2.5

$$B' = b\begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad , \qquad \det(B - \lambda^B \mathbb{1}) = 0$$

$$\rightarrow \begin{vmatrix} -\lambda^B & 0 & 0 \\ 0 & b-\lambda^B & 0 \\ 0 & 0 & -\lambda^B \end{vmatrix} = 0 \qquad \Rightarrow -\lambda^B (b - \lambda^B)\lambda^B = 0$$

$$\Rightarrow \lambda_1^B = b \quad \vee \quad \lambda_{2,3}^B = 0$$

$$\begin{pmatrix} -1 & & \\ & 0 & \\ & & -1 \end{pmatrix} \Rightarrow E_1 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} , \quad \begin{pmatrix} 0 & & \\ & b & \\ & & 0 \end{pmatrix} \Rightarrow E_{3,2} = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} \frac{1}{\sqrt{2}}$$

3.3

$$\frac{d p_H(t)}{dt} = \frac{i}{\hbar}[H, p_H(t)] = \frac{i}{\hbar}[H, e^{iHt/\hbar} p e^{-iHt/\hbar}]$$

$$= \frac{i}{\hbar} e^{iHt/\hbar}[H, p e^{-iHt/\hbar}] + \frac{i}{\hbar}\underbrace{[H, e^{iHt/\hbar}]}_{=0} p e^{-iHt/\hbar}$$

$$= \frac{i}{\hbar} e^{iHt/\hbar}\left([H,p]e^{-iHt/\hbar} + p[H, e^{-iHt/\hbar}]\right)$$

$$= \frac{i}{\hbar} e^{iHt/\hbar}[H,p]e^{-iHt/\hbar}$$

$$= \frac{i}{\hbar}(-i\hbar q E) = qE$$

$$\Rightarrow p_H(t) = p_H(0) + qE$$

$$[H,p] = \left[\frac{p^2}{2m} - qEx, p\right] = -qE[x,p] = -i\hbar q E$$