Table 3.2.1. *Time schemes for initial value problems dU/dt = F(U) (schemes (a)–(i)); dU/dt = $F_1(U)$ +$F_2(U)$ (schemes (j)–(k))*

(a) $\dfrac{U^{n+1}-U^{n-1}}{2\Delta t}=F(U^n)$	Leapfrog (good for hyperbolic equations, unstable for parabolic equations)
(a′) $\dfrac{U^{n+1}-\overline{U}^{n-1}}{2\Delta t}=F(U^n)$; $\overline{U}^n=U^n+\alpha(U^{n+1}-2U^n+\overline{U}^{n-1})$	Leapfrog smoothed with the Robert–Asselin time filter; $\alpha\sim 1\%$
(b) $\dfrac{U^{n+1}-U^n}{\Delta t}=F(U^n)$	Euler (forward, good for diffusive terms, unstable for hyperbolic equations)
(c) $\dfrac{U^{n+1}-U^n}{\Delta t}=F\left(\dfrac{U^n+U^{n+1}}{2}\right)$	Crank–Nicholson or centered implicit
(c′) $\dfrac{U^{n+1}-U^n}{\Delta t}=F\left(\dfrac{\beta U^n+(1-\beta)U^{n+1}}{2}\right)$; $\beta<0.5$	Implicit, slightly damping
(d) $\dfrac{U^{n+1}-U^n}{\Delta t}=F(U^{n+1})$	Fully implicit or backward
(e) $\dfrac{U^{*}-U^n}{\Delta t}=F(U^n)$; $\dfrac{U^{n+1}-U^n}{\Delta t}=F(U^{*})$	Euler-backward or Matsuno: good for damping high frequency waves
(f) $\dfrac{U^{*}-U^n}{\Delta t}=F(U^n)$; $\dfrac{U^{n+1}-U^n}{\Delta t}=F\left(\dfrac{U^n+U^{*}}{2}\right)$	Another predictor–corrector scheme (Heun)
(g) $\dfrac{U^{n+1}-U^n}{\Delta t}=F\left(\dfrac{3}{2}U^n-\dfrac{1}{2}U^{n-1}\right)$	Adams–Bashford (second order in time).
(h) $\dfrac{U^{n+1/2^{*}}-U^n}{\Delta t/2}=F(U^n)$; $\dfrac{U^{n+1/2^{**}}-U^n}{\Delta t/2}=F(U^{n+1/2^{*}})$; $\dfrac{U^{n+1^{*}}-U^n}{\Delta t}=F(U^{n+1/2^{**}})$ $\dfrac{U^{n+1}-U^n}{\Delta t}=\dfrac{1}{6}[F(U^n)+2F(U^{n+1/2^{*}})+2F(U^{n+1/2^{**}})+F(U^{n+1^{*}})]$	Runge–Kutta (fourth order)