Interdisciplinary Engineering Scientific Adventure: from Life to Research

Topic: Exploration of the Coffee-Ring Effect

Fall 2025

Instructor: **Dr. Wenwen Xu, Zheng Yang, Peng Zeng**
Office Hours: Wed. Morning 9：30 AM -12:00 PM

Course Description

This course offers an interdisciplinary exploration of the **coffee-ring effect**, a physical phenomenon where suspended particles in an evaporating droplet migrate and form a ring-like deposit. Students will investigate the underlying mechanisms through the perspectives of **chemistry, physics, and mathematics**, using the **scientific method** as a guiding framework. The course combines lectures, hands-on laboratory experiments, and computational modeling, encouraging students to analyze data, refine hypotheses, and apply interdisciplinary thinking. By engaging in both collaborative and individual research activities, students will develop skills in scientific reasoning, experimental design, data analysis, and communication. The course culminates in a **final project and presentation**, where students will integrate theory, experiment, and application.

Course Objectives

The goal of this course is to cultivate students' ability to think and work like interdisciplinary scientists. students will understand the full scientific method and how to use it to do real research. They will learn to observe a phenomenon, ask a clear question, state a testable hypothesis, and design a controlled experiment with defined variables and measurements. They will practice collecting data, analyzing results and drawing evidence-based conclusions. Students will also learn to communicate their findings clearly and to iterate—refining questions, methods, and models—while combining ideas from chemistry, physics, and mathematics to solve real-world problems.

Learning Outcomes:

By the end of the semester, students should be able to:

- **Explain fundamental mechanisms** of the coffee-ring effect using concepts from chemistry, physics, and mathematics.
- **Apply the scientific method** to design, conduct, and refine experiments with clear hypotheses, controls, and reproducibility.
- **Analyze and interpret data** using statistical tools, graphical visualization, and computational models.

- **Integrate interdisciplinary perspectives** to connect microscopic mechanisms (e.g., evaporation, fluid flow, particle transport) with macroscopic observations and applications.
- **Communicate scientific findings** clearly and effectively in English, both in writing (reports and papers) and orally (presentations and discussions).
- **Develop problem-solving and critical-thinking skills** that can be transferred to other areas of science and engineering.
- **Collaborate in teams** to plan, execute, and present research projects in a professional manner.

Course Format

- **Lectures and seminars** will introduce core concepts and theories.
- **Hands-on lab sessions** will provide opportunities to apply theoretical knowledge.
- **Discussions** and **group projects** will facilitate collaboration and critical thinking.

Additional Materials: Laboratory notebook, Python/Matlab (optional)

Assessment & Grading

- Attendance & Participation: 15%
- In-class Performance: 20%
- Experimental Report: 15%
- Final Paper (Weeks 12–15 drafting; final due Week 16): 30%
- Final Presentation & Showcase (Week 16): 20%

Note: The best final paper will be considered for submission to an educational journal as a bonus oppportunity.

Code of Academic Conduct

Upon accepting admission to SCUPI, you immediately assume to follow the SCUPI academic integrity guidelines. See a staff in the administrative office if you are not aware of it. The guidelines should be followed in homework, examinations, and other academic work. Violations of these guidelines may result in zero points for an exam or failure of the course.

Course Schedule

Week 1: Introduction to the Scientific Method
Week 2: Research Stories & Group Discussion
Week 3: From Nature to Engineered Materials
Week 4: Lab Safety, Research Norms & Experimental Design
Week 5: Experimental Kickoff & Initial Exploration
Week 6: Physics Behind the Experiments
Week 7: Evidence-Driven Iteration
Week 8: Data Analysis with Minitab (or Equivalent)
Week 9: Simulation
Week 10: Breakthrough Iteration
Week 11: Open Exploration & Applications
Week 12: Scientific Writing I
Week 13: Scientific Writing II (Peer Review)
Week 14: Presentation I
Week 15: Presentation II
Week 16: Course Summary & Final Showcase

*** This schedule may be adjusted depending on class progress and performance.