PHYS 570: Fusion Categories for Physics Fall 2025 Syllabus

Course Information

- PHYS 570: Fusion Categories for Physics Section 017 CRN 30996
- Twice weekly lecture course (in-person), 3.0 Credit Hours
- Prerequisites: proof-based linear algebra; quantum mechanics
- Brightspace: for announcements and grades only
- Course webpage: link available through our Brightspace page

Course Description

An introduction to fusion categories and their applications to physics. Students will learn to work with fusion categories and their algebraic precursors with an emphasis on graphical and computational methods with the goal of preparing for research in theoretical/mathematical physics. Applications to be covered may include but are not limited to: anyon models and topological phases of matter in (2+1)D, topological quantum field theory, generalized symmetries in (1+1)D, quantum error correction, topological quantum computation, superselection theory, and (1+1)D conformal field theory.

Resources, Technology & Texts

- The course webpage will be the main resource for the course material outside of class.
- The course is designed to be self-contained from the instructor's lectures and lecture notes.
- Lecture notes will be posted to the course webpage following each class.
- We will not be following or requiring any one textbook or set of notes as the content will draw from many different primary sources in different fields. Supplemental open-access reading may be suggested for each unit/topic as the course progresses.
- Students are encouraged to attend instructor office hours to discuss exercises or questions related to the course.

Learning Outcomes

1. Perform calculations in elementary group theory and representation theory and appreciate the role they play in physics.
2. Learn the definition of a skeletal unitary (and modular) fusion category and be able to work with the graphical calculus on trivalent graphs.
3. Learn the abstract definition of a fusion, braided fusion, modular, and module category and be able to manipulate string diagrams.
4. Understand the role of fusion categories in the theory of anyons, topological quantum field theory, topological quantum computation, generalized symmetry, and quantum error correction.
5. Be able to read recent research articles in theoretical physics or mathematics that use fusion category methods and communicate their results.

Assessments

Students may take the course for a letter grade or Pass/Fail. Grades will be assigned based on the following assessments and are designed to measure student achievement of the learning outcomes given above.

Participation

Students who make a good faith effort to participate in the course and who volunteer at least once to photograph the chalkboards during lecture will receive full credit on this portion of their grade. (The instructor will provide a device if the student does not wish to use a personal device.)

Here are some other possible ways to participate in the course:

Assessments	Timeline	Percentage of Total Grade
Participation	Throughout semester	10%
Exercises	Collected biweekly in class	60%
Final Project	To be presented or collected December 2025 in class	30%

- Regular attendance
- Asking questions during lecture or office hours
- Providing feedback through optional early and mid-semester surveys

Exercises

Exercises will be posted on the course website and collected approximately every other week at the beginning of class. (See the course schedule for all collection dates.)

- Exercise solutions can be either handwritten or typed.
- Collaboration is allowed in solving homework problems but each student is responsible for writing up and submitting their own solutions; no one should submit solutions they cannot independently reproduce.
- Exercises will be reviewed by our graduate student grader for completeness/understanding and will be returned in class within 10 days of submission.
- Students needing more time to complete exercises may request an extension by emailing the instructor ahead of the Thursday deadline.

Final Project

Starting in November students will select a research article related to the course.

- The instructor will provide a list of suggestions for articles and can make recommendations to students based on their background and interests.
- Students are also welcome to propose their own article subject to instructor approval.

In December, students will present an executive summary of their research article through an in-class presentation. Students will be asked to provide constructive feedback on one anothers' presentations with regards to clarity of communicating concepts..

Grading Scale

Students who earn a percentage of total points in the course greater than or equal to the following values are guaranteed the corresponding letter grade.

- ≧97% A+
- ≧93% A
- ≧90% A-
- ≧87% B+
- ≧83% B
- ≧80% B-
- ≧77% C+
- ≧73% C
- ≧70% C-
- ≧67% D+
- ≧63% D
- ≧60% D-