Revised 1/14/08

Penn State University
Department of Mechanical & Nuclear Engineering
ME 561 Structural Optimization Using Variational & Numerical Methods
Spring 2008

Tuesday, Thursday 9:45 – 11:00 a.m.
203 IST Bldg.

Prerequisites: graduate student standing, ME 461 Applied Finite Element Analysis or equivalent

Other skills required: programming language such as Matlab, C++, Fortran

Text: R. Haftka and Z. Gurdal, **Elements of Structural Optimization**, 3rd Revised and Expanded Edition, ©1992 Kluwer Academic Publishers

References (available on reserve in the Engineering Library)**:**

M. P. Bendsøe and O. Sigmund, **Topology Optimization : Theory, Methods, and Applications** , ©2003 Springer-Verlag

G. Rozvany, editor, **Topology Optimization in Structural Mechanics**, ©1997 Springer-Verlag Wein

Instructor: Dr. Mary Frecker
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Office Hours: Monday, Wednesday 9:00 – 10:00 a.m., or by appointment

Course Objectives: After completing this course, you should be able to:

- Derive optimality conditions for the following:
  - Size/shape optimization of continuous structures such as beams and rods
  - size optimization of discrete structures such as trusses
  - topology optimization of discrete structures
  - topology optimization of compliant mechanisms
- Derive sensitivities for optimal design problems
- Develop optimality conditions using Optimality Criteria methods
- Develop computer algorithms for solution of the above problems
- Develop an understanding of work and applications in the field through readings and in-class presentations
- Complete a design project using techniques from structural optimization

Schedule:

	Date		TOPIC	Reading/Assignment
Week 1	Tuesday	1/15/08	Course overview Introduction to structural optimization Function and parameter optimization	Haftka & Gurdal Ch. 1; Supplemental reading
	Thursday	1/17/08	Size, shape, and topology optimization Graphical Solution of constrained problems	Assign HW 1
Week 2	Tuesday	1/22/08	***Size and Shape Optimization of Continuous Structures*** Solution by differential calculus Variational methods Euler-Lagrange equation	Haftka & Gurdal 2.1- 2.2 Supplemental reading Post Article 1

	Thursday	1/24/08	Method of Lagrange multipliers	Haftka & Gurdal 2.3
Week 3	Tuesday	1/29/08	Method of Lagrange multipliers cont'd Function subject to integral constraint Function subject to several constraints	HW 1 due
	Thursday	1/31/08	Necessary and sufficient conditions Eigenvalue Problems	Haftka & Gurdal 2.5 Assign HW 2 Post Article 2
Week 4	Tuesday	2/5/08	Article #1 presentation	Article 1
	Thursday	2/7/08	***Size Optimization of Discrete Structures*** Optimization of Truss Structures	
Week 5	Tuesday	2/12/08	Truss minimization of compliance problem	HW 2 due Supplemental reading - Taylor Assign HW 3
	Thursday	2/14/08	Article #2 presentation **mid semester feedback**	Article 2
Week 6	Tuesday	2/19/08	Fail safe design of truss structures Approximation methods Sequential Linear Programming Sequential Quadratric Programming	Haftka & Gurdal 6, 6.1, 6.3
	Thursday	2/21/08	***Topology Optimization*** ground structure approach	Rozvany p. 57-90 Bendsoe & Sigmund 4, 4.1 HW 3 due Assign HW 4 Post Article 3
Week 7	Tuesday	2/26/08	Equivalences in truss topology optimization	Bendsoe & Sigmund 4.2
	Thursday	2/28/08	Continuum topology optimization theory	Bendsoe & Sigmund 1, 1.1-1.2
Week 8	Tuesday	3/4/08	Homogenization method	Bendsoe & Sigmund 3.1 Rozvany p. 101-133 HW 4 due
	Thursday	3/6/08	Article #3 presentation	Bendsoe & Sigmund 2 - 2.11 Article 3 Post Article 4
Week 9	Tuesday	3/11/01	NO CLASS – SPRING BREAK	
	Thursday	3/13/08	NO CLASS – SPRING BREAK	
Week 10	Tuesday	3/18/08	Topology design extensions and applications	Assign Project
	Thursday	3/20/08	Guest lecture	
Week 11	Tuesday	3/25/08	Article #4 presentation	Article 4 Assign HW 5
	Thursday	3/27/08	***Compliant Mechanism Design*** Topology design approach	Supplemental reading - Howell Bendsoe & Sigmund 2.6 Post Article 5
Week 12	Tuesday	4/1/01	Compliant mechanism design cont'd	Supplemental reading
	Thursday	4/3/08	Sensitivities by finite difference methods Sensitivities by direct and adjoint methods	HW 5 due Haftka & Gurdal 7.1-2
Week 13	Tuesday	4/8/08	***Optimality Criteria Methods*** Intuitive methods Fully stressed design	Haftka & Gurdal 9.1-2 Project Proposal due Post Article 6
	Thursday	4/10/08	Article #5 presentation	Article 5 Assign HW 6
Week 14	Tuesday	4/15/08	OC for single constraint	Haftka & Gurdal 9.3
	Thursday	4/17/08	OC for several constraints	
Week 15	Tuesday	4/22/08	Article #6 presentation Project Discussion	Haftka & Gurdal 9.4 Article 6
	Thursday	4/24/08	Visualization methods for multicriteria optimization	HW 6 due Supplemental reading

Week 16	Tuesday	4/29/08	Project presentations	
	Thursday	5/1/08	Project presentations	Draft of written report (optional)
FINAL EXAM week		TBA	Written project report due 5:00 p.m.	

Note: Items on schedule are subject to change.

Grading:

Homework	60%
Article Presentation	10%
Participation in Discussions	5%
Project: Proposal	5%
Project: Written Report	10%
Project: Oral Presentation	10%
TOTAL	100%

Homework: Assignments will be collected at the beginning of class on the days indicated above. Papers must be stapled, not folded at the corner or paper clipped.

Late Assignment Policy: No late assignments will be accepted.

Academic Integrity: Students are expected to abide by the College of Engineering's Academic Integrity policy, http://www.engr.psu.edu/CurrentStudents/acadinteg.asp. In this course, students are permitted to work together on homework assignments, but each student is required to submit his or her own original work. An example of behavior that is considered cheating is submitting a homework assignment in which the written solution procedure or computer code is identical to a classmate's.

Students are required to work together in teams on the presentation of a contemporary journal article and on the final project. The team should do the in-class presentation of a contemporary journal article jointly. On the final project, the team should submit a single written report and do the in-class presentation jointly. In all team assignments, each student is required to contribute significantly to group's work. A confidential evaluation of each team member's contribution will be done by his/her peers and by the instructor. Failure to contribute significantly to team work will result in a reduction of the delinquent student's grade.

Grading Complaints or Concerns: Must be submitted in writing.