Course description: This course provides an introduction to some of the mathematics underlying processes or phenomena that are related to investigations outside the field of mathematics. This course will emphasize basic modeling and conservation laws, properties of certain classical partial differential equations, and methods of solution to some of these structures.

Prerequisites: Math 616.

Your objectives:

By the end of this course, every passing student should ...

- how to use Green’s functions to solve boundary value problems.
- understand the mathematical properties of the Fourier transform.
- how to use Fourier transforms to solve PDEs.
- understand how to formulate variational problems.
- know how to produce Euler-Lagrange equations, given a variational problem.
- understand Hamilton’s Principle and canonical variables.
- understand elementary modeling techniques, nondimensionalization, scaling and Buckingham’s Π-Theorem.
- know how approximate solutions to ODEs using regular perturbations.
- know how to approximate solutions using singular perturbations and boundary layer analysis.
- know how to approximate integrals using perturbative methods.

Your resources: All of the following will help you achieve your objectives:

- Time: The best way to learn mathematics is to spend time with it. It is your responsibility to come to class each day, and it is unlikely that you will pass if you miss more than a day or two, regardless of the reason. Attendance is crucial to success in this course.


- Office hours: Tuesday 1000-1100, Thursday 1000-1100, Friday 1115-1215 or by appointment. This is time that I have set aside especially for you. Office hours are one of the most valuable and least used resources at the University, and I hope you will take advantage of them. I want to help you learn this material, so do not be shy about seeing me outside of class. If you need to see me at a time other than an office hour, feel free to “drop in” or make an appointment.
• Your classmates: Math is not a competitive sport. There are many obvious reasons to work together. Even if you end up helping others most of the time, teaching is one of the best ways to gain a deeper understanding of a subject.

**Grading policy:** Your grade is determined solely by your understanding of mathematics and your ability to communicate this knowledge to me on exams and other assignments. Your grade will be determined from the total points earned in class weighted as follows.

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<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homework</td>
<td>25%</td>
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<tr>
<td>Midterm exams (2)</td>
<td>25%</td>
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<tr>
<td>Final exam</td>
<td>25%</td>
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**Exams:** The two midterm exams will be taken at home and self-timed. The final exam will be administered in class.

**Homework:** Homework problems will be assigned. There is no late homework.

- Problem solutions must be neatly written.
- Like any academic field, solving mathematical problems involves reasoned induction and deduction. You should give the reader reason to believe that your steps in solving the problem are correct and appropriate. Reasoning should be noted and assumptions should be clearly stated.

**Student conduct:** To provide the best learning environment for all my students, I expect all my students to conduct all their scholarly activities with honesty and integrity. Students should note that in certain situations doing nothing can be dishonest. Though I hope there will never be a need to address academic dishonesty, I will strongly enforce all provisions noted in the Academic Regulations for Undergraduates. See *The University of Delaware Undergraduate and Graduate Catalog*

    http://www.udel.edu/catalog/current/ugacadregs.html#acadhonesty

for further discussion on basic responsibilities.
Tentative list of topics:

- Integral equations: Fredholm integral equations, separable kernels, symmetric kernels.
- Green’s functions for BVPs.
- Distributions, test functions.
- Green’s functions for PDEs.
- Fourier transforms and connections to Fourier series.
- Schwarz’s inequality and the Parseval relation for square integrable functions.
- Fourier transform techniques, convolutions, etc.
- Functionals, variational problems, stationary points.
- Euler-Lagrange equations, natural boundary conditions, higher derivatives, multiple unknowns.
- Buckingham’s Π Theorem.
- Non-dimensionalization, scaling, distinguished limits.
- Regular perturbations.
- Singular perturbations and boundary layers.
- Asymptotic expansions of integrals.

Important dates:

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>21 Feb</td>
<td>No fee drop/add deadline</td>
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<tr>
<td>11 Mar</td>
<td>Exam #1 passed out (due: 14 Mar).</td>
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<tr>
<td>18 Apr</td>
<td>W withdrawal deadline</td>
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<tr>
<td>15 Apr</td>
<td>Exam #2 passed out (due: 18 Apr).</td>
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<td>18 May</td>
<td>Last day of classes</td>
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<td>TBA</td>
<td>Final exam</td>
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