1D Time-Dependent Problems (Collocation method)

PDEs:

$$
\begin{aligned}
C_{11}(x,t,U1,...,UN)\frac{\partial U1}{\partial t} + \cdots + C_{1N}(x,t,U1,...,UN)\frac{\partial UN}{\partial t} &= \\
F_1(x,t,U1,U1_x,U1_{xx},...,UN,UN_x,UN_{xx}) & \\
. &= \\
. &= \\
C_{N1}(x,t,U1,...,UN)\frac{\partial U1}{\partial t} + \cdots + C_{NN}(x,t,U1,...,UN)\frac{\partial UN}{\partial t} &= \\
F_N(x,t,U1,U1_x,U1_{xx},...,UN,UN_x,UN_{xx}) &
\end{aligned}
$$

Boundary conditions (at endpoints):

$$
\begin{aligned}
G_1(t,U1,U1_x,...,UN,UN_x) &= 0 \\
. &= . \\
. &= . \\
G_N(t,U1,U1_x,...,UN,UN_x) &= 0
\end{aligned}
$$

(Periodic and “no” boundary conditions are also permitted.)

Initial conditions:

$$
\begin{aligned}
U1(x,t_0) &= U1_0(x) \\
. &= . \\
. &= . \\
UN(x,t_0) &= UN_0(x)
\end{aligned}
$$