MATH 8740 / ME 8740 Integration through Optimization
Spring 2019, T & Th 9:30 – 10:45 p.m., Riggs 301

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Course Description: The course covers theory, methodology, and applications of decomposition, integration, and coordination for large-scale optimization problems encountered in engineering design. Theory and methodology will be supplemented with examples, the use of commercial optimization codes, and case studies.
Prerequisites: MATH 8100, ME 8710 or equivalent.

Class cancellation: A class is canceled 15 minutes after the instructor fails to arrive.
Attendance: Regular attendance is strongly recommended.
Electronic equipment: Students are not allowed to use any electronic equipment in class for calling, texting, listening, etc.

Disability access: It is university policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students with disabilities requesting accommodations should make an appointment with Disability Services (656-6848), to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX statement: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The policy is located at
http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html.
Jerry Knighton serves as Clemson's Title IX coordinator and he may be reached at knightl@clemson.edu or 656-3181.

Textbook: There will be no mandated text for this course. The material will be presented in the form of lecture notes supported by handouts and Power Point slides posted on Canvas. A selection of research articles will be placed on Canvas.
Software: Modeling and optimization platforms : Mode Frontier, VisualDOC, MATLAB

Links:

Software: http://www.neos-server.org/neos/
http://www.mathworks.com/products/optimization/
http://plato.la.asu.edu/guide.html
http://www.esteco.com/modeFrontier/
http://www.vrand.com/visualdoc.html

Decomposition: http://www.openchannelfoundation.org/projects/DEMAID

Topical outline*: **Motivation** for decomposition and integration, and historical perspective
Software presentations through Examples of engineering optimization by students
Approximation
- Derivatives calculation including automatic differentiation
- Single-point, mid-range approximations, global approximations
- Response surface methods, kriging methods, artificial neural networks

Optimization Theory
- Karush-Kuhn-Tucker (KKT) optimality conditions
- Sensitivity of an optimal solution of nonlinear programs

Deterministic and **nondeterministic optimization** review
Decomposition of large-scale systems
Multidisciplinary optimization (MDO)
- Single objective and single level MDO
  - Multidisciplinary feasible (MDF)
  - Interdisciplinary feasible (IDF)
  - All-at-once (AAO)
- Mathematical representation of engineering information
  - Global sensitivity equations (GSE)
  - Kreisselmeier-Steinhauser (KS) function
  - Effectiveness coefficients
- Single objective and multilevel MDO
  - Collaborative optimization (CO)
  - Concurrent subspace optimization (CSSO)
  - Bi-level integrated system synthesis (BLISS)

Analytical target cascading (ATC)
- Lagrangian duality and Lagrangian relaxation
- Subgradient optimization

Network target coordination (NTC)
Additional topics
- Consensus optimization, Multiscenario optimization, multiobjective optimization

* Note: We will attempt to adhere to the outline. However, the actual topical content will depend on the students' background. The pace and content may be adjusted at the instructors' discretion.

Projects: The students will work on teams on five projects.

Topics and due dates:

PROJECT 1: Approximation based optimization (Feb 7)
PROJECT 2: Decomposition of a complex system (Feb 21)
PROJECT 3: MDO (March 14)
PROJECT 4: ATC (April 11)
PROJECT 5: NTC (May 1, 11:00 am)

Scores: The maximum score for a project is 95. The scores are based on an increment of 5.

Submission: Please submit a report to each instructor in two formats: a pdf file by email and a hard copy in the mailbox.

Student learning objectives: Upon successful completion of this course, a student is expected to
- identify and know the major decomposition and integration techniques of engineering design
- use commercial optimization software for engineering design
- recognize whether an optimization problem should be solved all-in-one or by decomposition
- solve complex optimization problems by decomposition and coordination

Grading: 5 projects (20% each). Late project submission will not be allowed.
Grading scale: A (86-95), B (71-85), C (51-70), F(≤50). The grading scale will be strictly enforced.

Academic Dishonesty Policy will be strictly enforced (see Student Handbook). *As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a high seminary of learning. Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity."*

For more information refer to the graduate academic integrity policy at
http://gradspace.editme.com/AcademicGrievancePolicyandProcedures#intergritypolicy