Department	Graduate Course in Dept. of Power Mechanical Engineering, NTHU	Instructor	Hsien-Chie Cheng

Required/Elective	Elective	Teaching Language	Chinese	Semester	Winter semester
Course Number	634100	Credit	3		

Course Title	Optimal Structural Design
Course Description	This is a graduate course on optimal structural design and theory for engineering applications. The course aims at providing the student with a first exposure to a rational integration of traditional design methodologies with concepts and techniques of modern optimization theory and practice for constrained/unconstrained, single-objective/multi-objective optimization problems. In addition, various design sensitivity analysis techniques are also included. Furthermore, existing engineering applications using design optimization techniques are also addressed. In principle, the student learns to create appropriate mathematical optimization models for structural design problems, and to use analytical and computational techniques to solve them.

Preliminary courses

Course Title	Related Theories, Methodology and Concept
Numerical Analysis	Vector analysis, Matrix computation, Linear Algebra, Calculus of Variation
Engineering Mathematics	Taylor Series Expansion、Numerical Differentiation/Integration

Course Goals v.s. Core Competence

Capability level：1 knowledge、2 understanding、3 application、4 analysis、5 synthesis、6 evaluation

Course Goals	Core Competence
1. To get familiar with classical and modern optimization techniques	**A-2**
2. To understand the modeling procedure and basic theoretical foundations behind structural optimization	**A-2**
3. To be able to undertake optimal structural design of various, basic engineering problems using existing design optimization techniques	**A-3**
4. To work as a team member to pursue optimal design of engineering applications	**B-2, C-2, D-2**
5. To be capable of making a fine presentation of their optimal design works to their classmates and instructor	**C-2**

Core Competence in Graduate Study

A. Is capable of utilizing the professional knowledge in mechanical engineering and science principles to analyze, propose and identify engineering problems, and also planning and carrying out case studies.

B. Is capable of independent study, problem solving, thesis writing, continued learning of advanced and new information and knowledge in mechanical engineering and innovative research and development.

C. Possess the skills of leadership and management、team work and interdisciplinary communication, integration and coordination.
D. Has good command of the international development trend of mechanical technology.
E. Understand professional ethics and social duty

Assessment Methods

1. Final grade for this class will be computed according to the following weighted scale:
   A. Midterm exam. 30%
   B. Final term project + Oral presentation 40%
   C. Homework 15%
   D. Class Participation 15%
2. Examination（Exam 1、Exam 2）：
   ※One midterm examination and one final term project report and oral presentation
3. Assignment：
   ※Twice per semester at least
4. Class Participation：
   ※Class roll call at every class

Textbook

1. Course handout materials

Reference Books

1. Papalambros, P.Y. and Wilde, D. J., Principles of Optimal Design, Cambridge University Press, 1988.
2. Haftka, R.T. and Gurdal, Z., Elements of Structural Optimization, Kluwer Academic Publishers, 1991.
3. Arora, J.S., Introduction to Optimum Design, McGraw-Hill Inc., 1989.
4. Luenberger, D. G., Linear and Nonlinear Programming, Addison-Wesley Publishing Co., 1984

Reference Website of the Course

1. https://www.mathworks.com/discovery/design-optimization.html
2. https://www.femto.eu/stories/design-optimization/

Teaching Progress Chart and Contents

Week	Topic	Assignment	Remark
1	Introduction to the course/Introduction of Structural Optimization		
2	Engineering Applications in Optimization		
3	Taguchi Experimental Design(1)		
4	Taguchi Experimental Design(2)		
5	Taguchi Experimental Design(3)		
6	Taguchi Experimental Design(4)/Classical Tools in Structural Optimization (1)	Homework 1	
7	Classical Tools in Structural Optimization (2)		
8	Classical Tools in Structural Optimization(3)		
9	Classical Tools in Structural Optimization(4)	Homework 2	
10	Midterm Examination	Written test	

11	Mathematical Programming for Unconstrained Function Minimization(1)		
12	Mathematical Programming for Unconstrained Function Minimization(2)		
13	Mathematical Programming for Unconstrained Function Minimization(3)		
14	Mathematical Programming for constrained Function Minimization(1)		
15	Mathematical Programming for constrained Function Minimization(2)/Genetic Algorithm		
16	Genetic Algorithm		
17	Machine Learning (ANN)		
18	Final Term Project	Term Report & Oral Presentation	