Problem 1:   Integrals

1.1)   Gaussian

$$\int_{-\infty}^{\infty} dx\, e^{-\alpha x^2} = \sqrt{\frac{\pi}{\alpha}} \tag{1}$$

1.2)   Trig functions

Use \begin{align*}...\end{align} for derivations.

$$\int_0^{\pi} \cos(x)\cos(3x)\,dx =$$

$$= \int_0^{\pi} \frac{1}{2}\left(\cos(4x) + \cos(2x)\right) dx$$

$$= \frac{1}{2(4} \sin(4x)\Big|_0^{\pi} + \frac{1}{2(2)} \sin(2x)\Big|_0^{\pi}$$

$$= 0$$

Problem 2:   Linear Algebra

$$\mathbf{H} = \begin{pmatrix} E_0 & V \\ V & E_1 \end{pmatrix} \tag{2}$$

Problem 3:   Quantum Mechanics

$$\hat{H}|\Psi(t)\rangle = i\frac{\partial}{\partial t}|\Psi(t)\rangle \tag{3}$$