PHY 517 Spring 2021 Midterm

Name:

1. A particle's non-normalized wavefunction is given by

$$\psi(\vec{r}) = (2Y_2^1(\theta,\phi) + 3Y_2^{-1}(\theta,\phi) + Y_2^{-2}(\theta,\phi))\, f(r)$$

where *f(r)* is the normalized radial function. Calculate the expectation value of $\vec{L}^2$.

2. The state $|\alpha\rangle_x = |j = 1,\ m_x = 0\rangle$ can be understood as the eigenstate of J_x with eigenvalue $m_x = 0$. The state, using the normal J_z basis $|j, m\rangle$, is written as the following:

$$|\alpha\rangle = \frac{1}{\sqrt{2}}\{|j = 1,\ m = 1\rangle - |j = 1,\ m = -1\rangle\}$$

   a) Verify that the expectation value of J_x for the state $|\alpha\rangle$ is indeed as expected, given $m_x = 0$.

   b) Rotate the state $|\alpha\rangle$ by $\pi/2$ around the $\hat{z}$ axis. Write the new state.

   c) What is the probability of measuring the original state $|\alpha\rangle$ after the rotation done in part b)?

*you may do this problem in bra-ket notation, or matrix notation