$$\mathcal{J}(j,k) = \begin{pmatrix} \frac{\partial F_j}{\partial u_k^{n+1}} & \frac{\partial F_j}{\partial u_{k+1}^{n+1}} & \\ \frac{\partial F_{j+1}}{\partial u_{k-1}} & \frac{\partial F_{j+1}}{\partial u_k} & \frac{\partial F_{j+1}}{\partial u_{k+1}} \\ & \dots & \dots \end{pmatrix}$$

$$\frac{\partial F_j(u_k^{n+1})}{\partial u_k^{n+1}} = \frac{\partial}{\partial u_k^{n+1}} \left(u_k^{n+1} - u_k^{n} - \nu \left(u_{k+1}^{n+1} - 2u_k^{n+1} + u_{k-1}^{n+1} \right) \frac{\Delta t}{\Delta x^2} \right)$$

$$= \cancel{\frac{(u_k^{n+1})^2}{2}} \; 1 - 0 - \nu \frac{\Delta t}{\Delta x^2} (0 - 2 + 0) = 1 - 2\nu \frac{\Delta t}{\Delta x^2}$$

$$\boxed{\frac{\partial F_j(u_k^{n+1})}{\partial u_k^{n+1}} = 1 - 2\nu \frac{\Delta t}{\Delta x^2}}$$

$$\frac{\partial F_j(u_k^{n+1})}{\partial u_{k+1}^{n+1}} = \frac{\partial}{\partial u_{k+1}^{n+1}} \left(\dots \right) = 0 - 0 - \nu(1 - 0 + 0) \frac{\Delta t}{\Delta x^2}$$

$$= -\nu \frac{\Delta t}{\Delta x^2}$$

$$\frac{\partial F_j(u_k^{n+1})}{\partial u_{k-1}^{n+1}} = 0 - 0 - \nu(0 - 0 + 1) \frac{\Delta t}{\Delta x^2} = -\nu \frac{\Delta t}{\Delta x^2}$$

$$\boxed{\frac{\partial F_j(u_k^{n+1})}{\partial u_{k-1}^{n+1}} = -\nu \frac{\Delta t}{\Delta x^2}}$$

$$\Rightarrow \mathcal{J}(j,k) = \begin{pmatrix} 1 - 2\nu \frac{\Delta t}{\Delta x^2} & -\nu \frac{\Delta t}{\Delta x^2} & 0 \\ -\nu \frac{\Delta t}{\Delta x^2} & 1 - 2\nu \frac{\Delta t}{\Delta x^2} & -\nu \frac{\Delta t}{\Delta x^2} \\ 0 & -\nu \frac{\Delta t}{\Delta x^2} & 1 - 2\nu \frac{\Delta t}{\Delta x^2} \end{pmatrix}$$