Assignment 1

Table of Contents

1(a). TriDiagLUFac.m 1
1(b). TriDiagSolver.m 1
1(c). Test of Functions 1
Set up given variables for Heat Conduction in Clothing 2
2. Create initial temperature profile 3
3. Create arrays and LU factorization 4
4. Find the temperature profile after ten minutes 4
5. Determine when the skin tmeperature drops below 20C 5

Evan Waldmann (S3620596)

1(a). TriDiagLUFac.m

Function to return the LU factorization of a tridiagonal matrix.

```
function [Aout,Bout]= TriDiagLUfac(a,b,c)
ndim=length(b);
for j = 1:ndim-1
    a(j)=a(j)/b(j);
    b(j+1)=b(j+1) - a(j)*c(j);
end;
Aout = a;
Bout = b;
end
```

1(b). TriDiagSolver.m

Function to solve a tridaigonal system that has been put into LU form.

```
function [Solution]=TriDiagSolver(a,b,c,f)

%forward substitution
ndim=length(f);
for j = 1:ndim-1
    f(j+1)=f(j+1)-a(j)*f(j);
end;

%The backward substitution stage
f(ndim)=f(ndim)/b(ndim);
for k = ndim-1:-1:1
    f(k)=(f(k) - c(k)*f(k+1))/b(k);
end;
Solution = f;
end
```

1(c). Test of Functions

Tested TriDiagLUfac.m and TriDiagSolver.m using a tridiagonal 6x6 matrix with a know solution.

```
% orginal matrix
 OM = [3.0000   23.0000         0         0         0         0;
       1.0000   34.0000   43.0000         0         0         0;
            0    2.0000   55.0000   22.0000         0         0;
            0         0    3.0000   18.0000    3.0000         0;
            0         0         0    4.0000   13.0000   77.0000;
            0         0         0         0    5.0000   56.0000];

 %vectors containing diagonals and solution
  c = [23 43 22 3 77];
  b = [3 34 55 18 13 56];
  a = [1,2,3,4,5];
  f = [45 43 33 67 89 76];
  knownSolution = [-11.9303    3.5127   -1.5000    4.9307   -5.7506
 1.8706];

 [a b] = TriDiagLUfac(a,b,c);

  L = diag(a,-1)+eye(6);
  U = diag(b)+diag(c,+1);
  LU= L*U
 %L*U is equal to the original Matrix

 %solve the system
 z = TriDiagSolver(a,b,c,f)
 %z is equal to the known solution

clear;
```

```
LU =

    3.0000   23.0000         0         0         0         0
    1.0000   34.0000   43.0000         0         0         0
         0    2.0000   55.0000   22.0000         0         0
         0         0    3.0000   18.0000    3.0000         0
         0         0         0    4.0000   13.0000   77.0000
         0         0         0         0    5.0000   56.0000


z =

  -11.9303    3.5127   -1.5000    4.9307   -5.7506    1.8706
```

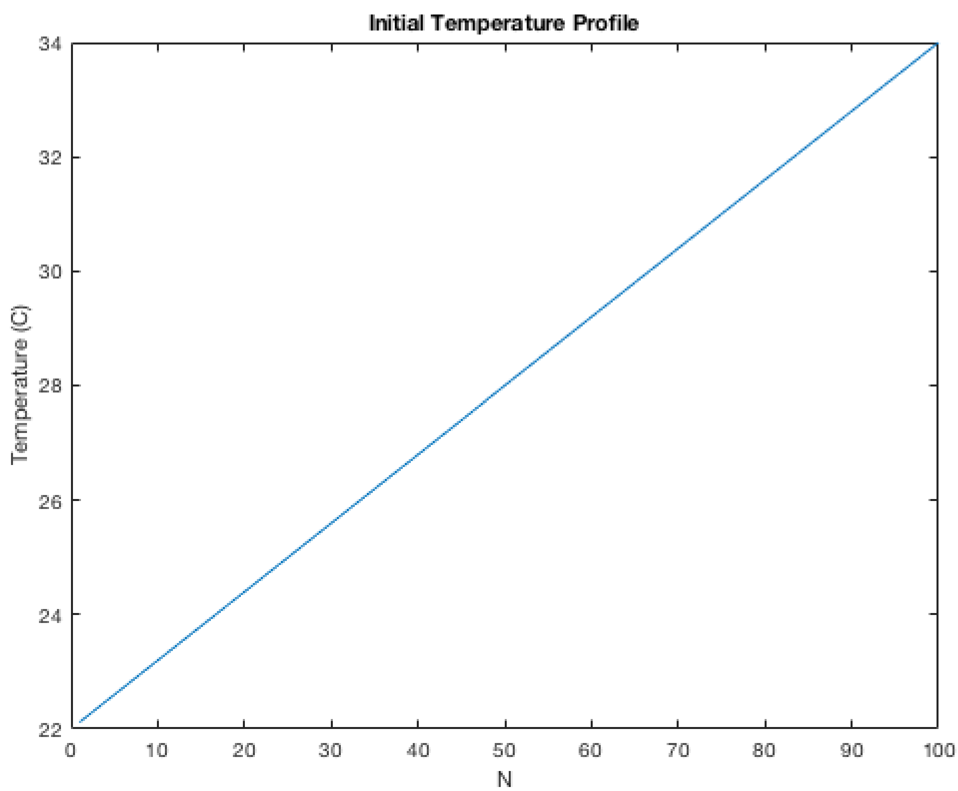
Set up given variables for Heat Conduction in Clothing

```
% Define variables using numbers per last digit of student number (6)
L = 5.5; %(cm)
Ua = -15; %(C)
N = 100;
```

```
Fl = 1.6; %(C/sec)
A = 12;
B = 22;
```

2. Create initial temperature profile

```
% define variables
k= .0055; %(cm^2/sec)
deltat = .5; %(sec)

% calculate h and s
h=L/N;
s=k*deltat/(h*h);

% calculate Inital Temperature profile
i = 1:N;
InitalTemp = A.*(i .* h./L) + B;
InitalTemp=InitalTemp';

plot(InitalTemp)
% label graph
title('Initial Temperature Profile');
xlabel('N');
ylabel('Temperature (C)');
```

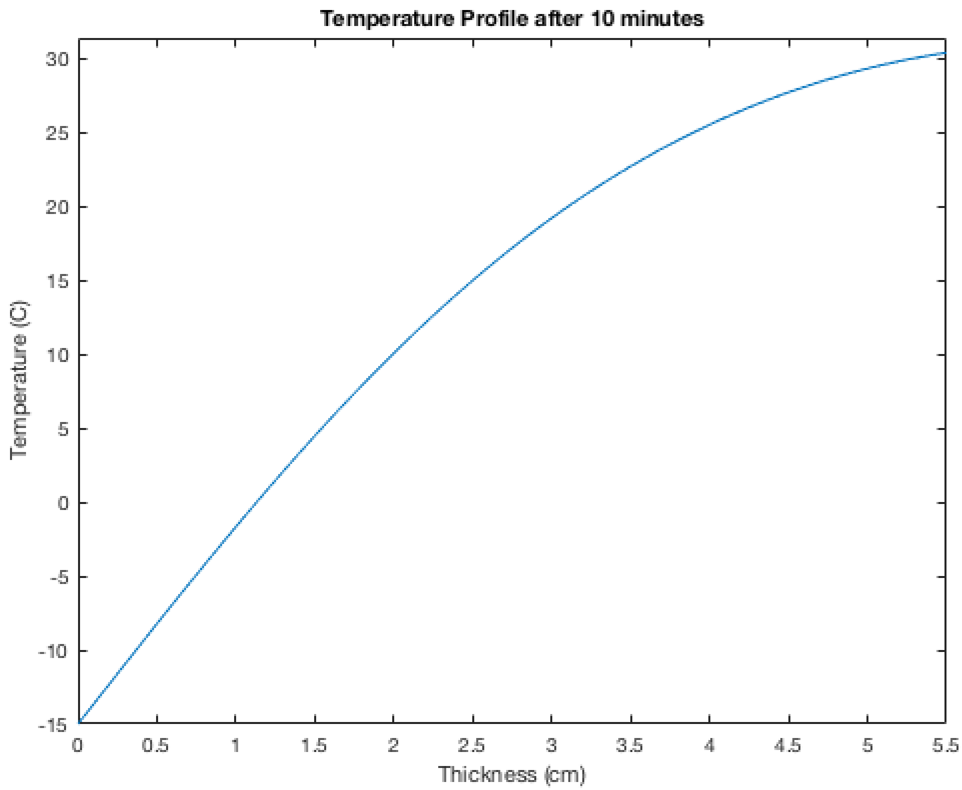


3. Create arrays and LU factorization

```
% set up arrays
b= ones(N,1) + 2*s*ones(N,1);
c= -s* ones(N-1,1);
a= -s* ones(N-1,1);
a(N-1) = -2*s;
j = zeros(N,1);
j(1) = Ua*s;
j(N) = 2*s*h*Fl;

% LU factorization
[Upper,Lower] = TriDiagLUfac(a,b,c);
```

4. Find the temperature profile after ten minutes

```
f = j+InitalTemp;

for y=1:1200
    a = TriDiagSolver(Upper,Lower,c,f);
    f = a+j;
end

% graph temperature profile
gridSpace = L/N;
gridPoints = i*h;
% add inital data point
X = [0, gridPoints];
Y = [Ua, a'];
plot(X, Y);
% label graph and fix axis
title('Temperature Profile after 10 minutes');
xlabel('Thickness (cm)');
ylabel('Temperature (C)');
axis([0,L,Ua,a(N)+1]);
```



5. Determine when the skin tmeperature drops below 20C

```
%reset the initial conditions
count=1;
s=k*(deltat )/(h*h);
j = zeros(N,1);
j(1) = Ua*s;
j(N) = 2*s*h*Fl;
f = j+InitalTemp;

while (a(N) >20)
a = TriDiagSolver(Upper,Lower,c,f);
count = count+1;
f = a+j;
end

% time in minutes taken to drop below 20 C
time = count*deltat/60
```

```
time =

   23.7333
```

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