In a nutshell: The finite-difference method for linear ordinary differential equations

Given a second order linear ordinary differential equation with constant coefficients

$$a_2(x)u^{(2)}(x) + a_1(x)u^{(1)}(x) + a_0(x)u(x) = g(x),$$

two spatial boundary points $[a, b]$ and two boundary values $u(a) = u_a$ and $u(b) = u_b$.

Parameters:

n The number of sub-intervals into which $[a, b]$ will be divided.

1. Set $h \leftarrow \frac{b-a}{n}$ and $x_k \leftarrow a + kh$ noting that $x_n = b$.
2. For k going from 1 to $n - 1$, assign the following:
$$\begin{aligned} p_k &\leftarrow 2a_2(x_k) - a_1(x_k)h \\ q_k &\leftarrow -4a_2(x_k) + 2a_0(x_k)h^2 \\ r_k &\leftarrow 2a_2(x_k) + a_1(x_k)h \end{aligned}$$
3. Create and solve the system of $n - 1$ linear equations in $n - 1$ unknowns
$$\begin{pmatrix} q_1 & r_1 & & & & & \\ p_2 & q_2 & r_2 & & & & \\ & p_3 & q_3 & r_3 & & & \\ & & p_4 & q_4 & r_4 & & \\ & & & \ddots & \ddots & \ddots & \\ & & & & p_{n-2} & q_{n-2} & r_{n-2} \\ & & & & & p_{n-1} & q_{n-1} \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ \vdots \\ u_{n-2} \\ u_{n-1} \end{pmatrix} = \begin{pmatrix} 2g(x_1)h^2 - p_1u_a \\ 2g(x_2)h^2 \\ 2g(x_3)h^2 \\ 2g(x_4)h^2 \\ \vdots \\ 2g(x_{n-2})h^2 \\ 2g(x_{n-1})h^2 - r_{n-1}u_b \end{pmatrix}$$
   Note that most of the entries in the matrix will be different and are dependent on x.
4. The approximation of $u(x_k)$ is u_k for $k = 1, \ldots, n - 1$ and $u(x_0) = u(a) = u_a$ and $u(x_n) = u(b) = u_b$