AE 6374 – Advanced Design Methods II

2004 - Spring Semester - Dr. J. R. Olds

Course Credit Hours: 3-0-3

Prerequisites: MATH 2403 or equivalent. Minimum programming skills such as those found in COE 1361.

Catalog Data:

Introduction to modern multidisciplinary design optimization methods and techniques. Numerical optimization with applications, stochastic methods, Genetic Algorithms, multidisciplinary decomposition methods, multi-level optimization strategies.

COURSE SYLLABUS

1. Course Introduction (1 hr.)

PART I – Numerical Optimization

2. Optimization Basics (2 hrs.)

   2.1 design vs. analysis, role of optimization, etc.
   2.2 terminology, design space, standard optimization form, etc.
   2.3 optimality conditions (Hessian eigenvalues, Kuhn-Tucker)

3. Unconstrained Methods (9 hrs.)

   3.1 methods without line searches
   - grid search, random search, random walk
   - coordinate pattern search, compass search

   3.2 1-D optimization/line searches
   - quadratic polynomial interpolation
   - golden section algorithm

   3.3 methods with line searches
   - non-gradient methods (univariate, Powell)
   - finite-differencing techniques for gradients
   - gradient methods (steepest descent, Fletcher-Reeves)

4. Indirect Methods for Constrained Problems (3 hrs.)

4.1 Penalty Functions
- exterior penalty functions
- interior penalty functions
- linear extended penalty functions

5. Direct Methods For Constrained Problems (6 hrs.)

5.1 linear programming (LP) (the Simplex Method)
5.2 method of feasible directions
5.3 sequential linear programming (SLP)
5.4 sequential quadratic programming (SQP)
5.5 branch-and-bound methods for mixed variable problems

6. Stochastic Methods (6 hrs.)

6.1 genetic algorithms (GA)
6.2 simulated annealing (SA)

PART II – Multidisciplinary Design Optimization

7. MDO Basics and the MDO Environment (4.5 hrs.)

7.1 contributing analyses, design-oriented analyses, legacy codes, variable complexity
7.2 design structure matrices (DSM)
- hierarchic and non-hierarchic coupling (circuits)
- rescheduling/reordering the DSM (DeMAID)

7.3 traditional multidisciplinary solutions using fixed-point iteration (NAND)
- convergence stability and the use of relaxation

8. Single-Level MDO Strategies (6 hrs.)

8.1 optimization-based decomposition (OBD with compatibility constraints)
- partial OBD (feedbacks only) and fully-parallel ODB (SAND)

8.2 global sensitivity equation/system sensitivity analysis (GSE/SSA)

9.1 Collaborative Optimization (CO)
9.2 Modified Collaborative Optimization (MCO)
9.3 Bi-Level Integrated System Synthesis (BLISS)
9.4 state-of-the-art in MDO

* Mid-term Exam= 1.5 hrs.