

Math 277A: Topics in computational and applied math - Mathematical biology

Vishal Patil
vipatil@ucsd.edu
Office: APM 6341

Winter 2025
Time: MWF 10 - 11
Place: APM 2402

Course pages:

1. <https://mathweb.ucsd.edu/~vipatil/teaching.html>
2. <https://canvas.ucsd.edu/courses/63440>

Office hours: After class or by request.

Outline: This course is primarily designed for graduate students with a background in at least one of the following topics: statistical mechanics, differential geometry (pure or applied), and PDE methods. The course will survey mathematical principles of living matter, with a focus on applications of differential geometry and topology. Topics include:

- Statistical mechanics of particles and fields in biology
- Statistics of polymers and membranes
- Applications of knot theory to filament mechanics
- Elastodynamics of living matter
- Homotopy theory and differential geometry of ordered media
- Topological modes and fiber bundles

Grading policy: Coursework will be graded as follows

- Problem set 1, due February 7 at 11am (25%)
- Problem set 2, due February 28 at 11am (25%)
- One project and presentation on a topic related to the course (50%). The presentations will take place March 10 - March 14, and the project report is due March 21.

Books:

- Kardar, Mehran. *Statistical physics of fields*. Cambridge University Press, 2007.
- Audoly, Basile, and Yves. Pomeau. *Elasticity and geometry: from hair curls to the non-linear response of shells*. Oxford University Press, 2008.
- Van Saarloos, Wim, Vincenzo Vitelli, and Zorana Zeravcic. *Soft Matter: Concepts, Phenomena, and Applications*. Princeton University Press, 2024.
- Ghrist, Robert W. *Elementary applied topology*. Vol. 1. Seattle: Createspace, 2014.
- Kauffman, Louis H. *Knots and physics*. Vol. 1. World scientific, 2001.
- Nakahara, Mikio. *Geometry, topology and physics*. CRC press, 2018.