

## Course Information

Course Number:  
Math 689

Course Title:  
**Special Topics in Topological Insulators I. Mathematical Tools for Solid State Theory.**

Section: 601  
Time: MW 5:35 – 6:50 pm  
Location: Blocker 148

Credit Hours: 3

## Instructor Details

Instructor:  
Peter Kuchment

Office: Blocker 614A  
Phone:  
E-Mail: [kuchment@math.tamu.edu](mailto:kuchment@math.tamu.edu)  
<http://www.math.tamu.edu/~kuchment>  
Office Hours: TBA

## Course Description

Topological insulators and super-conductors form the hottest class of novel materials being currently developed and studied around the world. It attracts leading mathematicians and physicists. It depends upon sophisticated mathematical tools. The goal of this first part of the course is to provide students with some analytic and topological techniques playing important role in the topological insulator theory. It includes the mathematics of solid-state and photonic crystalline media, spectral theory of such materials, Bloch and Wannier functions, and some topological issues arising in the theory.

**NOTE: Physics students who have taken a standard solid state course would find very little new in this class.**

## Course Prerequisites

Basics of the real, complex, and functional analysis, ordinary and partial differential equations, and Fourier transform (or instructor's consent).

## Special Course Designation

None

## Course Learning Outcomes

It is expected that after the class, students would be able to follow literature and get involved into research in topological materials.

## Textbook and/or Resource Materials

Due to the lack of established textbooks on the subject, the resources will consist of notes for the students and survey articles.

## Grading Policy

- Attendance and class participation – 70%
- Project/presentation – 30%
  
- *A: 85% and above*
- *B: 75% and above*
- *C: 65% and above*
- *D: 60% and above*
- *F: less than 60%*

## Late Work Policy

- Late work accepted for a university valid excuse. The instructor must be notified preferably before, but not later than 3 days after the due date.

## Course Schedule

The detailed schedule to be delivered later.

Tentative schedule of topics:

- \_ 1D Floquet theory
- \_ Crystallin media. Bravais lattices and fundamental (Wigner-Seitz) cells.
- \_ Quasi-momenta (=crystallin momenta) and Floquet multipliers.
- \_ Dual group and Brillouin zone.
- \_ Bloch(-Floquet-Gelfand-Zak) transform and its properties.
- \_ Bloch, Fermi and Floquet varieties and their properties.
- \_ Spectra and various properties of solutions.
- \_ Bloch and Wannier functions.
- \_ Bloch bundles and topological obstructions.
- \_ Elements of photonic crystals and waveguides.

- \_ Some other examples of topological quantities and effects (e.g., disclinations in liquid crystals, Berry's phase, etc.).
- \_ Some numerical illustrations.

## University Policies

### Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

### Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

### Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" ([Section 20.1.2.3, Student Rule 20](#)).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at [aggiehonor.tamu.edu](http://aggiehonor.tamu.edu).

**NOTE:** Faculty associated with the main campus in College Station should use this Academic Integrity Statement and Policy. Faculty not on the main campus should use the appropriate language and location at their site.

### Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit [disability.tamu.edu](http://disability.tamu.edu). Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

**NOTE:** Faculty associated with the main campus in College Station should use this Americans with Disabilities Act Policy statement. Faculty not on the main campus should use the appropriate language and location at their site.

### Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services](#) (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's [Title IX webpage](#).

**NOTE:** Faculty associated with the main campus in College Station should use this Title IX and Statement on Limits of Liability. Faculty not on the main campus should use the appropriate language and location at their site.

### Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at [suicidepreventionlifeline.org](https://suicidepreventionlifeline.org).

### College and Department Policies

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.