Homework

Solve the unsteady heat conduction equation by FTCS scheme.

$$\frac{\partial T}{\partial t} = a\,\frac{\partial^2 T}{\partial t^2}$$

Consider a large wall of thickness L whose initial temperature is given by $T(0,x) = 100\sin(p\,x/L)$. Please use FTCS scheme to obtain the temperature distribution and heat transfer rate with time at left side of the wall for the boundary condition:

$$(a)\quad T(t,0) = 0,\ T(t,L) = 0.$$

and

$$(b)\ T(t,0) = 0,\ T(t,L) = 100.$$

where $a = 0.02$ and L = 1.

```
program ftcs1
implicit none
integer :: t,m,i,j,k,nsteps
real(kind=8) :: u(0:100),v(0:100),x(0:100)
real(kind=8) :: r,length, alpha, dt, dx
character :: z
open(6,file='output1.dat')
length=1.
alpha=.02
dt=.0025001
nsteps=10000
m=100
dx=length/m
r=alpha*dt/dx**2
 write(*,'(" r= ",f6.4)') r
write(6,*) ' variables= "x" , "T(x,t)" '
! initial condition
  write(6,*) ' zone T=" ',0,'"'
 do j=0,m
   x(j)=dx*j
   v(j)=100.0*sin(3.14159265358979323846*x(j))
   write(6,'(2f15.4)')x(j),v(j)
 end do
!loop begins
do k=1,nsteps
! boudary conditions
   u(0)=0.
   u(m)=100.
!forward time and central space
   do j=1,m-1
      u(j)=v(j) + r * (v(j+1) - 2.*v(j) + v(j-1))
   enddo
! v(j) is the previous time step
   do j=0,m
      v(j)=u(j)
   enddo
  if((k/100)*100 == k) then
     write(6,*) ' zone T=" ',k,'"'
     do j=0,m
     write(6,'(2f15.4)')x(j),v(j)
     enddo
  endif
enddo
end program
```