# Selected Topics in CFD - list 8

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January 2026

## 1.

Consider the one-dimensional linear advection equation with constant velocity $u = 1$:

$$\frac{\partial \phi}{\partial t} + u\frac{\partial \phi}{\partial x} = 0,$$

with the initial condition

$$\phi(x) = \begin{cases} 4(x-1)^2(2-x)^2, & \text{for } 1 \leqslant x \leqslant 2, \\ 0, & \text{otherwise.} \end{cases}$$

Solve this equation using the forward Euler method for time integration and the following spatial discretizations:

1. second-order central differencing,
2. first-order upwind differencing.

- Determine an appropriate time-step size using the stability (CFL) condition.
- Examine the conservation of the total $\phi$ and $\phi^2$.
- Describe how truncation errors are expected to manifest in each scheme.
- Implement the method of Smolarkiewicz (1983) and compare the results.