MECH 577 Optimum Design

Prof. J. Angeles Office Hours: W. & Th. 9:00–10:00
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On-Line Tutoring: By addressing your queries to `angeles@cim.mcgill.ca`, you will obtain a prompt reply. Computation code and updates on the course are available at

`http://www.mcgill.ca/cden/courses/`

Course Outline

Objective: The development of the skills required for the formulation of mechanical design tasks as optimization problems, and of the pertinent solution methods. The role of optimization techniques is stressed as an aid to rather than as a substitution of the designer.

Topics

1. The role of optimization within the design process. Design methodology and design philosophy. Design variables and design space. Equality-constrained optimization and the design manifold. Inequality-constrained optimization and the design region. Feasibility. Normality and convexity conditions for unconstrained optimization problems in one and n dimensions.

2. Single-variable optimization: Unimodality assumption. Solution methods: Dichotomous search; Fibonacci search; and golden-section search.

3. Background on multivariable optimization: The numerical solution of *determined* systems of linear and nonlinear equations: LU-Decomposition (a.k.a. Gaussian elimination); the Cholesky decomposition of positive-semidefinite matrices; the Newton-Raphson method.

4. Unconstrained and equality-constrained multivariable problems: linear least-square and minimum-norm solutions. Solution algorithms. The orthogonal-decomposition algorithm (ODA). Nonlinear problems. Stabilization methods: The Broyden-Fletcher-Goldfarb-Shanno method and Gerschgorin stabilization.

5. Inequality-constrained problems: The Karush-Kuhn-Tucker conditions. Direct and indirect methods. Indirect methods: penalty functions and slack variables.

6. An outline of stochastic methods: genetic algorithms and their applications domains.

Marking Scheme: The final mark is computed as the average of three projects (total of 75%) and a final open-book quiz (25%) the final day of lectures. Individual project marks are based on (a) results (2/3 of total mark) and presentation (1/3 of total mark).

Bibliography:

Angeles, J., 2004, *MECH 577 Optimum Design Lecture Notes*, Department of Mechanical Engineering, McGill University, Montreal.

Boyd, S. and Vandenberghe, L., 2004, *Convex Optimization*, Cambridge University Press, Cambridge.

Luenberger, D., 1984, *Linear and Nonlinear Programming*, Second Edition, Addison-Wesley Publishing Company, Reading, MA.

Rao, S.S., 1996, *Engineering Optimization*, John Wiley & Sons, Inc., New York.

Note: McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see `http://www.mcgill.ca/integrity` for more information).