Nanoscale Transport

ECH6937 Class Number: 12740
Class Periods: M,W,F | Period 4 (10:40 AM - 11:30 AM)
Location: MAEA 0327
Academic Term: Spring 2019

Instructor:
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Office Hours: TBA

Teaching Assistants: **None**

Course Description
The main goal is to introduce theoretical concepts and approaches that allow describing nanoscale mass diffusion as well to discuss several highly-relevant examples of such diffusion. Problems involving molecular transport on small length scales often cannot be solved using relations derived for macroscopic displacements when effective diffusivity remains independent of diffusion time. Students will learn how to approach such nanoscale transport problems using random walk and other formalisms. Several case studies including diffusion in cell membranes and nanoporous materials will be considered in detail.

Course Pre-Requisites / Co-Requisites: **None**

Course Objectives
- Knowledge of the relationship between normal (i.e. Fickian) diffusion and transport on small length scales
- Derivation of a description of diffusion in the framework of the Random Walk approximation
- Knowledge of the origin and types of anomalous diffusion
- Development of skills that allow analyzing and formulating ideas related to nanoscale transport
- Development of presentation skills

Materials and Supply Fees: **None**

Required Textbooks and Software: **There is no required textbook**

Recommended Materials
1) Jörg Kärger, Douglas M. Ruthven, Doros N. Theodorou (2012), Diffusion in Nanoporous Materials, 2 Volume Set: Wiley-VCH Verlag GmbH & Co. KGaA, doi:10.1002/9783527651276
2) Oliver C. Ibe (2013), Elements of Random Walk and Diffusion Processes: Wiley Publishing, doi:10.1002/9781118618059
3) Ben-Avraham, D., & Havlin, S. (2000), Diffusion and Reactions in Fractals and Disordered Systems. Cambridge: Cambridge University Press, doi:10.1017/CBO9780511605826
4) Rudnick, J., & Gaspari, G. (2004), Elements of the Random Walk: An introduction for Advanced Students and Researchers. Cambridge: Cambridge University Press, doi:10.1017/CBO9780511610912
5) Regier, M.; Schuchmann, H. P. Monte carlo simulations of observation time-dependent self-diffusion in porous media models. Transport in Porous Media 2005, 59, 115-126.
6) Oliver C. Ibe (2013), Elements of Random Walk and Diffusion Processes: Wiley Publishing, doi:10.1002/9781118618059

Tentative Course Schedule

Week 1: Review of normal (i.e. Fickian) diffusion with examples
Weeks 2-3: Presentation of diffusion as random walk with examples
Weeks 4-5: Introduction to anomalous diffusion
Weeks 6-8: Fractals, diffusion in fractal systems, percolation
Weeks 9-12: Case studies related to nanoscale and microscale diffusion: diffusion in cell membranes, transport in microporous, mesoporous and macroporous membranes and catalysts. Presentations of Project 1.
Weeks 13-15: Review of the experimental techniques and computational approaches suitable for studies of mass transport on small length scales. Presentations of Project 1.

Attendance Policy, Class Expectations, and Make-Up Policy

Class attendance is strongly recommended. Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation. Requests for make-up tests will be granted only if appropriate documentation about illness, family emergency or UF-related travel are given to the Instructor.

Evaluation of Grades

Assignment	**Total Points**	**Percentage of Final Grade**
Quizzes (2)	10 each	30%
Project 1: Presentation of a review of a published research article related to molecular/ion transport on small length scales and participation in discussions of such reviews	10 each	30%
Project 2: Preparation of an NSF-style proposal related to molecular/ion transport on small length scales	10 each	40%

Quizzes

In-class quizzes will be announced at least 1 week in advance. Quizzes will test the knowledge of theoretical concepts discussed during class meetings.

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.