## EE 581: Optimization Techniques

<table>
<thead>
<tr>
<th>Lecture Schedule</th>
<th>Saturday 4:00 pm – 7:00 pm</th>
<th>Semester</th>
<th>Spring 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours</td>
<td>Three</td>
<td>Pre-requisite</td>
<td>Linear Algebra, Differential Equations</td>
</tr>
<tr>
<td>Instructor</td>
<td>Muhammad Tahir</td>
<td>Contact</td>
<td><a href="mailto:mtahir@uet.edu.pk">mtahir@uet.edu.pk</a></td>
</tr>
<tr>
<td>Office</td>
<td>N/A</td>
<td>Office Hours</td>
<td>Monday 15:00 – 16:00, Saturday 10:00 – 11:00</td>
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<tr>
<td>Teaching Assistant</td>
<td>None</td>
<td>Lab Schedule</td>
<td>N/A</td>
</tr>
<tr>
<td>Office</td>
<td>N/A</td>
<td>Office Hours</td>
<td>N/A</td>
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### Course Description

This course will be covering two distinct areas: 1) Linear optimization (also called linear programming) and 2) Nonlinear optimization, techniques. Linear programming part will cover the following topics:
- Review of matrix algebra, geometry of linear programming.
- Simplex method, duality theory

Nonlinear programming part will cover the following topics:
- Introduction to convex sets and convex functions.
- Quadratic programming
- Convex programming
- Geometric programming

### Expected Outcomes

The objective of this course is to make students acquire a systematic understanding of optimization techniques. The course will start with linear optimization (being the simplest of all optimization techniques) and will discuss in detail the problem formulation and the solution approaches. Then we will cover a class of nonlinear optimization problems where the optimal solution is also globally optimal, i.e. convex nonlinear optimization and its variants.

In the discussion of different optimization techniques, some well known research problems in the domain of communication networks (e.g. power control at physical layer, flow control at transport layer) will also be discussed.

### Textbooks


### References


### Grading Policy

- Assignments: 05%
- Quizzes: 10%
- Midterm: 20%
- Final: 50%
- Viva: 15%
<table>
<thead>
<tr>
<th>Weeks</th>
<th>Topics</th>
<th>Readings</th>
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| 1*    | **Introduction to Optimization**  
Statement of optimization, Objective function, Problem constraints and constraint surface, Classification of optimization problems | Class notes |
| 1*    | **Linear Programming**  
Variants of linear programming, examples of linear programming problems, linear algebra background, graphical representation for two dimensional space | Chapter 1 (T1) |
| 1*    | **Geometry Linear Programming**  
Polyhedra and convex sets, extreme points, vertices, existence of extreme points, optimality of extreme points | Chapter 2 (T1) |
| 2*    | **Simplex Algorithm**  
Optimality conditions, identifying an optimal point, development of simplex algorithm, two phases of simplex algorithm, column geometry of simplex algorithm, computational complexity of simplex algorithm | Chapter 3 (T1) |
| 1*    | **Duality Theory**  
Duality in linear programming, primal-dual relations, duality theorem, dual simplex method, optimal dual variables | Chapter 4 (T1) |
| 1*    | **Nonlinear Optimization**  
Least-squares & linear optimization, Nonlinear optimization, Convex optimization | Chapter 1 (T2) |
| 1      | MIDTERM | |
| 1*    | **Convex Sets**  
Affine and convex sets, convexity preserving operations, separating and supporting hyper-planes, generalized inequalities | Chapter 2 (T2) |
| 2*    | **Convex Functions**  
Operations preserving convexity, conjugate function, Quasi-convex functions, Log-concave and log-convex functions, Convexity with respect to generalized inequalities | Chapter 3 (T2) |
| 2*    | **Convex Optimization**  
Convex optimization problems, quadratic optimization, geometric optimization, Duality, Lagrange dual function, dual problem, geometric interpretation, optimality conditions, | Chapter 4 & 5 (T2) |
| 2*    | **Algorithms**  
Unconstrained problems, equality constrained problems | Chapter 9-10 (T2) |
| 1*    | **Algorithms**  
Interior point methods | Chapter 11 (T2) |

* - Tentative