MATH 650 Foundations of Optimization
Section 0101 Fall 2011

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- Lectures: Mon and Wed, 7:10–8:25 pm, at Math/Psyc 106
- Office hours: Mon and Wed, 3:30–4:30 pm or by appointment
- Course web-page: http://www.math.umbc.edu/~shenj
- Prerequisites: analysis, linear algebra, multi-variable calculus
- Text: *Foundations of Optimization* by Osman Güler, Springer, 2010
- Other references:
  - M.S. Bazaraa, H.D. Sherali, and C.M. Shetty. *Nonlinear Programming: Theory and Applications*, John Wiley & Sons Inc., New York, 2nd edition, 1993;
  - D.P. Bertsekas. *Nonlinear Programming*, Athena Scientific, Belmont, MA, 2nd edition, 1999;
  - J.M. Borwein and A.S. Lewis. *Convex Analysis and Nonlinear Optimization*, CMS Books in Mathematics, Springer-Verlag, New York, 2000;
  - S. Boyd and L. Vandenberghe. *Convex Optimization*, Cambridge University Press, 2004.
- **Tentative exam dates**:
  - Exam I: Mon, Oct. 3 (in class)
  - Exam II: Wed, Nov. 9 (in class)
  - Final Exam: Mon, Dec. 12

  These dates are subject to change.

Course Description Optimization techniques are widely used in diverse areas, including engineering, operations research, economics and finance, statistics, science and social science. They have also stimulated a deep and elegant mathematical theory which becomes the foundation of various optimization methods and algorithms. This course treats the basic theory of continuous optimization in finite dimensions. Fundamental techniques from multivariable calculus (e.g. G/F-differentiability, the Implicit Function Theorem) and convex analysis (e.g. convex sets/functions, separation theorems, polyhedra theory) will be presented in this course. By exploring these techniques, unconstrained and constrained optimization problems will be discussed. Focused topics include the Lagrange multiplier approach, Fritz John and Karush-Kuhn-Tucker conditions, constraint qualifications, local and global optimality conditions, and duality theory.

Homework Weekly or biweekly homework will be assigned; each homework set contains some proofs and hand-computation problems. Homework must be turned in by a specified date; *no late due will be accepted.* Please present your answers neatly and show all your work; answers without supporting work may not receive full credit.

Exams There will be two (2) in-class exams, and one (1) final exam (see the tentative dates on the front page). Each mid-term exam mainly focuses on topics covered in that month, but the final exam will be comprehensive. Please be alerted that (i) there will be *no* optional final exam, and all the exams are closed book; (ii) calculators and other computing devices are *not* allowed for any exam.

Grading Policy The grading scheme is as follows:

- homework: 30%
- mid-term exams: 40% (20% for each)
- final exam: 30% (the final is comprehensive)

The letter grade will be computed based upon the numerical grade:

$A : \geq 85; \quad B : 84 - 73; \quad C : 72 - 60; \quad D : 59 - 50; \quad F :< 50$

Academic Integrity

- The UMBC Academic Integrity Statement:

  "*By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC Policies section of the UMBC Directory [or for graduate courses, the Graduate School website]*".

- All work in homework or an exam must be your own; collaborating on an exam is *not* permitted. Discussions with other students on homework problems are allowed and encouraged, but you should present your own work in the final turn-in; simply copying other people's work is a violation of UMBC's academic integrity code.

- If you wish to contest a graded exam, you must make an appeal within *one week* of the return date to the class. If you must miss an exam due to a prior obligation, you must speak to the instructor *in advance* of the exam. If you must miss an exam due to an unforseen but valid reason (e.g. illness), you must submit a written excuse. Failing to do so may result in loss of substantial points off the top in your make-up.

Tentative Schedule and Topics

Here is a list of the tentative schedule and topics we will be covering in chronological order with text citations:

No.	Week	Topic	Section(Guler)
1	Aug. 29–Sept. 2	Introduction, multi-variable calculus	1.1-1.2
2	Sept. 5–Sept. 9	Multi-variable calculus (continued), Unconstrained optimization, examples	1.3-1.5, 2.2-2.3
3	Sept. 12–Sept. 16	Existence theory of optimal solutions	2.1, 2.7
4	Sept. 19–Sept. 23	Implicit function theorem, Equality constrained optimization	2.5
5	Sept. 26–Sept. 30	Equality constrained opt., affine geometry	4.1
6	Oct. 3–Oct. 7	Exam I, convex sets	4.2,
7	Oct. 10–Oct. 14	Convex functions, differentiable convex funcs	4.3-4.4
8	Oct. 17–Oct. 21	Continuity of convex functions, Optimization on a convex set	5.7, 4.5
9	Oct. 24–Oct. 28	Projection onto a convex set, Separation of convex sets	6.1, 6.2
10	Oct. 31–Nov. 4	Applic. of separation thms, D-M lemma	6.3, 6.5
11	Nov. 7–Nov. 11	Convex polyhedral, Exam II	7.1
12	Nov. 14–Nov. 18	Transposition theorems, Farkas' lemma	7.2-7.3
13	Nov. 21–Nov. 25	1st-order conditions, constraint qualifications	9.1, 9.4-9.5
14	Nov. 28–Dec. 2	2nd-order optimality conditions, examples	9.6-9.8
15	Dec. 5–Dec. 9	Saddle points, strong duality, review	11.2, 11.4
16	Dec. 12–Dec. 16	Final Exam	

Please notice that the topics and dates in the list are subject to change, depending on the class progress.