ME 4750 (14430)/5750 (11015): Optical Measurement and Quality Inspection

Course Syllabus

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Office Hours: Monday and Wednesday from 6:00 to 7:00 PM in EC410 or by appointment

Class Time: Jan. 3, 2018 – Apr. 25, 2018
Lecture: Monday and Wednesday from 7:30 to 9:17 pm in Hannah Hall 123
Lab & Demo: TBD

Course Description:

This course is offered in response to the industrial demand for higher product quality and product reliability, which has called for new/improved measurement and inspection techniques. Topics include state-of the-art optical methods such as laser triangulation/laser scanning method, three-dimensional computer vision, digital image correlation, digital holographic interferometry/Electronic Speckle Pattern Interferometry(ESPI), digital shearography/Electronic Speckle Pattern Shearing Interferometry(ESPSI) and so on; with applications to measurement of 3D dimensional gauging, 3D-displacements and strains, vibration, material properties, residual stresses, quality inspection, nondestructive testing, etc. The course is heavily laboratory and project oriented so that students will gain hands-on experiences.

Prerequisites: ME 361, and senior standing and major standing

Text Book:

No textbook will be used. Lectures are based on hands out, notes and materials extracted from scientific journals. However, the following books are recommended for reference:

(1) “Optical Methods of Engineering Analysis”, by Gary Cloud, Cambridge University Press 1998, ISBN 0-521-63642-6
(2) “Digital Shearography – Theory and Application of Digital Speckle Pattern Interferometry”, By Wolfgang Steinchen, Lianxiang Yang, SPIE Press 2003, Bellingham, Washington USA, ISBN 0-8194-4110-4
(3) “Digital Shearography: New Developments and Applications” by Lianxiang Yang and Xin Xie, SPIE Press 2016, Bellingham, Washington USA, ISBN: 9781510601567.

Course Objectives:

A successful student will be able to:

- List and describe relevant professional terminology related to optical measurement and quality inspection. (a, e, f, h)
- Explain the laser triangulation technique and its applications in engineering. (a, b, e, j)
- Explain the principle of three-dimensional computer vision and applications in engineering. (a, b, e, j)

- Explain the Digital Image Correlation technique and its applications in engineering. (a, b, e, j)
- Explain the principle of digital holography/ESPI and its applications in engineering. (a, b, e, j)
- Explain the principle of digital shearography/ESPSI and its applications in engineering. (a, b, e, j)
- Introduce the principles of ultrasonic technique for nondestructive testing. (a, d, h, j)
- Introduce the principles of X-ray technique for nondestructive testing. (a, d, h, j)
- Design and perform experiments. Evaluate and analyze experimental results and write technical reports. (a, b, d, e, f, g, I, k)
- Apply these techniques to analyze and solve engineering problems, train how to do research through conducting a term project. (a, b, d, e, f, g, h, i, k)

Course Topics:

Chapter 1: Introduction + demo (0.5 week)
Chapter 2: Review of Relevant Optics and Mechanics (1 weeks)
Chapter 3: Laser Triangulation and Its Applications + lab and demo (1 week)
Chapter 4: 3D Computer Vision and Its Applications + lab and demo (2.5 weeks)
Chapter 5: Introduction of Digital Image Correlation Technique and Its applications + demo (1.5 week)
Chapter 6: Digital Holography/ESPI and Their Applications + lab and demo (2.5 weeks)
Chapter 7: Digital Shearography and Its Applications + demo (1.5 week)
Chapter 8: Introduction of the principles of ultrasonic technique for nondestructive testing (0.5 week)
Chapter 9: Introduction of the principles of X-ray technique for nondestructive testing (0.5 week)
Chapter 10: Term Project+ presentation (2.5 weeks)

Assignments, Demos, Labs & Project:

- 4 assignments
- 4 labs with lab reports
- 4 ~ 5 demos
- *1 term project*

Grades:

The semester grade will be based on:

Assignments, Demo and Class Participation	15%
Labs and the reports	15%
Term Project and the Presentation	15%
Two Minor Quizzes	50%
Final Oral Exam (Optional)	5%

About the term Project

You may do the project in a group of 6 to 8 members. The project will typically involve the following tasks:

1. Choose a project.
2. Study a few papers on the subject.
3. Plan the laboratory setup, and determine the equipment and specimen needs.
4. Prepare the needed specimen(s), fixture, etc.
5. Perform the necessary experiment(s).

6. Write a group report.
7. Give a 15-minutes group presentation.

Program Outcomes (ABET):

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environ., social, political, ethical, health, safety, manufactured ability, sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global economical, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice