

1 Problem Set I solving wave equation

$$\frac{\partial^2 \phi}{\partial^2 t} = c^2 \frac{\partial^2 \phi}{\partial^2 x} \quad (1)$$

1.1 fully first order formulation

$$\eta = \phi_{,t}, \quad \chi = \phi_{,x} \quad (2)$$

$$\eta(t,x)\chi(t,x)\vec{u}(\phi,\eta,\chi)$$

$$\vec{u}_{,t} + \mathbf{A}\vec{u}_{,x} = \vec{S} \quad (3)$$

1.2 initial condition

$$\phi(0, x) = e^{\sin^2(\frac{\pi x}{L})} - 1, \quad 0 \leq x \leq L \quad (4)$$

with periodic condition:

$$\phi(t, x) = \phi(t, x \pm L) \quad (5)$$

2 Program

```
1 // The C++ standard version:
2 #include <cstdio>
3 #include <cmath>
4 #include <fstream>
5 #include <iostream>
6 using namespace std ;
7
8 int main(int argc, char** argv)
9 {
10
11     init();
12
13
14     // cases for solver
15     //{{solving method second order}}
16     //{{solving method forth order}}
17
18     // Initialize 2D array using loop
19     for (int i = 0; i < 4; i++) {
20         for (int j = 0; j < 4; j++) {
21             arr[i][j] = i + j;
22         }
23     }
24     return 0;
25 };
26
27 void initalCondition(){
28
29 }
30 void init(){
31     // Declaring 2D array
32     int arr[4][4];
33     initalCondition();
34 }
```

```

35 }
36
37
38 //example function in cpp
39 void pred_corr(double x[],double h,int i,double dxdt[])
40 {
41     double
42     gam=1.,
43     beta=2.
44     ;
45     double n =7;
46     //predictor step
47     dxdt[i]=beta*x[i-tau]/(1+pow(x[i-tau],n))-gam*x[i];
48     x[i+1]=x[i]+h/12.*(23.*dxdt[i]-16.*dxdt[i-1]+5.*dxdt[i-2]);
49     //corrector step
50     dxdt[i+1]=beta*x[i+1-tau]/(1+pow(x[i+1-tau],n))-gam*x[i+1];
51     ↪ x[i+1]=x[i]+h/12.*(5.*dxdt[i+1]+8.*dxdt[i]-dxdt[i-1]);
52 };

```