- Course syllabus

    - Course info: This course Phys 839J:Topology in Condensed Matter: Tying Quantum Knots will be a flipped classroom addition to the online EdX course http://tiny.cc/topocm. For taking this course, you will be required to sign-up for the free EdX course online, which will have a combination of reading material/videos/assignments. The in-class components will meet on Wednesdays 2pm to 3:30pm will combine discussion of materials together with presentation of solutions/papers.

- Week 0: The class begins a week ahead of the online course. For the first two weeks we will brush up on the basic necessities of the course, Bloch's theorem and theory of bandstructures. Then we will discuss Berry phases and the theory of polarization in crystals as an illustration of topological effects as a preamble to the main course.

- Week 1: Preface : **Background information**

    - About this course
    - Starting questionnaire
- Week 1 : **Topology in toy models**

    - Hamiltonians, topology, and symmetry
    - Bulk-edge correspondense in the Kitaev chain
    - Assignments
- Week 2 : **Majoranas I**

    - From Kitaev chain to a nanowire
    - Majorana signatures: 4π-periodic Josephson effect, Andreev conductance quantization
    - Why Majoranas are cool: braiding and quantum computation
- Week 3 : **More parameters: charge pumping**

    - Thouless pumps and winding invariant
    - Laughlin argument: pumping electrons in Landau levels on a cylinder
    - Quantum Hall effect: edge states and quantized Hall conductance
- Week 4 : **Chern insulators**

    - Chern number invariant description of Quantum Hall
    - Quantum Hall transition and the Dirac equation
    - Haldane model and Hofstadter butterfly
- Week 5 : **Quantum spin Hall effect**

    - Combining quantum Hall effect with time-reversal symmetry
    - Kane-Mele and BHZ models
    - Experiments and materials for QSHE
- Week 6 : **Three-dimensional topological insulators**

    - Dirac equation of the surface states, magneto-electric effect
    - BHZ model of 3D TI

    - Materials and experiments
- Week 7 : **Alternative realizations of Majorana fermions**
    - Proximity effect in QSHE and 3D TI
    - Atomic chains
    - Review of experimental progress
- Week 8 : **General approach to topological classification**
    - 10 symmetry classes and the periodic table of topological insulators
    - Topological defects and Dirac-like equations
    - Alternative approaches to topological invariants
- Week 9 : **Anderson localization and topology**
    - Disorder and the scaling theory of localization
    - Flow diagram of topological insulators
- Week 10 : **Extensions of classification I**
    - Topology in gapless systems
    - The role crystalline symmetries
    - Mechanical systems
- Week 11 : **Extensions of classification II**
    - Floquet topological insulators
    - Quantum Walks
    - Josephson junctions
- Week 12 : **Beyond single-particle physics**
    - Topological order and the toric code
    - Fractional quantum Hall effect and topological particles