The Diffusion Equation with No-Flux Boundary Conditions

Solve the one-dimensional diffusion equation for $|x| \le L$ using the Crank-Nicolson method. Assume no flux boundary conditions.

Script @

Reference Solution

Bave CReset

MATLAB Documentation (https://www.mathworks.com/help/)

```
1 D=1; %diffusion coefficient
3 Lx=1; %domain: -Lx < x < Lx
4 Nx=500; %# of intervals
5 nx=Nx+1;%# of gridpoints in x
6 dx=2*Lx/Nx; %grid length in x
7 x=-Lx + (0:Nx)*dx; %x values on the grid
9 nsteps=10000; %number of time steps
10 nout=500; %plot every nout time steps
11 dt=(dx)^2/(2*D); %borderline stability of FTCS scheme
12 alpha=dt*D/dx^2; %equation parameter
14 diagonals = [2*(1+alpha)*ones(nx,1), -alpha*ones(nx,2)];
15 A=spdiags(diagonals,[0 -1 1], nx, nx);
16 I=speye(nx);
17 A([1 nx],:)=I([1 nx],:); %boundaries
19 sigma=Lx/16;
20 u=1/(sigma*sqrt(2*pi))*exp(-0.5*(x/sigma).^2); u=u';
21 plot(x,u,'r'); hold on;
22 xlabel('$x$','Interpreter','latex','FontSize',14);
23 ylabel('$u(x, t)$','Interpreter','latex','FontSize',14);
24 title('Solution of the diffusion equation', 'Interpreter', 'latex', 'FontSize', 16);
b = [(1/3)*(4*u(2)-u(3)); [alpha*u(1:nx-2) + 2*(1-alpha)*u(2:nx-1) + alpha*u(3:nx)]; (1/3)*(4*u(nx-1)-u(nx-2))];
27
28
29
     if mod(m,nout)==0, plot(x,u,'b'), end
30 end
31
```

8 ► Run Script

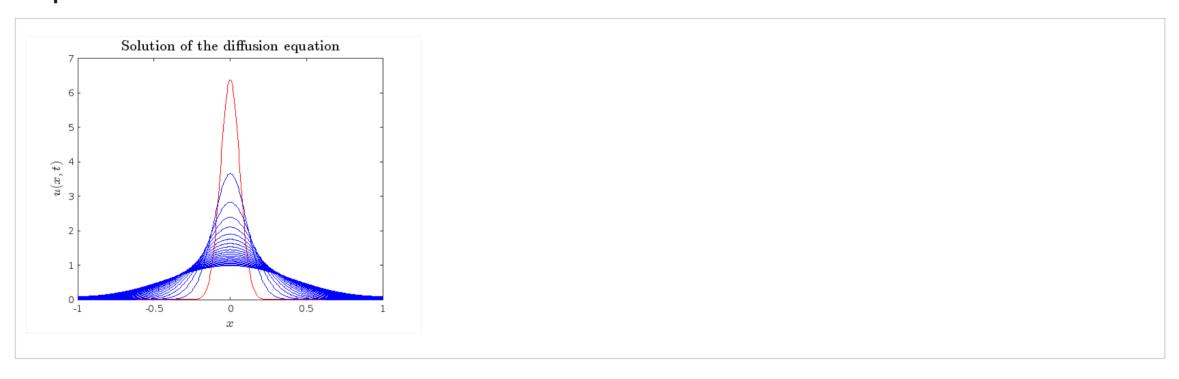
Assessment: All Tests Passed

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Check the final value of u

Output



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