## EE 505: Optimization Theory

<table>
<thead>
<tr>
<th>Lecture Schedule</th>
<th>Monday-Wednesday 16:30 am – 18:00 am</th>
<th>Semester</th>
<th>Spring 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours</td>
<td>Three</td>
<td>Pre-requisite</td>
<td>Linear Algebra</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>, <a href="mailto:umar.rashid@uet.edu.pk">umar.rashid@uet.edu.pk</a></td>
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<tr>
<td>Office</td>
<td></td>
<td>Office Hours</td>
<td>Monday 14:00 – 15:00, 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:

- Introduction to convex sets
- Geometry of linear programming
- Duality theory

Nonlinear programming part will cover the following topics:

- Introduction to convex functions
- Quadratic and convex programming
- Interior point method

### 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 electrical engineering will also be discussed. In addition, the students are expected to learn the use of different optimization solvers including MATLAB optimization tool box, Mosek etc.

### Textbooks


### Grading Policy

- Assignments: 20%
- Presentations: 10%
- Midterm: 30%
- Final: 40%
<table>
<thead>
<tr>
<th>Weeks</th>
<th>Topics</th>
<th>Readings</th>
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</thead>
</table>
| 1*    | Introduction to Optimization  
Statement of optimization, Objective function, Problem constraints and constraint surface, Classification of optimization problems | Class notes |
| 1.5*  | Linear Programming  
Variants of linear programming, examples of linear programming problems, linear algebra background, graphical representation for two dimensional space | Chapter 1 (T1) |
| 2*    | Convex Sets and Geometry of Linear Programming  
Affine and convex sets, polyhedra, extreme points, vertices, existence of extreme points, optimality of extreme points convexity preserving operations, separating and supporting hyperplanes | Chapter 2 (T1 + T2) |
| 1.5*  | Duality Theory  
Duality in linear programming, primal-dual relations, duality theorem, optimal dual variables | Chapter 4 (T1) |
| 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) |
| 1     | MIDTERM |
| 2*    | Convex Optimization  
Convex optimization problems, quadratic optimization, geometric optimization, geometric interpretation, optimality conditions, | Chapter 4 (T2) |
| 1*    | Duality Theory  
Duality, Lagrange dual function, dual problem, duality gap | Chapter 5 (T2) |
| 1*    | Sensitivity Analysis  
Relaxing or tightening of constraints | Chapter 5 (T2) |
| 2*    | Interior-Point Methods  
Barrier method, logarithmic barrier function, complexity analysis, primal-dual interior-point methods | Chapter 11 (T2) |
| 1*    | Optimization adaptation  
Augmented Lagrangians, introduction of PID control for dynamic optimization | Research papers |
| 1*    | Research paper presentations |

* - Tentative