MATH 451H: Methods of Applied Mathematics II (Capstone II)

Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: Small teams of students conduct research projects under the guidance of faculty members who perform applied research. Effective From: Spring 2009.

Number of Credits: 3

Prerequisites: Math 450H with a grade of C or better.

Course-Section and Instructors

<table>
<thead>
<tr>
<th>Course-Section</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>Math 451-H02</td>
<td>Professor L. Kondic</td>
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Course Materials:

- Selected research articles (to be provided by the instructor).

University-wide Withdrawal Date: Please note that the last day to withdraw with a W is *March 30, 2015*. It will be strictly enforced.

POLICIES
DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

<table>
<thead>
<tr>
<th>Projects and Presentations</th>
<th>70%</th>
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<tr>
<td>Final Report and Presentation</td>
<td>30%</td>
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Attendance Policy: Attendance at all classes will be recorded and is mandatory. Please make sure you read and fully understand the Math Department’s Attendance Policy. This policy will be strictly enforced.

ADDITIONAL RESOURCES

Math Tutoring Center: Located in Cullimore, Room 214 (See: Spring 2015 Hours)

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department’s webpage for Instructor Office Hours and Emails.

All students must familiarize themselves with and adhere to the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. The Department of Mathematical Sciences takes these policies very seriously and enforces them strictly.

Important Dates (See: Spring 2015 Academic Calendar, Registrar)

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
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<tbody>
<tr>
<td>January 20, 2015</td>
<td>T</td>
<td>First Day of Classes</td>
</tr>
<tr>
<td>January 26, 2015</td>
<td>M</td>
<td>End of Add/Drop Period</td>
</tr>
<tr>
<td>March 15 - 22, 2015</td>
<td>S - S</td>
<td>Spring Recess</td>
</tr>
<tr>
<td>March 30, 2015</td>
<td>M</td>
<td>Last Day to Withdraw</td>
</tr>
<tr>
<td>April 3, 2015</td>
<td>F</td>
<td>Good Friday - University Closed</td>
</tr>
<tr>
<td>May 5, 2015</td>
<td>T</td>
<td>Last Day of Classes</td>
</tr>
<tr>
<td>May 6 &amp; 7, 2015</td>
<td>W &amp; R</td>
<td>Reading Days</td>
</tr>
<tr>
<td>May 8 - 14, 2015</td>
<td>F - R</td>
<td>Final Exam Period</td>
</tr>
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Course Outline

Theoretical, Computational, and Experimental Research:
Instabilities in Two-phase Flow of Complex Fluids
**Theoretical Component:**

- Navier-Stokes equations in viscous regime; simplifications in Hele-Shaw geometry using consistent asymptotic expansion;
- Understanding of the concept of instability in a two-phase flow; discussion of Saffman-Taylor instability;
- Introducing and implementing the concept of linear stability analysis;
- Discussing modifications of linear stability analysis due to non-Newtonian (shear thinning) behavior on instability development.
- Discuss the formulation of Hele-Shaw limit for liquid crystal flows.
- Discuss influence of electric field on instabilities in Hele-Shaw flow of liquid crystals.

**Computational component:**

- Finite difference based methods for solving linear and nonlinear elliptic problems;
- Boundary integral methods for solving linear elliptic problems;
- Applications of the numerical methods (1) and (2) to Saffman-Taylor instability;
- Development of diffusion-limited aggregation (Monte-Carlo type of simulations) approach to simulating Hele-Shaw flow of two fluids; applications to Newtonian, liquid crystal, and shear-thinning flow configurations.

**Experimental Component:** Carrying out experiments involving an air or water bubble spreading into (1) viscous fluid (glycerin); (2) nematic liquid crystal with and without electric field, and (3) shear-thinning fluid such as corn starch. Discuss the issues involved in carrying out controlled, reproducible experiments and quantify the error bounds. Interpret the results in the context of the theoretical and computational results.