Homework 5

Notes:

1. Due date: Nov 12, 2024, By 11:59 PM
2. Textbook = Introduction to Quantum Mechanics, 3rd Edition, Griffiths and Schroeter

1. Normalized angular wave functions, called spherical Harmonics, are given by

$$Y_l^m(\theta,\phi) = \sqrt{\frac{(2l+1)}{4\pi}\frac{(l-m)!}{(l+m)!}}\, e^{im\phi} P_l^m(cos\theta)$$

Using the equation 4.27 and 4.28 form textbook to evaluate $P_l^m(cos\theta)$, compute the exact expressions for Y_0^0, Y_1^0, Y_1^1 Y_2^0, Y_2^1, and Y_2^{-2}. Use Table 4.3 in textbook to verify your results.

Submit your solution in writing. (Credit 30 points)

2. Using a programming language of your choice, create 3D plots of Y_0^0, Y_1^0, Y_1^1 Y_2^0, Y_2^1, and Y_2^{-2}. Choose the radial dimension r so that the plots are visually clear.

While it may be difficult for me to fully understand the core details of your code, please structure it in a way that allows me to run it without needing to grasp every line. For instance, include a section where I can easily select values for l and m., and ensure the program outputs the corresponding plot of Y_l^m. For example, if I input $l = 1$, and $m = 0$, I should obtain a plot of Y_1^0. And so on.

Submission guidelines:

1. Submit a PDF via email containing all the plots generated by your code.
2. If you believe your program is easy to run, include a 'user-friendly' version of the code along with instructions for running it when submitting it for grading.
3. If your code relies on system-specific dependencies, schedule a meeting with me before the due date so you can demonstrate your work in person. For full credit, the program must run successfully during the demonstration.

(Credit 70 points)