Group theory is the mathematics of symmetry. In this course we will develop the formal mathematical structure of group theory and show how it is used to simplify physics problems and reveal the nature of physical laws. Particular emphasis will be placed on the uses of group theory in quantum mechanics, with applications drawn primarily from atomic, molecular, and solid-state physics. However we will also occasionally consider applications in classical physics. It is expected that students have a good grounding in quantum mechanics and linear algebra, at least at the undergraduate level.

Grading Policy: There will be no exams in this course. Grades will be based 100% on approximately 8-10 homework assignments, due dates for which will be announced when each assignment is handed out. Ranges for letter grades will be no worse for you than:

- A+ [Nonexistent]
- B+ = [83-85]
- C+ = [73-75]
- D = [50-65]
- A = [87-100]
- B = [77-83]
- C = [67-73]
- F = [0-50]
- A− = [85-87]
- B− = [75-77]
- C− = [65-67]

Here a square bracket means the end point is included in the range, and a round bracket (parenthesis) means the end point is not included in the range. Actual grade ranges may end up having lower cutoffs, depending on the overall level of performance.

Homework Policy:

- Homework assignments are to be handed in to my mailbox in the departmental main office (or to my hand) by the announced deadline.
- If you ask for an extension on an assignment, I will most likely grant it, provided you don’t abuse the privilege. I would rather you ask for an extension and hand in a complete assignment than hand in a partially completed assignment on time. However, handing an assignment in late without prior approval is not acceptable.
- I encourage you to interact with each other on homework, but the write-up you hand in must be your own work, not copied or paraphrased from someone else’s work.
- Please use 8½”×11” paper (i.e., letter, not legal) for your homework write-ups, and make sure to staple the pages in order in the upper left corner before handing it in. On the last page of your write-up, please list all classmates you worked with so as to give fair attribution. Neatness counts; so please write legibly and clearly.
Attendance Policy: Attendance is not required, but is strongly encouraged. If you miss a class, it is your responsibility to learn the missed material on your own and to obtain lecture notes and in-class announcements from one of your classmates.

Textbooks: There is not one required textbook for this course, as material will be drawn from many sources. However three classic books (all inexpensive Dover publications) are listed as recommended texts:

- *Group Theory in Quantum Mechanics* by Volker Heine (Dover, 1993).

Many other very fine books on the subject of group theory and its applications in physics are available, as well. Here is an abridged list of others you may wish to consult:

- *Group Theory: A Physicist’s Survey* by Pierre Ramond (Cambridge, 2010).

Academic Honesty: All students are responsible for knowing, understanding, and abiding by the academic honesty policy of the University of Georgia, which can found online at http://honesty.uga.edu/. If you have any questions about this policy and how it pertains to your work in this course, please ask me for clarification.

Course Content: It is my intention that we cover (or at least touch on) all of the following topics, time permitting:

- Motivation for studying group theory and introduction to its basic structure
- Fundamental definitions and theorems of group theory and symmetries
- The theory of group representations
- Relationship of group theory to problems in physics
- Direct product theory
- Discrete groups and their applications
  - Molecular and crystallographic point groups
  - Space groups and applications to solid-state physics
  - Spatial-inversion and time-reversal symmetries
- Continuous groups and their applications
  - Fundamentals of Lie groups and Lie algebras
  - The translation group in N dimensions: T(N)
  - The rotation group in 2 and 3 dimensions: SO(2) and SO(3)
  - The “special unitary group of degree 2”: SU(2)
- Permutation (or symmetric) group of n objects: P(n)