The operator $\hat{L}_z$ that represents the z-component of angular momentum, the operator $\hat{L}^2$ that represents the total angular momentum, and the operator $\hat{H}$ that represents the energy for the rigid rotor (a particle confined to the unit sphere) have eigenvalues given by

$$\hat{L}_z \left|\ell, m\right\rangle = m\hbar \left|\ell, m\right\rangle \tag{1}$$

$$\hat{L}^2 \left|\ell, m\right\rangle = \ell(\ell+1)\hbar^2 \left|\ell, m\right\rangle \tag{2}$$

$$\hat{H} \left|\ell, m\right\rangle = \frac{\hbar^2}{2I} \ell(\ell+1) \left|\ell, m\right\rangle \tag{3}$$

Find the matrix representations for these operators.