Problem 2. 1  Reading Assignment

- 1.7 Stiffness and implicit methods
- 1.8 Multi-step methods
- 1.9 Runge-kutta methods

Problem 2. 2  Accuracy and stability analysis

Consider the following numerical integration methods:

1.  
   \[ v^{n+1} = -4v^n + 5v^{n-1} + 4\Delta t F(v^n) + 2\Delta t F(v^{n-1}) \]

2.  
   \[ v^{n+1} = v^n + \frac{3}{2} \Delta t F(v^{n+1}) - \frac{1}{2} \Delta t F(v^{n-1}) \]

- For each scheme, determine whether it is zero stable.
- For each scheme, determine its global order of accuracy.
- For each scheme, determine whether it is eigenvalue stable in solving the equation
  \[ \frac{du}{dt} = -\lambda u \]
  for a real, nonnegative \(\lambda\). If your answer depends on \(\Delta t\), state the range of \(\Delta t\) for which the scheme is eigenvalue stable.

Problem 2. 3  Backward Euler for a nonlinear equation

Write down the backward Euler scheme for solving the nonlinear equation

\[ \frac{du}{dt} = -u^2. \]

From it, how do you compute \(v^{n+1}\) from \(v^n\)?
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