$$\langle \hat{p}_x^2(t)\rangle = \langle \psi(t)|\hat{p}_x^2|\psi(t)\rangle$$

$$= \frac{1}{3}\langle \varphi_0|\hat{p}_x^2|\varphi_0\rangle + \frac{2}{3}\langle \varphi_1|\hat{p}_x^2|\varphi_1\rangle + 2\frac{\sqrt{2}}{3}\,\mathrm{Im}\left(e^{\frac{i}{\hbar}(\varepsilon_1-\varepsilon_0)t}\langle \varphi_1|\hat{p}_x^2|\varphi_0\rangle\right)$$

Usando:

$$\langle \varphi_{n'}|\hat{p}_x^2|\varphi_n\rangle = -\frac{m\hbar\Omega}{2}\left(\sqrt{(n+1)(n+2)}\,\delta_{n',n+2} + \sqrt{(n-1)(n-2)}\,\delta_{n',n-2} - (2n+1)\delta_{n'n}\right)$$

$$\Rightarrow \langle \varphi_0|\hat{p}_x^2|\varphi_0\rangle = \frac{m\hbar\Omega}{2}, \quad \langle \varphi_1|\hat{p}_x^2|\varphi_0\rangle = 0$$

$$\langle \varphi_1|\hat{p}_x^2|\varphi_1\rangle = \frac{3}{2}m\hbar\Omega$$

$$\langle \hat{p}_x^2(t)\rangle = \frac{1}{3}\frac{m\hbar\Omega}{2} + \frac{2}{3}\cdot\frac{3}{2}m\hbar\Omega = \frac{7}{6}m\hbar\Omega.$$

$$\Delta p_x(t) = \sqrt{\langle \hat{p}_x^2(t)\rangle - \langle \hat{p}_x(t)\rangle^2}$$

$$= \sqrt{\frac{7}{6}m\hbar\Omega - \frac{8}{9}m\hbar\Omega\cos^2(\Omega t)}$$