ISE 599 Special Topics: FALL 2017

Location: Grace Ford Salvatori Hall (GFS) 205
Class hours: Wednesday 2:00–4:50 PM

Instructor. Jong-Shi Pang
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Title. Functions of Several Variables for Applied Mathematical Sciences

Number of Units. 3 units

Goals. Targeted for graduate students interested in the fundamentals of contemporary applied mathematics for modern-day applications in engineering and economics, and taught with rigor for the motivated learners, this is an accelerated course on the theory and methods of functions of several variables. The course complements much of the traditional mathematics curriculum and aims to provide a rigorous treatment of point-set theory, multivariate calculus, elements of matrix theory, solving equations, and polyhedral theory, all in the setting of a finite-dimensional Euclidian space.

Grading. The course grade is based on four monthly homework assignments, each weighed equally, and the presentation of their solutions in discussion sessions. There are no examinations.

Tentative weakly breakdown. We plan to cover the following six main topics each with several sub-topics listed. It is estimated that two to three weeks will be spent on each main topic.

- Point-set theory
  — vector and matrix norms; set-theoretic properties; the Bolzano-Weierstrass' theorem; convergence of sequences
- Multivariate differentiation
  — first and second derivatives; mean-value theorems; implicit and inverse function theorems; local and global homeomorphisms; differentiability of piecewise functions
- Some fundamental tools
  — a touch of degree theory; fixed-point theorems; contraction mappings
- Elements of matrix theory
  — eigenvalues and eigenvectors; spectral radius; positive (semi)definite matrices; matrix factorizations; selected matrix classes; Perron-Frobenious theory
- Solution methods for equations
  — linear equations: factorization and matrix splitting;
  nonlinear equations: Newton methods and coordinate methods;
  fixed-point iteration: Picard theory and extensions
- Polyhedral theory and linear inequalities
  — properties of polyhedra; the Goldman-Tucker decomposition;
  separation theorems via projection; duality; theorems of the alternatives

Due to time constraints, it may not be possible to cover all topics to their full extent.

Pre-requisites. 1-year multi-variate calculus and 1-semester of linear and matrix algebra, both at the college level. Interest in mathematical rigor and self-motivation are essential to benefit the

most from the course.

Textbooks. Several highly recommended classics containing the above listed topics.

J.M. Ortega and W.C. Rheinboldt. *Iterative Solution of Nonlinear Equations in Several Variables*. SIAM Classics in Applied Mathematics 30 (Philadelphia 2000). `http://dx.doi.org/10.1137/1.9780898719468`

J.M. Orgega. *Numerical Analysis: A Second Course*. SIAM Classics in Applied Mathematics 3 (Philadelphia 1990). `http://epubs.siam.org/doi/book/10.1137/1.9781611971323`.

R.A. Horn and C.A. Johnson. *Topics in Matrix Analysis*. Volumes I and II. Cambridge University Press (Cambridge, England 1991). Online publication (2011): `http://dx.doi.org/10.1017/CBO9780511840371`.

J. Stoer and Ch. Witzgall. *Convexity and Optimization in Finite Dimensions I*. Springer-Verlag: Die Grundlehren der mathematischen Wissenschaften 163 (Berlin 1970).

University policies

• *Statement for Students with Disabilities*. Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to your course instructor (or TA) as early in the semester as possible. DSP is located in STU 301 and is open from 8:30am to 5:00pm, Monday through Friday. Website and contact information for DSP: `http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html`, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX), ability@usc.edu.

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