

FTCS Finite Difference Example for the HEAT EQUATION

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% FTCS finite difference Method and Heat Equation
% file: heatConductionPDE.m (oct 16, 2016)
clc, clear, close

% --- Define constants and initial condition
L = 10;      % length of domain in x direction
tmax = 3;    % end time
nx = 6;      % number of nodes in x direction
nt = 31;     % number of time steps
dx = L/(nx-1); % step size in x
dt = tmax/(nt-1); % step size in t
k=0.835;     % thermal diffusivity

r = k*dt/dx^2; r2 = 1 - 2*r; % r = lambda

% Nodes coordinates
iii=[1:nx];
it=[1:nt];

% Table title
x=([1:nx]-1)*dx;
fprintf(' x ==>      ');
fprintf('%10d ',x); fprintf('\n');
fprintf(' t, below');

% Initial condition
t = 0;
u(1)=100; u(2:1:5)=0; u(6)=50;

uu=zeros(nt,nx);
uu(1,iii)=u;
fprintf('\n');

% --- Loop over time steps
for m=2:nt
    uold = u; % prepare for next step
    t = t + dt;
    for i=2:nx-1 % only interior nodes
        u(i) = r*uold(i-1) + r2*uold(i) + r*uold(i+1);
    end

    uu(m,iii)=u;
end

tt=[0:dt:tmax]';
% T=table(tt,uu, 'VariableNames',{'t' 'T'})

uuu=[tt,uu];

for jj=1:nt
    % fprintf('%d ',jj);
    for ii=1:nx+1 % Output
        fprintf('%10.3f ', uuu(jj,ii));
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    end
    fprintf('\n');
end
fprintf('\n');

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OUTPUT

x ==>	0	2	4	6	8	10
t, below						
0.000	100.000	0.000	0.000	0.000	0.000	50.000
0.100	100.000	2.087	0.000	0.000	1.044	50.000
0.200	100.000	4.088	0.044	0.022	2.044	50.000
0.300	100.000	6.006	0.128	0.064	3.003	50.000
0.400	100.000	7.845	0.249	0.127	3.923	50.000
0.500	100.000	9.610	0.405	0.209	4.805	50.000
0.600	100.000	11.305	0.593	0.309	5.653	50.000
0.700	100.000	12.933	0.811	0.426	6.467	50.000
0.800	100.000	14.497	1.056	0.561	7.250	50.000
0.900	100.000	16.002	1.326	0.710	8.002	50.000
1.000	100.000	17.449	1.619	0.876	8.727	50.000
1.100	100.000	18.842	1.934	1.055	9.424	50.000
1.200	100.000	20.183	2.269	1.248	10.097	50.000
1.300	100.000	21.475	2.622	1.454	10.745	50.000
1.400	100.000	22.721	2.991	1.672	11.371	50.000
1.500	100.000	23.922	3.375	1.902	11.974	50.000
1.600	100.000	25.081	3.773	2.143	12.558	50.000
1.700	100.000	26.200	4.184	2.395	13.122	50.000
1.800	100.000	27.281	4.606	2.656	13.668	50.000
1.900	100.000	28.326	5.039	2.927	14.197	50.000
2.000	100.000	29.336	5.481	3.206	14.709	50.000
2.100	100.000	30.313	5.931	3.494	15.205	50.000
2.200	100.000	31.259	6.390	3.789	15.687	50.000

2.300	100.000	32.175	6.854	4.092	16.155	50.000
2.400	100.000	33.062	7.325	4.401	16.610	50.000
2.500	100.000	33.922	7.802	4.717	17.052	50.000
2.600	100.000	34.756	8.282	5.039	17.482	50.000
2.700	100.000	35.566	8.767	5.366	17.901	50.000
2.800	100.000	36.351	9.256	5.699	18.310	50.000
2.900	100.000	37.114	9.747	6.037	18.708	50.000
3.000	100.000	37.856	10.241	6.379	19.097	50.000