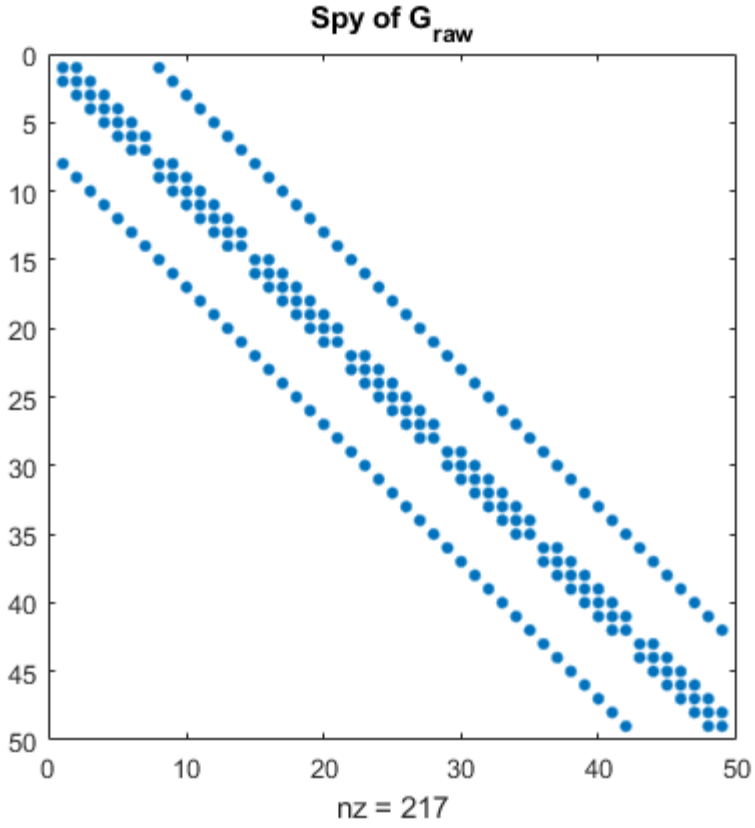
```
 (6,13)        -28000
(12,13)        -28000
(13,13)        112000
(14,13)        -28000
(20,13)        -28000
 (7,14)        -28000
(13,14)        -28000
(14,14)        112000
(21,14)        -28000
 (8,15)        -28000
(15,15)         98000
(16,15)        -28000
(22,15)        -28000
 (9,16)        -28000
(15,16)        -28000
(16,16)         87500
(17,16)        -28000
(23,16)        -28000
(10,17)        -28000
(16,17)        -28000
(17,17)        112000
(18,17)        -28000
(24,17)        -15750
(11,18)        -28000
(17,18)        -28000
(18,18)        112000
(19,18)        -28000
(25,18)        -28000
(12,19)        -28000
(18,19)        -28000
(19,19)        112000
(20,19)        -28000
(26,19)        -15750
(13,20)        -28000
(19,20)        -28000
(20,20)        112000
(21,20)        -28000
(27,20)        -28000
(14,21)        -28000
(20,21)        -28000
(21,21)         61250
(28,21)        -28000
(15,22)         -3500
(22,22)         10500
(23,22)         -3500
(29,22)         -3500
(16,23)         -3500
(22,23)         -3500
(23,23)         10500
(24,23)         -3500
(30,23)         -3500
(17,24)        -28000
(23,24)         -3500
(24,24)         63000
(25,24)        -15750
(31,24)         -3500
(18,25)        -28000
(24,25)        -15750
(25,25)         87500
(26,25)        -15750
(32,25)         -3500
```

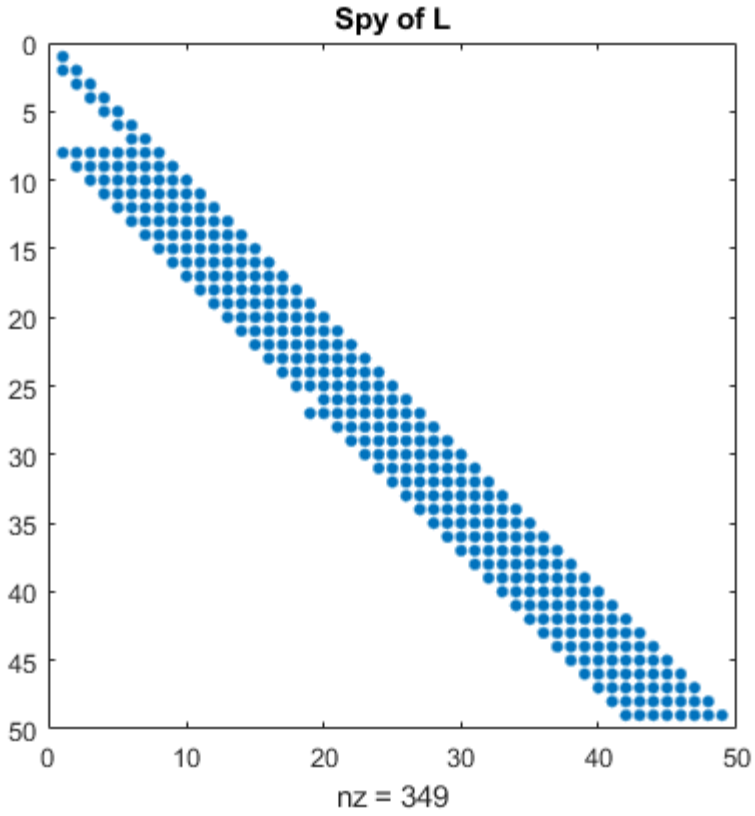
```
    (19,26)        -28000
    (25,26)        -15750
    (26,26)             4
    (27,26)        -28000
    (33,26)         -3500
    (20,27)         -3500
    (26,27)         -3500
    (27,27)         14000
    (28,27)         -3500
    (34,27)         -3500
    (21,28)         -3500
    (27,28)         -3500
    (28,28)         10500
    (35,28)         -3500
    (22,29)         -3500
    (29,29)         10500
    (30,29)         -3500
    (36,29)         -3500
    (23,30)         -3500
    (29,30)         -3500
    (30,30)         14000
    (31,30)         -3500
    (37,30)         -3500
    (24,31)        -28000
    (30,31)         -3500
    (31,31)         14000
    (32,31)         -3500
    (38,31)         -3500
    (25,32)         -3500
    (31,32)         -3500
    (32,32)         14000
    (33,32)         -3500
    (39,32)         -3500
    (26,33)         -3500
    (32,33)         -3500
    (33,33)         14000
    (34,33)         -3500
    (40,33)         -3500
    (27,34)         -3500
    (33,34)         -3500
    (34,34)         14000
    (35,34)         -3500
    (41,34)         -3500
    (28,35)         -3500
    (34,35)         -3500
    (35,35)         10500
    (42,35)         -3500
    (29,36)         -3500
    (36,36)         10500
    (37,36)         -3500
    (43,36)         -3500
    (30,37)         -3500
    (36,37)         -3500
    (37,37)         14000
    (38,37)         -3500
    (44,37)         -3500
    (31,38)         -3500
    (37,38)         -3500
    (38,38)         14000
    (39,38)         -3500
    (45,38)         -3500
```

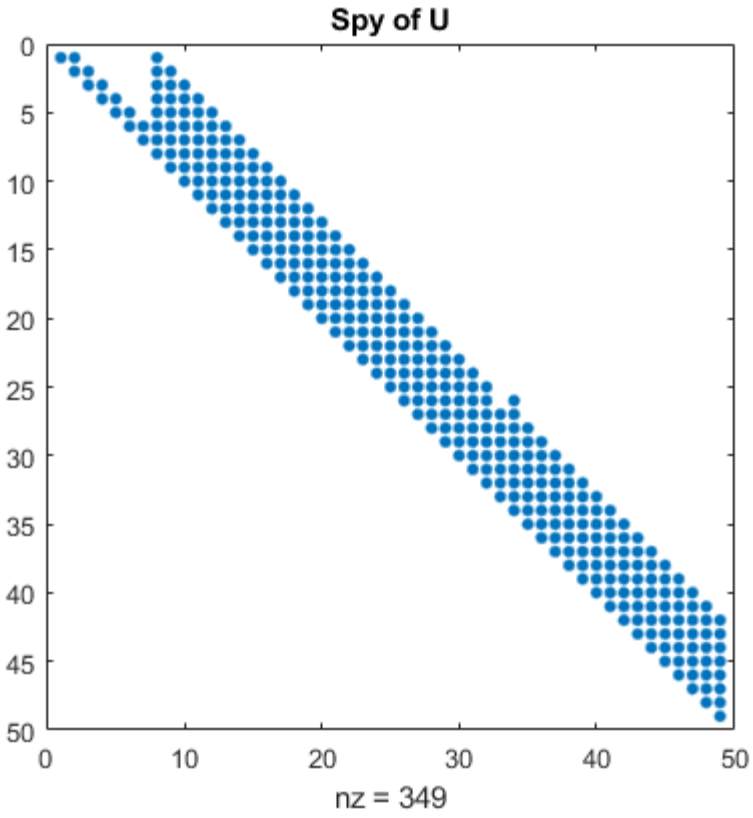
```
   (32,39)         -3500
   (38,39)         -3500
   (39,39)         14000
   (40,39)         -3500
   (46,39)         -3500
   (33,40)         -3500
   (39,40)         -3500
   (40,40)         14000
   (41,40)         -3500
   (47,40)         -3500
   (34,41)         -3500
   (40,41)         -3500
   (41,41)         14000
   (42,41)         -3500
   (48,41)         -3500
   (35,42)         -3500
   (41,42)         -3500
   (42,42)         10500
   (49,42)         -3500
   (36,43)         -3500
   (43,43)         14000
   (44,43)         -3500
   (37,44)         -3500
   (43,44)         -3500
   (44,44)         17500
   (45,44)         -3500
   (38,45)         -3500
   (44,45)         -3500
   (45,45)         17500
   (46,45)         -3500
   (39,46)         -3500
   (45,46)         -3500
   (46,46)         17500
   (47,46)         -3500
   (40,47)         -3500
   (46,47)         -3500
   (47,47)         17500
   (48,47)         -3500
   (41,48)         -3500
   (47,48)         -3500
   (48,48)         17500
   (49,48)         -5250
   (42,49)         -3500
   (48,49)         -3500
   (49,49)         14000

sparse(b)

ans =

   (1,1)       200
   (1,2)       100
   (1,3)       100
   (1,4)       100
   (1,5)       100
   (1,6)       100
   (1,7)       200
   (1,8)       100
   (1,9)       100
   (1,10)      100
```

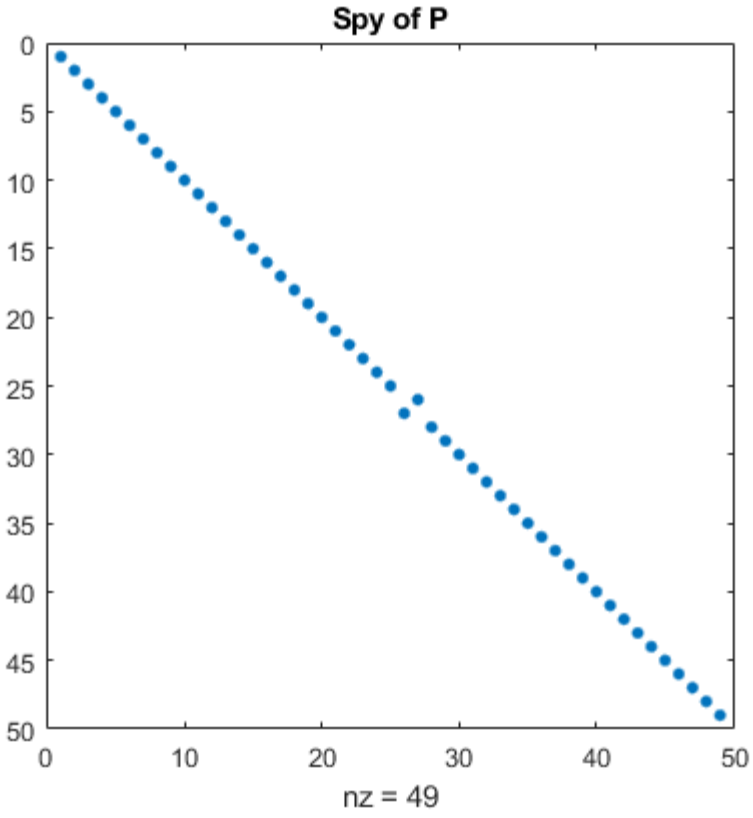
```
    (1,11)     100
    (1,12)     100
    (1,13)     100
    (1,14)     100

C_total

C_total =

    0.0043
    0.0051
    0.0052
    0.0048
    0.0043
    0.0040
    0.0037
    0.0050
    0.0072
    0.0073
    0.0061
    0.0048
    0.0044
    0.0035
    0.0050
    0.0079
    0.0071
    0.0040
    0.0009
    0.0016
    0.0025
    0.0356
    0.0435
    0.0093
    0.0018
   -0.0069
   -0.0106
    0.0032
    0.0236
    0.0222
    0.0104
    0.0033
   -0.0017
   -0.0034
   -0.0002
    0.0131
    0.0114
    0.0067
    0.0028
    0.0001
   -0.0010
   -0.0005
    0.0042
    0.0036
    0.0023
    0.0010
    0.0002
   -0.0002
   -0.0002

C_final
```

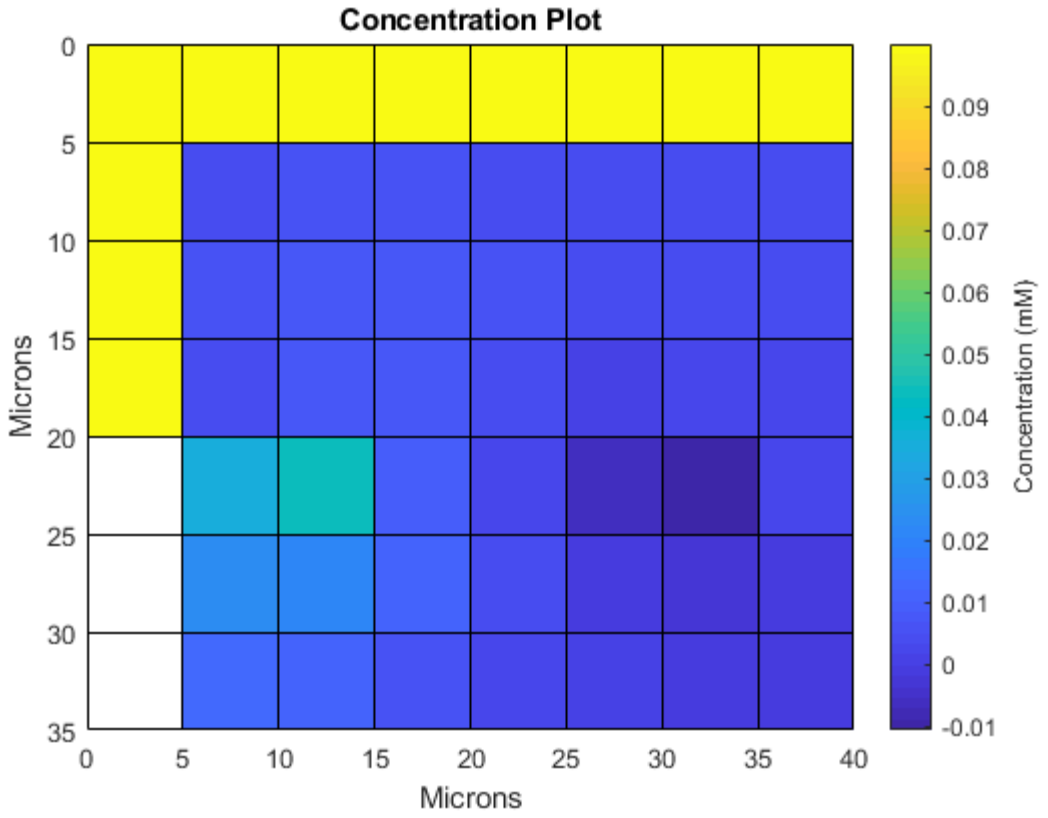
```
C_final =

    0.0043    0.0051    0.0052    0.0048    0.0043    0.0040    0.0037
    0.0050    0.0072    0.0073    0.0061    0.0048    0.0044    0.0035
    0.0050    0.0079    0.0071    0.0040    0.0009    0.0016    0.0025
    0.0356    0.0435    0.0093    0.0018   -0.0069   -0.0106    0.0032
    0.0236    0.0222    0.0104    0.0033   -0.0017   -0.0034   -0.0002
    0.0131    0.0114    0.0067    0.0028    0.0001   -0.0010   -0.0005
    0.0042    0.0036    0.0023    0.0010    0.0002   -0.0002   -0.0002

C_final2

C_final2 =

  Columns 1 through 7

    0.1000    0.1000    0.1000    0.1000    0.1000    0.1000    0.1000
    0.1000    0.0043    0.0051    0.0052    0.0048    0.0043    0.0040
    0.1000    0.0050    0.0072    0.0073    0.0061    0.0048    0.0044
    0.1000    0.0050    0.0079    0.0071    0.0040    0.0009    0.0016
       NaN    0.0356    0.0435    0.0093    0.0018   -0.0069   -0.0106
       NaN    0.0236    0.0222    0.0104    0.0033   -0.0017   -0.0034
       NaN    0.0131    0.0114    0.0067    0.0028    0.0001   -0.0010
       NaN    0.0042    0.0036    0.0023    0.0010    0.0002   -0.0002

  Columns 8 through 9

    0.1000    0.1000
    0.0037    0.1000
    0.0035    0.1000
    0.0025    0.1000
    0.0032       NaN
   -0.0002       NaN
   -0.0005       NaN
   -0.0002       NaN

echo off
```

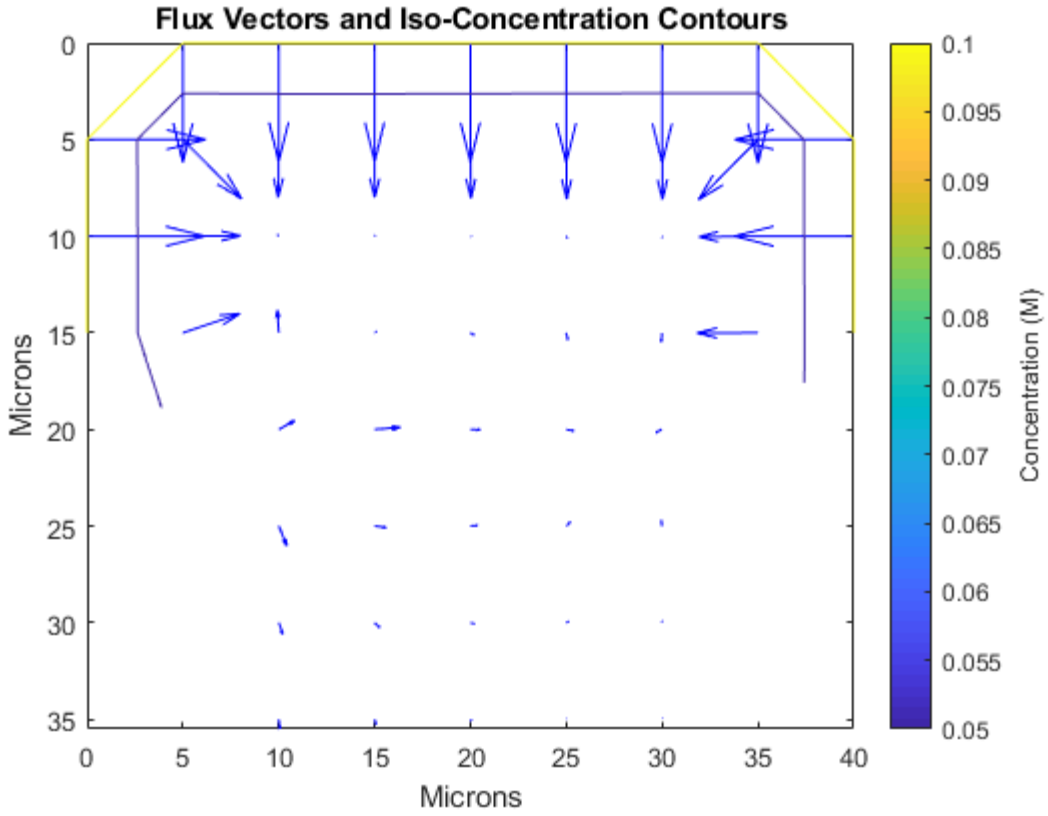

Spy of G raw
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
nz = 217


Spy of L
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
nz = 349


Spy of U
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
nz = 349


Spy of P
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
nz = 49





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BE 601 HW 2 Problem 3

Part A $H = \begin{bmatrix} 1/2 & 0 & 0 & 0 & 0 \\ 1 & 1/2 & 0 & 0 & 0 \\ 1 & 1 & 1/2 & 0 & 0 \\ 1 & 1 & 1 & 1/2 & 0 \\ 1 & 1 & 1 & 1 & 1/2 \end{bmatrix}$

Part C

$$A = \int_0^2 \sin(\pi/2\, t)\, dt = \frac{2}{\pi}\int \sin u\, du \rightarrow -\frac{2\cos(u)}{\pi} \rightarrow -\frac{2\cos\left(\frac{\pi t}{2}\right)}{\pi}\Bigg|_0^2$$

$$-\frac{2}{\pi}\left[\underset{-1}{\cos\pi} - \underset{1}{\cos(0)}\right] = \frac{4}{\pi} \approx \underline{1.2732}$$

$$\frac{1/2\ y[4]}{1.2732} = \frac{1/2 \cdot 2.4142}{1.2732} = 0.9481 \longrightarrow \underline{94.81\%}$$

```
clear all
close all
clc

%Alternate H set up
D = diag(0.5 * ones(1,5));
lt = tril(ones(5,5));
ltt = lt - diag(diag(lt));
H_check = D + ltt;

%H set up with circshift and loops
matint = zeros(5,5);
mat = [1 1 1 1 1/2];
shifted_mat = circshift(mat, -1, 2);
H = matint;
ii = 1;

for i = 1:size(matint)

    matint(i,:) = matint (i,:) + mat;
    for j = 1:size(matint)
        H(j,:) = circshift(matint(j,:), ii, 2);
        ii = ii + 1;
    end
end

for jj = 1:size(matint)-1
    H(jj,jj+1:size(matint)) = 0;
end

t = 0:0.5:2;
x = sin((pi/2).*t);
n = 0:4;
y = H*x';

f0 = figure('Name','Stem Plot of Trapezoidal Integrator, 2 Hz Sampling');

stem(n,y, 'filled', 'Linewidth', 2, 'color', 'magenta');
xlabel('n (0.5s intervals)')
ylabel('y[n]')
title('Trapezoidal integrator, 2 Hz sampling')
grid on

diary vj_problem3.txt
echo
x
H
y
echo off
diary off
```

```
x

x =

         0    0.7071    1.0000    0.7071    0.0000
```

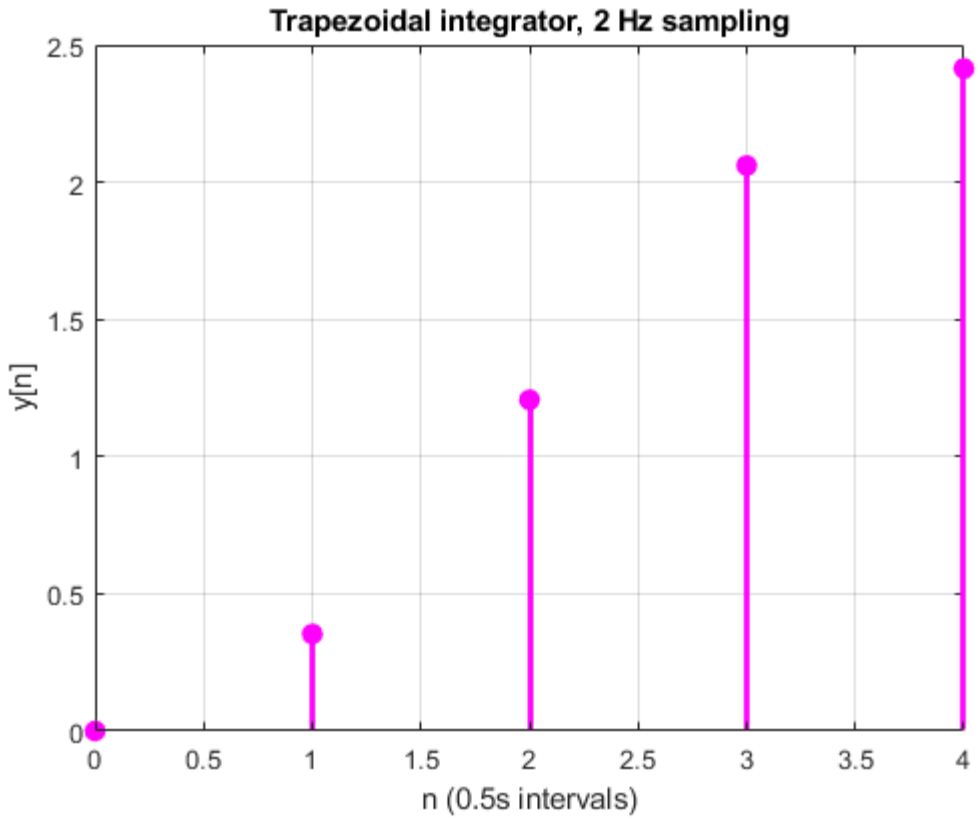
```
H
```

```
H =

    0.5000         0         0         0         0
    1.0000    0.5000         0         0         0
    1.0000    1.0000    0.5000         0         0
    1.0000    1.0000    1.0000    0.5000         0
    1.0000    1.0000    1.0000    1.0000    0.5000
```

```
y
```

```
y =

         0
    0.3536
    1.2071
    2.0607
    2.4142
```

```
echo off
```



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