MAR 513: Modeling Project # 1

Consider the following one-dimensional advection problems:

$$\frac{\partial \phi}{\partial t} + C\frac{\partial \phi}{\partial x} = S(x,t)$$

where $S(x,t)$ is the source of ϕ . Consider the following two cases.

Case 1:

$$S(x,t) = 0$$

$$\phi(x,0) = \begin{cases} 5 & -2 \le x \le 2 \\ 0 & \text{otherwise} \end{cases}$$

Case 2:

$$S(x,0) = \begin{cases} 0.1 & 0 \le x \le 4; \quad 0 \le t \le 5 \\ 0 & \text{otherwise} \end{cases}$$

$$\phi(x,0) = 0$$

Solve each problem numerically using both the centered time/centered space scheme and the forward time/backward space scheme.

For Case 1: Run the model for the following cases:

C	Δt	Δx
1	0.5	1
1	0.25	1
3	0.5	1
-1	0.25	1

Plot $\phi(x,5)$ and $\phi(x,10)$ **for each case.**

For case b: Run the model only for the case

$$C = 1,\ \Delta x = 1.0 \text{ and } \Delta t = 0.5$$

And plot contours of $\phi(x,t)$ on the (x,t) plane.

After finishing all the model runs,

1) compare the results of the two numerical schemes with each other and with the analytical solutions;
2) Discuss reasons for the differences.

You are welcomed to use any programs to solve this problem. As a request, you must hand in all the programs used to solve this advective equation.