ECE 520 Course Information

Course Learning Objectives

By the time the students successfully complete the course, they should be able to:

1. Analyze optimization problems to determine appropriate solution methods, including applying analytical and numerical methods.
2. Apply necessary conditions and sufficient conditions for optimality.
3. Analyze optimization algorithms in terms of properties including descent, convergence, and order of convergence.
4. Make precise statements about optimization problems and their solutions.

Each module will have its own learning objectives related to these course objectives.

The ultimate goal of this course is to change the way you think.

Brief Course Description

- Theory of unconstrained and constrained optimization
- Necessary and sufficient optimality conditions
- Algorithms and search methods for optimization, and their analysis
- Examples from various engineering applications

Textbook

- There is no requirement to purchase your textbook from any particular vendor or in any particular format (e-book, softcover, hardcover, etc.). As long as it works well for you, it's fine.

Prerequisites

- Undergraduate linear algebra.
- Undergraduate multivariable calculus.

Workload

Because this is a three-credit course, the standard expectation is that you spend 10-12 hours total on average each week.
The modules, readings, quizzes, homework sets, and tests are designed so that the workload is spread out throughout the semester in a manageable way. You will have ample time to complete them because the available time is generous. Nonetheless, some students have reported that this is a challenging course because it requires a lot of thinking. (Sorry, but it's good for you!)

**Grading**

- Homework and Quizzes: 15%
- Tests: 85%

**Assessment Approach**

The quizzes, homework sets, and tests are all designed to help you learn and master the material in this course. There are two types of homework questions:

1. Questions that ask you to perform straightforward tasks related to the material. These are designed to ensure that you have basic experience in working with the types of problems involved. They are typically easy to answer.
2. Questions that ask you to perform challenging tasks. They are designed to prompt you to think hard about the material and synthesize integrative knowledge. These questions are typically more difficult to answer than the first type (above), take more thinking time, and will assess your mastery of the material. Moreover, they have high pedagogical value because they prompt you to go through the process of consolidating your thinking, knowledge, and skills. They are also designed to ensure that you will learn something new by the time you complete them.

The test questions will focus mainly on the second type because they are meant to consolidate your learning and to test your mastery of the subject matter. The bulk of your final grade is based on the tests (almost 30% each).

**Examples of Applications**

- Engineering design
- Data sciences
- Machine learning
- Robotics and artificial intelligence
- Communication systems
- Control systems
• Signal and image processing  
• Computer systems  
• Information theory  
• Biological processes  
• Manufacturing systems  
• Finance and investment planning  
• Economics  
• Decision making  

**ECE 520 Course Schedule, Spring 2023**

<table>
<thead>
<tr>
<th>Week</th>
<th>Module</th>
<th>Assignments</th>
</tr>
</thead>
</table>
| 1    | **Start here: Introduction and Overview**  
      | **Module 1: Mathematical Preliminaries** | **Prerequisite quiz**  
      |            | **Homework 1** |
| 2    | Module 2: Set Constraints | **Homework 2** |
| 3    | **Module 3: One-Dimensional Search**  
      | **Module 4: Gradient Methods** | **Homework 3**  
      |            | **Homework 4.1** |
| 4    | **Module 4: Gradient Methods**  
      | **Module 5: Newton’s Method** | **Homework 4.2**  
      |            | **Homework 5** |
| 5    | **Module 6: Conjugate-Direction Methods**  
      | **Module 7: Quasi-Newton Methods** | **Homework 6**  
      |            | **Homework 7** |
| 6    | Module 8: Randomized Search | **Homework 8** |
| 7    | **Module 9: Constrained Search**  
      | **Module 10: Least-Squares Problems** | **Homework 9**  
      |            | **Test 1 (thru Module 7)** |
| 8    | **Module 10: Least-Squares Problems**  
      | **Module 11: Linear Programming** | **Homework 10** |
| 9    | Spring Break | **Celebrate** |
| 10   | **Module 11: Linear Programming**  
<pre><code>  | **Module 12: Simplex Method** | **Homework 11** |
</code></pre>
<p>| 11   | <strong>Module 12: Simplex Method</strong> | <strong>Homework 12</strong> |
| 12   | <strong>Module 13: Duality in LP</strong> | <strong>Homework 13</strong> |
| 13   | <strong>Module 14: Equality Constraints in NLP</strong> | <strong>Homework 14</strong> |</p>
<table>
<thead>
<tr>
<th>Module Number</th>
<th>Module Title</th>
<th>Homework</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Module 15: Inequality Constraints in NLP</td>
<td>Homework 15</td>
</tr>
<tr>
<td>15</td>
<td>Module 16: Convex Optimization</td>
<td>Homework 16</td>
</tr>
<tr>
<td>16</td>
<td>Module 17: Lagrangian Duality in NLP</td>
<td>Test 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Modules 13-16)</td>
</tr>
</tbody>
</table>