Solving one-dimensional temperature diffusion problems by the fourth-order RK method

一、Governing equation

Without sources and sinks, the evolution of temperature follows the diffusion equation：

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

where D is the diffusion coefficient. One-dimensional problem becomes：

$$\frac{\partial T}{\partial t} = D\frac{\partial^2 T}{\partial x^2}$$

The evolution of the temperature is solved by numerical methods.

二、Numerical methods

The differential method and parameters are as follows.

The spatial discretization is done by the central difference and the temporal discretization is done by the fourth-order Runge-Kutta (RK) method.

Computational space area.: $x \propto [0\sim1]$ m

Computational time: $t \propto [0\sim20]$ s

Initial condition：$T = x - x^2$ (K)

Boundary Condition：$T = 0@x = 0; T = 0@x = 1;$

Diffusion coefficient：$D = 10^{-3}\mathrm{m}^2/\mathrm{s}$

Step： $dt = 0.01$ s; $dx = 0.01$ m

Please note: All units are in the International System.

三、Numerical results

The calculation results can be referred to Figure 1.

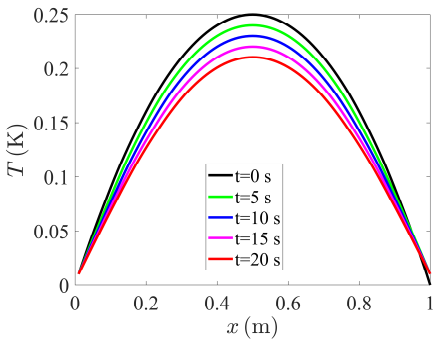

Figure 1. Temperature diffusion process