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Assignemnt

PDE's

```
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% Department  : Applied Mechanics
```

Part 1 (Preprocessing)

```
clc;
clear;
close all;

% Parameters
alpha = 1;
h = 0.1;
k = 0.001;

x_start = 0;
x_end = 1;
t_start = 0;
t_end = 0.1;

% Discretize domain
xs = x_start:h:x_end;
ts = t_start:k:t_end;

nx = length(xs);
nt = length(ts);

% Initialize
T = zeros(nx, nt);       % FTCS
T_CN = zeros(nx, nt);    % Crank–Nicolson

% Initial condition
for i = 1:nx
    T(i,1) = sin(pi * xs(i)) + sin(2*pi * xs(i));
    T_CN(i,1) = T(i,1);
end

T(1,:) = 0;
```

```
T(end,:) = 0;
T_CN(1,:) = 0;
T_CN(end,:) = 0;
```

Part 2 (Processing / Using the Algorithms)

FTCS

```
for j = 1:nt-1
    for i = 2:nx-1
        T(i,j+1) = T(i,j) + (alpha * k / h^2) * (T(i+1,j) - 2*T(i,j) +
T(i-1,j));
    end
end
```

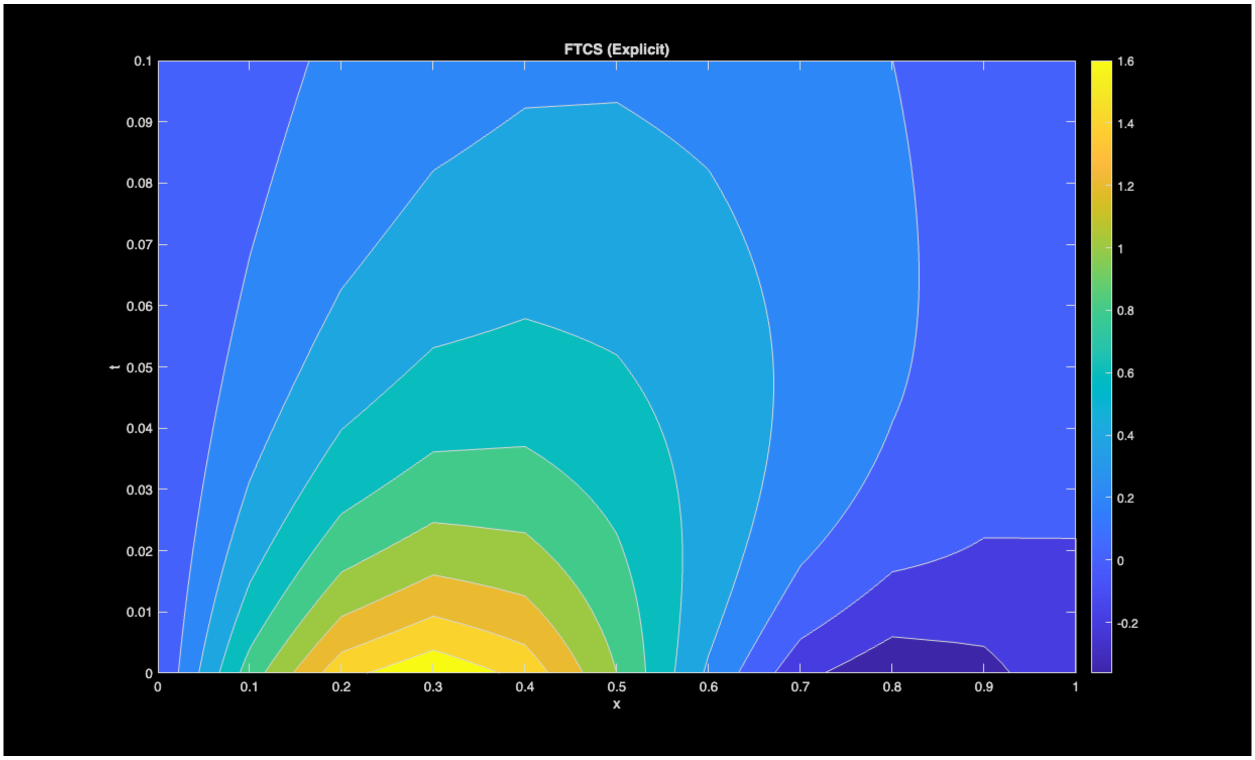
Crank–Nicolson

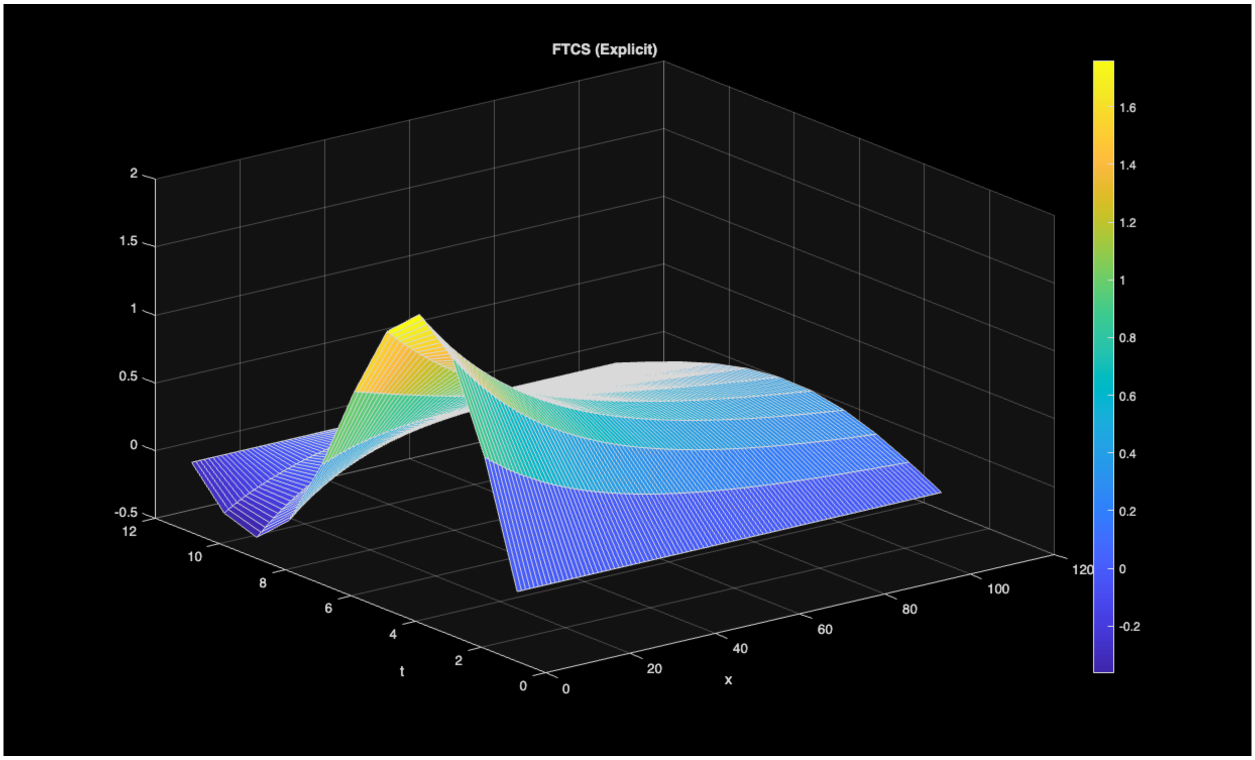
```
r = alpha * k / (2 * h^2);
A = diag((2 + 2*r) * ones(nx, 1)) + diag(-r * ones(nx-1, 1), 1) + diag(-r *
ones(nx-1, 1), -1);

% Boundary conditions
A(1,:) = 0;
A(1,1) = 1;
A(nx,:) = 0;
A(nx,nx) = 1;

for j = 1:nt-1
    Tj = T_CN(:, j);
    d = zeros(nx, 1);
    d(1) = 0;
    d(nx) = 0;
    for i = 2:nx-1
        d(i) = r*Tj(i-1) + (2 - 2*r)*Tj(i) + r*Tj(i+1);
    end
    T_CN(:, j+1) = A \ d;
end


% r = alpha * k / (2 * h^2);
% A = diag((2 + 2*r) * ones(nx, 1)) + diag(-r * ones(nx-1, 1), 1) + diag(-r
* ones(nx-1, 1), -1);
%
% Boundary conditions
% A(1,:) = 0;
% A(1,1) = 1;
% A(nx,:) = 0;
% A(nx,nx) = 1;
%
% tolerance = 1e-10;
% max_iter = 1000;
%
% T_history = [];
```

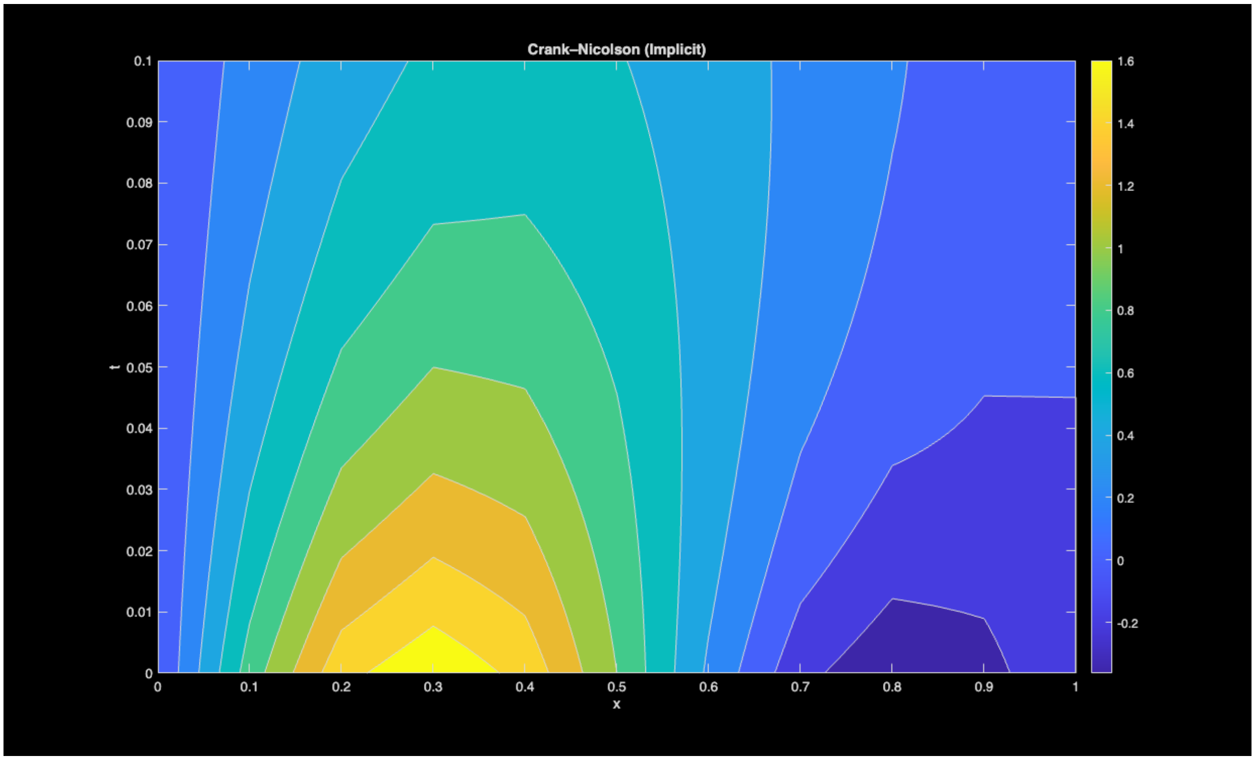
```
%
% for j = 1:nt-1
%     Tj = T_CN(:, j);
%     d = zeros(nx, 1);
%     d(1) = 0; d(nx) = 0;
%     for i = 2:nx-1
%         d(i) = r*Tj(i-1) + (2 - 2*r)*Tj(i) + r*Tj(i+1);
%     end
%
%     T_new = T_CN(:, j);  % initial guess
%     T_history = zeros(max_iter, nx);
%
%     for iter = 1:max_iter
%         T_old = T_new;
%         for i = 2:nx-1
%             T_new(i) = (r*T_new(i-1) + (2 - 2*r)*Tj(i) + r*T_new(i+1)) /
(2 + 2*r);
%         end
%         T_history(iter, :) = T_new;
%         if max(abs(T_new - T_old)) < tolerance
%             T_history = T_history(1:iter, :);
%             break;
%         end
%     end
%
%     T_CN(:, j+1) = T_new;
% end
```

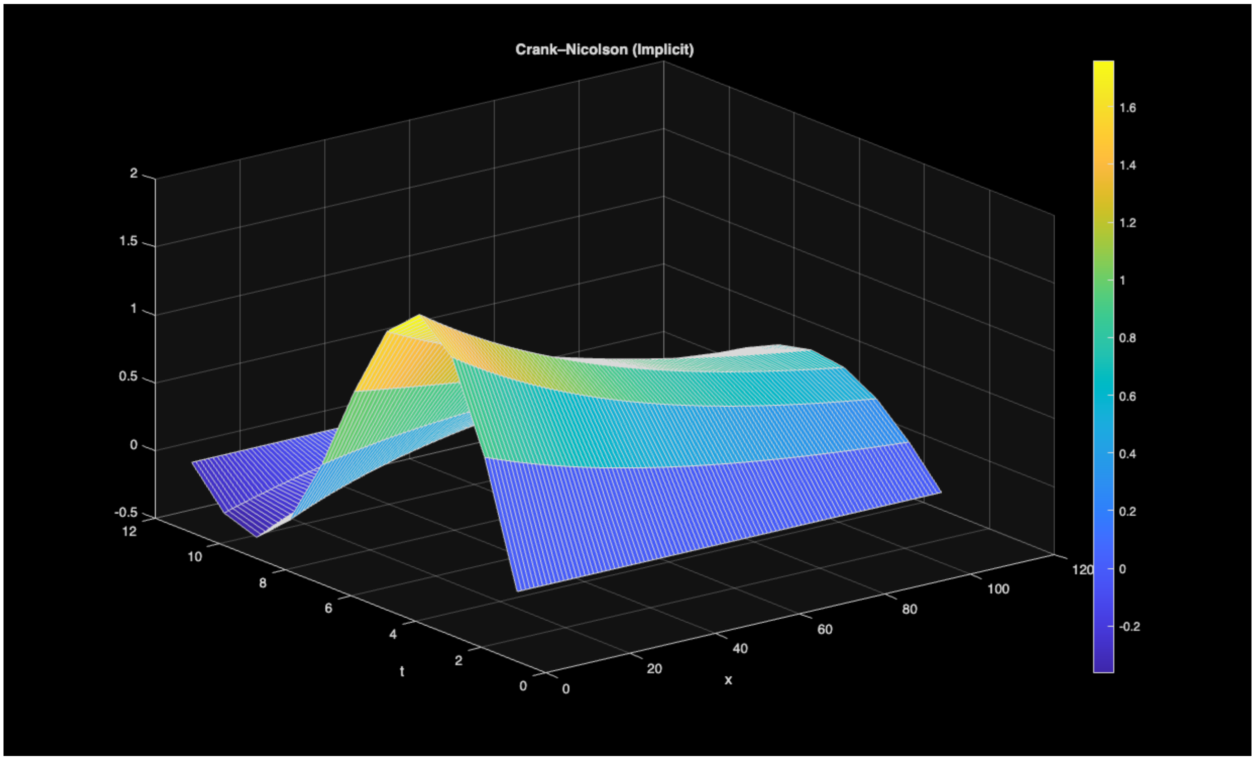
Part 3 (Post Processing / Plotting)

```
[X, Y] = meshgrid(xs, ts);

figure;
contourf(X, Y, T');
title('FTCS (Explicit)');
xlabel('x'); ylabel('t'); colorbar

figure;
surf(T);
title('FTCS (Explicit)');
xlabel('x'); ylabel('t'); colorbar

figure;
contourf(X, Y, T_CN');
title('Crank–Nicolson (Implicit)');
xlabel('x'); ylabel('t'); colorbar


figure;
surf(T_CN);
title('Crank–Nicolson (Implicit)');
xlabel('x'); ylabel('t'); colorbar
```


FTCS (Explicit)
t
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
x
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2


FTCS (Explicit)
2
1.5
1
0.5
0
-0.5
t
12
10
8
6
4
2
0
x
0
20
40
60
80
100
120
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2





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