MEC 316 - Instrumentation and Solid Mechanics Laboratory

Syllabus by Fu-Pen Chiang

Course Description:

The aim of this course is to teach students instrumentation and techniques that are pertinent to perform experiments in solids as they respond to external static/dynamic loads. Students are to learn and witness different modes of material/structural failure such as yielding, ultimate stress, material fatigue, structural instability, vibration and stress concentration. Another aim is to perform experiments to check the validity (and the lack of) of the beam theory described in MEC 363(Solid Mechanics). Experiments will be performed to show the existence of neutral axis in a beam under bending, the visualization and calculation of stress concentration due to the existence of a circular hole under tension. Students form groups of 3 to 4 who are collectively responsible for the lab projects. Lectures at the beginning of the course provide background information and theories of experimentation. Not to be taken in the same semester with MEC 317. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisites: MEC major; C or better in MEC 363; PHY 134 Corequisites: MEC 220; MEC 300; AMS 361 or MAT 303
Credits allocated: 2 credits

Instructor:

Fu-Pen Chiang
Contact: Email: fu-pen.chiang@stonybrook.edu Office hours: Thurs., 2:00 - 4:00 pm
Office: Light Engineering 105

Laboratory Technical Staff:

Austin Giordano
Contact: Email: austin.giordano@stonybrook.edu Office hours: Tues. & Thurs., 11:30 am - 1:00 pm
Office: Heavy Engineering 152

Required Course Textbook and Materials:

Lab Manual and necessary materials will be uploaded on Brightspace.

Recommended Readings/Bibliography:

• Measurement System, Application and Design, 3rd Ed., by Ernest O. Debelin, McGraw-Hill,1983.
• Mechanics of Solids. An Introduction, by T.J. Lardner and R. R. Archer, McGraw-Hill, 1994.
• Experimental Stress Analysis, 2nd Ed., by J.W. Dally and W. F. Riley, McGraw-Hill, 1978.
• Manual on Experimental Stress Analysis . Society for Experimental Mechanics J. Doyle, J. Phillips, and D. Post, Society for Experimental Mechanics, 1989.
• The Dynamical Behavior of Structures, 2nd Ed., by G. B. Warburton, Pergamon Press, 1976.
• Theory and Design for Mechanical Measurements, by R. S. Figliola and D. E. Beasley, John Wiley, 1991.

All reference books above are reserved in the engineering library.

Course Learning Objectives and Assessments

Learning Objectives and Activities:

Upon completion of the course, students will be able to:

1. Learn to apply mathematics, physics, and engineering principles to measurement problems in mechanical engineering pertaining to the mechanics of solids.
2. Design and conduct experiments and interpret data.
3. Learn modern measurement techniques as applied to mechanical structures and systems.
4. Identify, formulate, and solve engineering problems.
5. Learn to communicate effectively.

How to Succeed in this Course:

- Complete all assigned readings in the course
- Complete all assigned reports in a timely manner

Assignments and Expectations:

Lab Reports (90%): In this course, you need to complete lab reports, which are due on the day of the course (Tuesday/Thursday) by the following weekly lab session that they are assigned. You will bring one printed lab report as a group each week they are due, which demonstrates your understanding of the experiments. A rubric for the report is as follows in part 4.

Report Content:

1. Title Page (experiment title, *all* names, the completed section by name date due)
2. Abstract
3. Introduction
4. List of Equipment
5. Theory (includes drawings and descriptions)
6. Experimental Procedures
7. Results (includes calculation of experimental results; figures, graphs and tables must be labeled with a number and a caption; units, and all numerical quantities must be included)
8. Discussion (trends in the results, comparison with theoretical predictions)
9. Error Analysis
10. Conclusions
11. References (you must have them!)
12. Appendices (handwritten calculations, spreadsheet calculations, and other data)

Reports must be typed with a 12 pt font and double-spaced. Graphs of data must be computer generated using a software such as Excel.

Experiment Presentation (10%): Near the end of this course, you need to complete a presentation based on one of the experiments that you performed in this class. The presentation follows the same rubric as the rubric for the reports is as follows in part 4. These presentations will take place during the final weeks of the course (weather permitting).

Lab Reports

1. **Lab 1:** Determination of Material Properties: Young's Modulus and Poisson's Ratio
2. **Lab 2:** Natural Vibration Modes of a Cantilever Beam
3. **Lab 3:** Labview Based Instrumentation to Calibrate a Linear Variable Differential Transformer, and DC voltage and AC Signal Measurements
4. **Lab 4:** Pholoelastic Stress Analysis of Beams
5. **Lab 5:** Shadow Moiré Method for Shape Measurement, and Optical Metrology

6. **Lab 6:** Determination of Material Properties: Shear Modulus and Material Fatigue
7. **Lab 7:** Structural Instability
8. **Lab 8:** Straightness Measurement of Linear Motion
9. **Lab 9:** Digital Image Correlation/Digital Speckle Photography Techniques
10. **Lab 10:** Photoelasiticity for Stress Concentration Analysis

Course Schedule

- **Learning Module 1 Introduction part 1 Labs 1-5**
  - Learning Objectives
    - Introduction to the course
    - Design and conduct experiments and interpret data.
    - Identify, formulate, and solve engineering problems.
  - Read/Listen:
    - begin to read over the lab manual provided on Brightspace, emphasis on writing lab reports for MEC 316, time saving tips, error analysis, and the uncertainty tree: towards a more enjoyable error analysis
  - Complete:
    - Form groups of 3 or 4 students, before next week, using online signup sheet
  - Coming Up:
    - Labs 1- 5 begin.
- **Learning Module 2 Labs 1-5**
  - Learning Objectives
    - Learn to apply mathematics, physics, and engineering principles to measurement problems in mechanical engineering pertaining to the mechanics of solids.
    - Design and conduct experiments and interpret data.
    - Learn modern measurement techniques as applied to mechanical structures and systems.
    - Learn to communicate effectively.
  - Read/Listen:
    - *Lab manual labs 1-5*
    - Recorded Lecture/Experimentation videos for the corresponding lab, Brightspace
  - Complete:
    - Lab reports for one group
  - Coming Up:
    - Introduction part 2 Labs 6-10
- **Learning Module 3: Introduction part 2 Labs 6-10**
  - Learning Objectives
    - Introduction to the course
    - Design and conduct experiments and interpret data.
    - Identify, formulate, and solve engineering problems.
  - Coming Up:
    - Labs 6 - 10 begin.
- **Learning Module 4 Labs 6-10**
  - Learning Objectives
    - Learn to apply mathematics, physics, and engineering principles to measurement problems in mechanical engineering pertaining to the mechanics of solids.
    - Design and conduct experiments and interpret data.
    - Learn modern measurement techniques as applied to mechanical structures and systems;

        - Learn to communicate effectively.
    - Read/Listen:
        - *Lab manual labs 6-10*
        - Recorded Lecture/Experimentation videos for the corresponding lab, Brightspace
    - Complete:
        - Lab reports for each group
    - Coming Up:
        - Course Presentation
- **Learning Module 5 Presentation**
    - Learning Objectives
        - Learn to communicate effectively.
    - Read/Listen:
    - Complete:
        - Lab Presentation as one group
    - Coming Up:
        - Course completion

Grading, Attendance, and Late Work Policies

Assessment & Grading:

Percentage/Points	Activity/Assignment
90	10 Lab Reports
10	Experiment Presentation
100	**Total Possible**

Report Rubric

Abstract (5 points)
Introduction (5 points)
List of Equipment (5 points)
Theory (10 points)
Experimental Procedure (10 points)
Results (15 points)
Discussion (15 points)
Error Analysis & Tree (15 points)
Conclusion (5 points)
Quality of Writing (15 points)
Clarity (5 points)
Style (5 points)
Format (5 points)
Total (100 points)

Letter Grades:
Final grades assigned for this course will be based on the percentage of total points earned and are assigned as follows:

A (100-94)	A- (93-90)	B+ (89-87)	B (86-82)
B- (81-79)	C+ (78-76)	C (75-72)	C- (71-68)
D+ (67-64)	D (63-60)	F (59 or below)	

Late Work Policy:

I will accept late work only in extenuating circumstances, with requisite proof to verify this circumstance. Discuss with your group members if something comes up, then contact the instructor/TAs.

Course and University Policies

Student Accessibility Support Center Statement:

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center. For procedures and information go to the following website: https://ehs.stonybrook.edu//programs/fire-safety/emergency-evacuation/evacuation-guide-disabilities and search Fire Safety and Evacuation and Disabilities.

Academic Integrity Statement:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Professions, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.

Understand When You May Drop This Course:

It is the student's responsibility to understand when they need to consider disenrolling from a course. Refer to the Stony Brook Academic Schedule for dates and deadlines for registration: http://www.stonybrook.edu/commcms/registrar/calendars/academic_calendars

Incomplete Policy:

Under emergency/special circumstances, students may petition for an incomplete grade. Circumstances must be documented and significant enough to merit an Incomplete. If you need to request an incomplete for this course, contact me for approval as far in advance as possible.

Course Materials and Copyright Statement:

Course material accessed from Brightspace, SB Connect, SB Capture or a Stony Brook Course website is for the exclusive use of students who are currently enrolled in the course. Content from these systems cannot be reused or distributed without written permission of the instructor and/or the copyright holder. Duplication of materials protected by copyright, without permission of the copyright holder is a violation of the Federal copyright law, as well as a violation of Stony Brook's Academic Integrity.

Course schedule

	Tuesday 1:15 – 4:05 pm HE 206 A/B
Week 1 (01/22-01/28)	**23-Jan** **Lab 1-5 : Group 1-10**
Week 2 (01/29-02/04)	**30-Jan** **Lab 1-5 : Group 1-10**
Week 3 (02/05-02/11)	**6-Feb** **Lab 1-5 : Group 1-10**
Week 4 (02/12-02/18)	**13-Feb** **Lab 1-5 : Group 1-10**
Week 5 (02/19-02/25)	**20-Feb** **Lab 1-5 : Group 1-10**
Week 6 (02/26-03/03)	**27-Feb** **Lab 1-5 : Group 1-10**
Week 7 (03/04-03/10)	**5-Mar** **Lab 6-10 Overview : Group 1-10**
Week 8 (03/11-03/17)	**12-Mar** **No Lab (Spring Break)**
Week 9 (03/18-03/24)	**19-Mar** **Lab 6-10 : Group 1-10**
Week 10 (03/25-03/31)	**26-Mar** **Lab 6-10 : Group 1-10**
Week 11 (04/01-04/07)	**2-Apr** **Lab 6-10 : Group 1-10**
Week 12 (04/08-04/14)	**9-Apr** **Lab 6-10 : Group 1-10**
Week 13 (04/15-04/21)	**16-Apr** **Lab 6-10 : Group 1-10**
Week 14 (04/22-04/28)	**23-Apr** **Lab – Complementary sessions (if necessary)**
Week 15 (04/29-05/05)	**30-Apr** **Lab – Complementary sessions (if necessary)**

Tuesday Groups					
	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5
Week 2 Tue (01/30/2024)	Group 1	Group 3	Group 5	Group 7	Group 9
	Group 2	Group 4	Group 6	Group 8	Group 10
Week 3 Tue (02/06/2024)	Group 9	Group 1	Group 3	Group 5	Group 7
	Group 10	Group 2	Group 4	Group 6	Group 8
Week 4 Tue (02/13/2024)	Group 7	Group 9	Group 1	Group 3	Group 5
	Group 8	Group 10	Group 2	Group 4	Group 6
Week 5 Tue (02/20/2024)	Group 5	Group 7	Group 9	Group 1	Group 3
	Group 6	Group 8	Group 10	Group 2	Group 4
Week 6 Tue (02/27/2024)	Group 3	Group 5	Group 7	Group 9	Group 1
	Group 4	Group 6	Group 8	Group 10	Group 2
	Lab 6	Lab 7	Lab 8	Lab 9	Lab 10
Week 9 Tue (03/19/2024)	Group 1	Group 3	Group 5	Group 7	Group 9
	Group 2	Group 4	Group 6	Group 8	Group 10
Week 10 Tue (03/26/2024)	Group 9	Group 1	Group 3	Group 5	Group 7
	Group 10	Group 2	Group 4	Group 6	Group 8
Week 11 Tue (04/02/2024)	Group 7	Group 9	Group 1	Group 3	Group 5
	Group 8	Group 10	Group 2	Group 4	Group 6
Week 12 Tue (04/09/2024)	Group 5	Group 7	Group 9	Group 1	Group 3
	Group 6	Group 8	Group 10	Group 2	Group 4
Week 13 Tue (04/16/2024)	Group 3	Group 5	Group 7	Group 9	Group 1
	Group 4	Group 6	Group 8	Group 10	Group 2