2) Consider a class of observables

$$\vec{v}\cdot\vec{\sigma} = v_1\sigma_1 + v_2\sigma_2 + v_3\sigma_3$$

where $\vec{v} = (v_1, v_2, v_3)$ is a real unit vector, and $\sigma_1, \sigma_2, \sigma_3$ are Pauli matrices:

$$\sigma_1 = X = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \sigma_2 = Y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}, \quad \sigma_3 = Z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}.$$

I) let $M = X$, $(\vec{v} = (1,0,0))$. What is $E(M)$ for the states:

a) $|0\rangle$
b) $|1\rangle$
c) $\frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$

II) Let $M = \frac{-Z - X}{\sqrt{2}}$. What is $E(M)$ for states:

a) $|0\rangle$
b) $|1\rangle$
c) $\frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$

3) Read the given papers on Bell inequality.

a) Make sure you understand Eq. 2.225

b) Verify Eq. 2.230

observable QS means $Q \otimes S$, etc.

eg. for $Q = Z_1$ (acting on the first qubit) and $S = \frac{-Z_2 - X_2}{\sqrt{2}}$ (acting on the second qubit)

we get

$$QS = Q \otimes S = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \otimes \frac{1}{\sqrt{2}} \begin{pmatrix} -1 & -1 \\ -1 & 1 \end{pmatrix} = \dots$$