Sample Syllabus

ME 444: OPTIMIZATION

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Office Hours: TBD/See Canvas

Spring 2019
MWF 125 - 215
108 Sackett
3 credits (undergraduate)

COURSE DESCRIPTION:
Problem formulation, algorithms and computer solution of various engineering optimization problems. Students will learn to formulate and solve a variety of engineering optimization problems. Basic concepts, problem formulation, scaling, use of different optimizers, effect of tuning parameters and starting points and solution interpretation will be taught. Example problems will be taken from mechanical and other engineering disciplines. This course will complement other engineering design courses, such as capstone design. Students will learn how optimization can reduce product turnaround time, and to make decisions involving weight, stiffness, strength, performance, energy utilization, and other attributes. Pedagogy will focus on hands-on experience through problem-solving and graphical understanding. Technology classrooms and computer labs for instruction will be used. A by-product of this course is increased math and computer skills.

PREREQUISITES/COREQUISITES:
MATH 220; MATH 230 or MATH 231; CMPSC 200, or CMPSC 201 or CMPSC 202

REQUIRED TEXTS AND RESOURCES:

- Optimization Concepts and Applications in Engineering, Belegundu/Chandrupatla, latest edition, Cambridge University Press

ATTENDANCE: You are expected to attend the entirety of each class (World Campus: review the entirety of each lecture).

COMMUNICATION:

- CANVAS EMAIL is the expected method of communication. Direct email to my psu account may not get a response.
- Please set your preferences in Canvas to send notifications of changes to course content.
- Advance notice of absences is appreciated.
- Unless otherwise noted, all assignments should be scanned and uploaded to the Canvas course page by the closing date for the submission. No extensions will be given.

COURSE REQUIREMENTS

ASSIGNMENTS: The following is a breakdown of weightings for assignments in the course. Problem sets will be assigned roughly every 2 weeks as shown. Due dates may shift, but will not be advanced. And, you will be given at least two weeks to complete each problem set.

Assignment	Group or Individual	Percentage	Topics Covered	Time Period Covered	Assigned Due
Problem Set 1	G	10	Fundamental Concepts (Ch1)	Wks 1 – 3 1/7 – 1/21	1/14 1/28
Problem Set 2	G	10	Unconstrained Optimization (Ch 2,3,7)	Wks 3 – 5 1/23 – 2/8	2/1 2/15
Problem Set 3	G	10	Constrained Optimization (Ch 4,5,6)	Wks 6 – 7 2/11 – 2/22	2/15 2/25
Midterm Quiz	I	20	Review	Wk 8 2/25 – 2/27	2/27 3/1
Problem Set 4	G	10	Multiobjective Optimization (Ch 8)	Wks 9 – 10 3/11 – 3/24	3/18 4/1
Problem Set 5	G	10	Optimization of Structures (Ch 12)	Wks 11 – 12 3/25 – 4/7	4/1 4/15
Problem Set 6	I	*	Integer, Discrete … (Ch 9,11)	Wks 13 – 14 4/8 – 4/22	4/15 4/29
Term Project	I	20		Assigned: 3/11 – 3/15 Presentations:4/22-24	
Participation	I	10		as assigned	

- Fifty percent of the coursework will be completed in groups with the remaining 50% completed individually.
- Problem Sets 1-5 will be graded in groups. Problem Set 6, which can optionally replace your lowest Problem Set grade, however, is an individual assignment. Note that Problem Set 6 will replace only the individua's lowest grade, not the group's.
- The Midterm Quiz is an individual assignment that will cover all material of problem sets 1-3. The quiz is meant to verify that you are participating fully in group work. The quiz will be conducted / submitted over Canvas.
- The Term Project is an individual assignment that will task you with using concepts learned in class to complete a problem requiring optimization. More details will be given later in the

semester. Deliverables will include a written project proposal and a final presentation.

- Participation grades will be based on completion of very small *ad hoc* assignments throughout the semester and peer evaluations of performance on problem sets.
- Submission*:* Unless otherwise stated, all assignments must be submitted via Canvas. Scan and upload written assignments as pdf files. All assignments must be submitted by the closing date for the submission; closing times will be 1:25PM unless otherwise stated*. No extensions will be given.*

GRADING POLICIES: Grades will be determined from the weighted sum of scores earned on the listed assignments above. These will be converted to letter grades as follows:

Final Average	> 93.0	90.0-92.99	87.0-89.99	83.0-86.99	80.0-82.99
Letter Grade	A	A-	B+	B	B-

Final Average	77.0-79.99	73.0-76.99	65-72.99	< 65
Letter Grade	C+	C	D	F

LATE WORK: Issues with conference travel or any other outside commitments, issues, or occurrences should be resolved by turning work in early. Please discuss your concerns with me as soon after the assignment is released as possible. No late work will be accepted..

RESUBMISSIONS: Problem sets, projects, quizzes, and exams may not be resubmitted.

COURSE OUTLINE

Fundamental Concepts

(Chp. 1, Text; Problem Set 1)

- NLP (Nonlinear Programming) formulation, Example Problems
- Graphical approach for two-variable problems, unconstrained and constrained
- Wierstraas Existence Theorem
- Quadratic forms, positive definite and positive semi-definite matrices, Continuity, Numerical differentiation using forward, backward and central differences
- Taylor series in n-variables, linear and quadratic approximation of functions,

Unconstrained Optimization

(Chps. 2,3,7, Text; Problem Set 2)

- Optimality conditions, Convexity
- Interval of Uncertainty, Three point pattern, Golden Section Search, Quadratic Fit
- Non-unimodal functions
- Steepest Descent, Newton and Quasi-Newton methods
- Coordinate Search, Nelder-Meade, Genetic algorithms

Constrained Optimization

(Chps. 4,5,6, Text; Problem Set 3)

- Linear Programming
- Nonlinear Programming: optimality conditions; gradient based numerical methods
- Penalty function based methods

Multiobjective Optimization

(Chp.8, Text; Problem Set 4)

- Concept of Pareto optimality (dominated vs non-dominated designs, Pareto surface / efficient frontier)
- Weighted, Constraint approaches and their implications
- Min-max points
- Genetic algorithm

Optimization of Structures
(Chp. 12, Text; Problem Set 5)

- Topology / Sizing / Shape Optimization of structures

Integer, Discrete Problems; Transportation, Assignment, Network Problems (if time permits)
(Chps. 9,11, Text; Problem Set 6)

- Integer and Discrete problems
- Transportation, Assignment and Network problems

CELL PHONES, COMPUTERS, AND OTHER ELECTRONIC DEVICES: As a professional courtesy to your classmates and myself, please avoid the use of cell phones in class. Calls or texts that must be acknowledged should be taken outside the classroom.

FOOD AND DRINK: Please refer to the policy of the classroom.

ACCOMMODATIONS: Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments in this course, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services Web site at http://equity.psu.edu/ods/. In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the PSU guidelines at: http://equity.psu.edu/ods/guidelines/documentation-guidelines). If the documentation supports the need for academic adjustments, then ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.

ACADEMIC INTEGRITY: Academic honesty is tacitly expected. Noting that issues arise when course workload and other time commitments come into conflict, please work with me to mitigate those situations. Academic dishonesty will deal with it according to the rules of the University (see https://www.engr.psu.edu/faculty-staff/academic-integrity.aspx)

COUNSELING & PSYCHOLOGICAL SERVICES (CAPS): CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State such as involving anxiety, depression, difficulties in relationships, etc. You can contact CAPS by calling the Main CAPS number/Appointment Scheduling: 814-863-0395 or visit 5th Floor Student Health Center.

SEXUAL ASSAULT AND RELATIONSHIP VIOLENCE HOTLINE:A hotline has been established for victims and observers of sexual assault and relationship violence. Trained counselors on the hotline will help students access appropriate resources. Penn State students from any campus can call 1 (800) 560-1637 to access the 24 hour a day, seven day a week hotline.