Numerical Methods in Aeronautical Engineering
HW2 - Theoretical Questions

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1.1 A

We are asked to prove:

$$\delta^2 = \Delta - \nabla \tag{1}$$

Where:

- $\delta f = f_{\left(x+\frac{h}{2}\right)} - f_{\left(x-\frac{h}{2}\right)}$
- $\Delta f = f_{(x+h)} - f_{(x)}$
- $\nabla f = f_{(x)} - f_{(x-h)}$

$$\begin{aligned}
\delta^2 f &= \delta\left(f_{\left(x+\frac{h}{2}\right)} - f_{\left(x-\frac{h}{2}\right)}\right) \\
&= \delta f_{\left(x+\frac{h}{2}\right)} - \delta f_{\left(x-\frac{h}{2}\right)} \\
&= f_{(x+h)} - f_{(x)} - f_{(x)} + f_{(x-h)} \\
&= f_{(x+h)} - 2f_{(x)} + f_{(x-h)}
\end{aligned} \qquad
\begin{aligned}
\Delta f - \nabla f &= f_{(x+h)} - f_{(x)} - f_{(x)} + f_{(x-h)} \\
&= f_{(x+h)} - 2f_{(x)} + f_{(x-h)}
\end{aligned} \tag{2}$$

$$\Downarrow$$

$$\delta^2 = \Delta - \nabla \qquad \blacksquare$$

1.2 B