PHY 401-402 COURSE LEARNING GOALS

1. Math/physics connection: Students should be able to translate a physical description of a senior-level quantum mechanics problem to a mathematical equation necessary to solve it. Students should be able to explain the physical meaning of the formal and/or mathematical formulation of and/or solution to a senior-level QM problem. Students should be able to achieve physical insight through the mathematics of a problem.

2. Visualize the problem: Students should be able to sketch the physical parameters of a problem (e.g., psi, potential, probability distribution), as appropriate for a particular problem.

3. Organized knowledge: Students should be able to articulate the big ideas from each chapter, section, and/or lecture, thus indicating that they have organized their content knowledge. They should be able to filter this knowledge to access the information that they need to apply to a particular physical problem.

4. Communication. Students should be able to justify and explain their thinking and/or approach to a problem or physical situation, in either written or oral form.

5. Problem-solving techniques: Students should be able to choose and apply the problem-solving technique that is appropriate to a particular problem. This indicates that they have learned the essential features of different problem-solving techniques (e.g., separation of variables, power series solutions, operator methods). They should be able to apply these problem-solving approaches to novel contexts (i.e., to solve problems which do not map directly to those in the book), indicating that they understand the essential features of the technique rather than just the mechanics of its application. They should be able to justify their approach for solving a particular problem. ...
   a. Approximations: Students should be able to recognize when approximations are useful, and use them effectively (e.g., when the energy is very high, or barrier width very wide,...). Students should be able to indicate how many terms of a series solution must be retained to obtain a solution of a given order. ...
   b. Symmetries: Students should be able to recognize symmetries and be able to take advantage of them in order to choose the appropriate method for solving a problem (e.g., when parity allows you to eliminate certain solutions).

6. Problem-solving strategy: Students should be able to draw upon an organized set of content knowledge (LG#3), and apply problem-solving techniques (LG#4) to that knowledge in order to organize and carry out long analyses of physical problems. They should be able to connect the pieces of a problem to reach the final solution. They should recognize that wrong turns are valuable in learning the material, be able to recover from their mistakes, and persist in working to the solution even though they don’t necessarily see the path to the solution when they begin the problem. Students should be able to articulate what it is that needs to be solved in a particular problem and know when they have solved it.

7. Expecting and checking solution: When appropriate for a given problem, students should be able to articulate their expectations for the solution to a problem, such as general shape of the wave function, dependence on coordinate choice, and
behavior at large distances. For all problems, students should be able to justify the reasonableness of a solution they have reached, by methods such as checking the symmetry of the solution, looking at limits, relating to cases with known solutions, checking units, dimensional analysis, and/or checking the scale/order of magnitude of the answer.

8. **Intellectual maturity:** Students should accept responsibility for their own learning. They should be aware of what they do and don’t understand about physical phenomena and classes of problem. This is evidenced by asking sophisticated, specific questions; being able to articulate where in a problem they experienced difficulty; and take action to move beyond that difficulty.

**Build on Earlier Material.** Students should deepen their understanding of Phy 235 material, i.e., the course should build on earlier material.