# 有限元程序

```
clear; clc
global h

a = 0; b = 1;    %空间域边界
n = 50;           % 空间基函数个数，没有边界两个端点的基函数
h = (b-a)/(n+1);  %空间步长
t0 = 0; T=0.5;    %初始时间 和 结束时间
L = 50;              % 时间步数的最大值
tau = (T-t0)/L;  % 时间步长
tk = t0;          % 与时间步数对应的时间
c = zeros(n+2,L+1);
c(:,1)=sin(pi*(a:h:b));

for k = 2:L+1
    M = Mij(n);
    K = Kij(n);
    tk = tk + tau;
    % B = bi(n);
    B=0;
    A = K+M/tau;
    Y = M*c(2:n+1,k-1)/tau + B;
    c(2:n+1,k) =A\Y;
end
% c

%% 精确解数值解对应的三维图像及其节点处的误差值
figure(1)
[x,t]=meshgrid(a:0.01:b,0:0.01:T);
z=exp(-pi*pi*t).*sin(pi*x);    %精确解的函数表达式
mesh(t,x,z);    %精确解图像
figure(2)
[x,t]=meshgrid(a:h:b,0:tau:T);
mesh(t,x,c'); %用有限元法求得的数值解的图像
figure(3)
z=exp(-pi*pi*t).*sin(pi*x);
mesh(t,x,c'-z);  %节点处的误差值
d=c'-z;
MAE=max(abs(d(:)))


%%
```

```
function M=Mij(n)
global  h;
M=diag(h*2/3*ones(1,n));
for i = 2:n-1
    M(i,i+1) = h/6;
    M(i,i-1) = h/6;
end
M(1,2) = h/6;
M(n,n-1) = h/6;
end

function K=Kij(n)
global h;
K = diag( 2/h *ones(1,n) );
for i=2:n-1
    K(i,i+1) = -1/h;
    K(i,i-1) = -1/h;
end
K(1,2) = -1/h;
K(n,n-1) = -1/h;
end

function B=bi(n)
global h tk;
B=zeros(n,1);
for i = 1:n
    b1 = integral( @(x) f(x,tk).*(1+(x-i*h)/h),(i-1)*h,i*h );
    b2 = integral( @(x) f(x,tk).*(1-(x-i*h)/h),i*h,(i+1)*h );
    B(i) = b1+b2;
end
end

function fxt = f(x,t)
fxt = 0*t;
end
```