**New Jersey Institute of Technology**
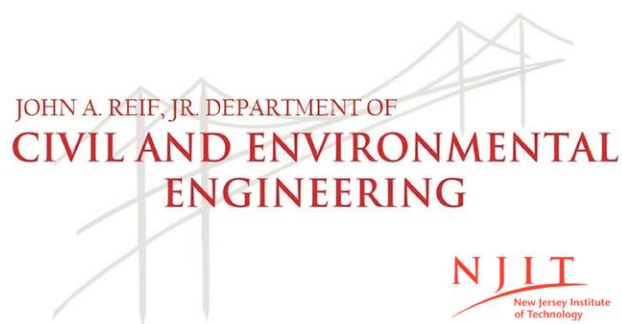# Digital Commons @ NJIT

Fall 2018

# MECH 237-005-007: Strength of Materials

G Milano

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JOHN A. REIF, JR. DEPARTMENT OF
## CIVIL AND ENVIRONMENTAL ENGINEERING

NJIT
New Jersey Institute
of Technology

**Mech 237 - Strength of Materials - FALL 2018**

| | |
|---|---|
| **Texts:** | 1. Beer, Johnson, DeWolf and Mazurek, <u>Mechanics of Materials</u>, <mark>Seventh Edition</mark>, McGraw-Hill, 2014. Go to NJIT bookstore for access code for e-book. |
| | 2. <u>NCEES, Fundamentals of Engineering Supplied-Reference Handbook, Eighth Edition</u>, 2nd. revision <br> (or reproduce pages from: <br> http://www.ncees.org/exams/study_materials/fe_handbook/) |
| | 3. Hsu, C.T. Thomas, <u>Strength of Materials Laboratory Manual</u>, (posted on Moodle site). |

**Course Instructors:**
Prof. G. Milano, P.E., 239-Colton Hall, 973-596-5830, milano@njit.edu
  MECH 237-001 and -003, Lecture, Tues., 10:00-12:50, KUPF-118
  MECH 237-005 and -007, Lecture, Thurs., 2:30-5:20, KUPF-205
Prof. E. Castro, P.E., 262-Colton Hall, ecastro@njit.edu
  MECH 237-009 and -011, Lecture, Fri., 1:00-3:50, KUPF-205
  MECH 237-101 and -103, Lecture, Thur., 6:00-9:05, ECEC-115

**Lab Instructors:**
Mr. Masoud Seyed Shirkhorshidi, PhD Candidate, ss3929@njit.edu
  MECH 237-001, -003, -005, -007
Mr. Hasan Tariq, PhD Candidate, ht99@njit.edu
  MECH 237-009, 011, 101, and -103

**Tutoring: Colton Hall Rm. 423**
The Lab Instructors will have tutoring hours in **423-Colton** and will be available to all students in all of the Strength of Materials sections. Lab Instructors are available for help with course material and lab questions.

*Prerequisite: Mech235, Math 112, or equivalents, and a working knowledge of Statics with emphasis on force equilibrium and free body diagrams. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions. Lab should be taken concurrently.*

<mark>**Students must earn a grade of C or better in this course to register for CE332, CE341 or CE431.**</mark>

**All students must have proper prerequisites for Mech 237, Strength of Materials; Mech 235 Statics and Math 112 Calculus II. Students without these prerequisites will be dropped from the course.**

**Course Policies:**
- Attendance is mandatory
- There will be NO need for electronic devices during class time.  Turn OFF your cell phone and put it away.  Put away your laptop, tablet, or any other electronic device.
- Bring your textbook to each class meeting or pages from the relevant chapter.
- Take notes and pay attention.  Ask questions.
- Be prepared to participate with board work and/or class problem solving.  Bring your calculator.

**Quizzes and/or Exams and Grading Policies:**
- Your instructor will announce dates for exams.  These will be 50% of your grade.
- There will be a Final Exam during Finals Week.  This will be 25% of your grade.
- Exam problems must have Free-Body-Diagrams.  ALL work must be shown for full credit.
- There will be NO make-up exams unless there is documentation provided to the Dean of Students Office to validate your absence.  Such circumstances may include sickness documented by a doctor or NJIT Health Service; a receipt from your mechanic for car failure; etc.
- We do NOT drop the lowest grade.
- We do NOT curve the grades.
- For more information on the grading scale, read the information following the course outlines.
- You must receive a passing grade in both the lab and the lecture to pass the course. Failure of either requires repeating both lecture and lab. In other words, failing the lab or the lecture means failing the course, so, do all of your work, please.

**Homework Policies:**
- Follow the syllabus and do the homework problems suggested.  Exam problems may be taken from the homework problems or be very similar to the homework or those Sample Problems in the textbook.
- Homework may be collected on a random basis.  Not all assigned problems will be collected.  Only a select few will be collected randomly.  Do your homework.  Have it ready each week.
- NO late homework will be accepted.
- All homework MUST include a Free-Body-Diagram.  All work must be shown for full credit.
- Homework NOT submitted will earn MINUS points.
- Have your homework ready each class meeting.
- For more information on the format for homework and the type of paper, read the information following the course outlines.

*The NJIT Honor Code will be upheld and any violations will be brought to the immediate attention of the Dean of Students.

NJIT classes begin on Tuesday, September 4.  Semester ends with the last day, Wed., Dec. 12

| WEEK | TOPICS (subject to change) | ARTICLES | Homework Problems (instructor may modify) |
|---|---|---|---|
| 1 - Ch. 1 | Concept of Stress and Strain with a Review of Statics | p. 1-26 p. 27-50 | 1.3, 1.11, 1.26 1.29, 1.55 |
| 2 - Ch. 2 | Stress and Strain - Axial Loading | p. 55-77 | 2.4, 2.7, 2.21, 2.24 |
| 3 - Ch. 2 | Composites, Temperature Change, and Poisson's Ratio | p. 82-104 p. 133-143 | 2.37, 2.47, 2.59 2.64, 2.65 |
| 4 – Ch. 3 | Torsion   Angle of Twist | p. 148-166 p. 167-184 | 3.3, 3.4, 3.11, 3.15 3.33, 3.34, 3.37, 3.41 |
| 5 – Ch. 3 | Transmission Shafts | p. 185-193 | 3.64, 3.66, 3.74 |
| 6 – Ch. 4 | Pure Bending   Composite Materials | p. 237-257 p. 259-269 | 4.3, 4.4, 4.10, 4.22 4.33, 4.40 |
| 7 – Ch. 5 | Analysis and Design of Beams for Bending:  Shear and Moment Diagrams | p. 345-359 | **Draw the V & M diagrams:** 5.7, 5.8, 5.9, 5.11 |
| 8 – Ch. 5 | Section 5.2  Develop Equations Section 5.3  Design / Select the Beam | p. 360-370 p. 371-380 Review 407-413 | **Write the V&M equations** 5.40, 5.41, 5.42, 5.54 Design / select the beam for:      5.70, 5.73 |
| 9 – Ch. 7 | Transformations of Stress and Strain, Section 7.2  Mohr's Circle | p. 477-491 p. 492-503 | Solve by equations: 7.1, 2, 6 & 10,  or 7 & 11 Draw Mohr's Circle: 7.35, 36, 37 |
| 10 – Ch. 7 | Transformation of Plane Strain Strain Rosettes | p. 529-537 p. 538-552 | 7.128 & 132 7.147,  7.148 |
| 11 – Ch. 9 | Deflection of Beams, Integration Method | p. 599-622 | 9.13,  9.15 |
| 12 – Ch. 9 | Deflection of Beams, Superposition Method | p. 635-645 | 9.65,  9.78 |
| 13 – Ch. 10 | Columns | p. 691-708 | 10.1,  10.2,  10.20, 10.121 |
| 14 – Ch. 10 | Column Buckling continued Review for the final exam | | |
| 15 – | FINAL EXAM The Registrar announces the dates for final exams. | | |

## Laboratory Schedule  -  You must pass BOTH Lab and Lecture to pass the course.

Lab sessions meet in Colton Hall, room 423 for Pre-Lab instructions.

| Class | Lab Topic | Due |
|-------|-----------|-----|
| 1 | Room 423-Colton Hall:  Introduction, Safety Procedures for Lab, Instructions on how to prepare your Lab Reports, Grading Policies | READ about Reports in Lab Manual |
| 2 | Experiment 1:  **Pre-Lab Presentation** in 423-Colton Hall Tension Test of Metals, Automated Testing of Steel and other metal (refer to Ch. 1 and 2 in text) | . |
| 3 | Experiment 1:  **Experiment** in room 422-Colton Hall Tension Test of Metals, Automated Testing of Steel and other metal | Formal report due week 6 |
| 4 | Meet with Lab Instructor for assistance with Analysis of Data and using Spreadsheets for the Labs and how to prepare your Lab Report | . |
| 5 | Experiment 2:  **Pre-Lab Presentation** in 423-Colton Hall Torsion Test of Metallic Materials   (refer to Ch. 3 in text) | . |
| 6 | Experiment 2:  **Experiment** in room 422-Colton Hall Torsion Test of Metallic Materials | Formal report due week 8 |
| 7 | Meet with Lab Instructor for help to complete lab reports and begin to study for the next experiment | . |
| 8 | Experiment 3:  **Pre-Lab Presentation** in 423-Colton Hall Stresses, Strains and Deflection of Steel Beams in Pure Bending (refer to Ch. 4 and 5 in text) | . |
| 9 | Experiment 3:  **Experiment** in 422-Colton Hall Stresses, Strains and Deflection of Steel Beams in Pure Bending | Formal report due week11 |
| 10 | Experiment 4:  **Pre-Lab Presentation** in 423-Colton Hall Strain Measurements Using Strain Rosettes in Aluminum Beams (refer to Ch. 7 in text) | . |
| 11 | Experiment 4:  **Experiment** in 422-Colton Hall Strain Measurements Using Strain Rosettes in Aluminum Beams | Informal report due week 13 |
| 12 | Experiment 5 :  **Pre-Lab Presentation** in 423-Colton Hall Compression Test of Steel Columns, Column Buckling (refer to Ch. 10 in text) | . |
| 13 | Experiment 5 :  **Experiment,**  in 422-Colton Hall Compression Test of Steel Columns, Column Buckling | Informal report due week 14 |
| 14 | Experiment 5 reports are due this week. | . |

Remember to cite your references when writing your lab reports.  Each person will contribute to and be responsible for each lab report submitted.

Prepared by Milano, 8/25/14, 1/8/15, 1/16, 1/17, 5/18, 8/18

| GRADES: | RANGE | GRADE |
|---------|-------|-------|
| Exams ...... 50% | 88 -100 | A |
| Final Exam ........  25% | 82-87 | B+ |
| Homework ........ 10% | 76-81 | B |
| Laboratory ........ 15% | 70-75 | C+ |
|  | 65-69 | C |
| **There is no grade of D for CEE Students** | 60-64 | D |
|  | 59 and below | F |

Students will be consulted for any substantial changes to the course outline.  Changes will be discussed and announced in advance.

EXAMS AND FINAL    (Attendance at exams is mandatory.  Excused absences will require appropriate documentation.)

1. Exam problems will include theory as well as numerical problems. Questions on the laboratory may also be asked.
2. All exams and final exam are closed book and may include multiple choice problems.
3. All problem solutions must be done on paper provided. The format of the solution must include assumptions and the solution or answer clearly shown.
4. The solution must illustrate the understanding of the material. Correct numerical solutions alone are <u>insufficient</u> for any credit.
5. If a problem starts with incorrect assumptions and formulations, it will receive no credit.
6. All answers must be accompanied by units.
7. Exams and final are to be taken with a fully charged calculator. Calculators may not be borrowed during the quizzes.
8. The dates of the exams will be announced.
9. The grade of "I" (incomplete) will not be given for unsatisfactory academic performance.
10. No mid-term warning notice will be given. Maintain your own records of grades.
11. Students cannot leave the classroom during quizzes or exam.
12. Cell phones must be OFF and laptop computers / notebooks / tablets not necessary in class.

HOMEWORK

1. Homework sets are due as announced by your instructor in advance.
2. Homework must be submitted in sets, arranged in order as in course outline.
3. The homework must be written on quadrille 8½ x 11 engineering pad. Sets must be stapled together in the upper left hand corner. DO NOT HAND IN CLASS NOTES.  Put the problem number in the UPPER RIGHT corner.
4. NO LATE Homework will be accepted.

**HOMEWORK INSTRUCTIONS**

The following are to be observed when handing in homework for grading.

1. Use 5-square per inch National Computation pad paper <u>ONLY</u> (sold at the NJIT Bookstore). The proper form consists of doing the problems on <u>one side</u> of 8-1/2 x11 pad paper.  Also acceptable; engineering paper from office supply stores.
2. On the top of each page, in the space provided, <u>PRINT</u> your name, course and section, and problem number,
3. The problems must be presented in numerical order as assigned. One problem per page.   Write on one side of the sheet only. Lettering and numbers are to be neat, clear and legible.
4. Draw neat, clear F.B.D's as required. Use a straight edge or other drawing instruments as needed.
5. Box in the final answer.

## Laboratory Safety

Your safety and the safety of those around you are of prime importance. Efforts have been made to reduce the hazard in the lab as much as possible. If you should see anything that you consider to be a safety hazard report this condition to your lab instructor. Take your experiments seriously. Forces into the thousands of pounds will be used throughout the course and if these forces are released in an uncontrolled manner injuries are possible. Horseplay will not be tolerated and will constitute grounds for dismissal from the course.

## Grading Policies

Your lab grade will represent 15% of your course grade. The lab grade will be averaged into your lecture grade to determine your final grade. You must receive a passing grade in both the lab and the lecture to pass the course.  Failure of either requires repeating both lecture and lab. In other words, failing the lab or the lecture means failing the course, so, do all of your work, please.

All reports should be word processed. Graphs are to be computer generated.

The results of the experiment are the results you must work with. Do not "cook" the results to produce the "expected" results. Draw your conclusions based on these results. If they are not as expected (you should have an idea of the expected results), account for the discrepancies.

Reports are also graded on your presentation. Is the material presented in a logical way? Can all of the required results be found with ease? Are the results discussed intelligently, in a good technical language? Can all the questions that enter the readers mind be satisfied? Be advised that your discussion and conclusions will probably carry more weight than production of the right answers.

All labs are due at the meeting after they were conducted. Due dates are listed on the syllabus. After the due date reports will be accepted for 75% credit. After the reports have been returned to the class late papers will be accepted for only 50% credit. Papers more than two weeks late will not be accepted.

You should keep a copy of the work you turn-in. If a report is "lost" it is a favor to the instructor, and insurance for you, to be able to submit a copy of the report.

Students are expected to properly maintain their registration status. If your name does not appear on the final grade sheet, it is not possible to assign you a grade and it will be necessary for you to repeat the course.

**Outcomes Course Matrix MECH 237 Strength of Materials**

| Strategies, Actions and Assignments | ABET Student Outcomes (1-7) | Program Educational Objectives | Assessment Measures |
|---|---|---|---|
| **Student Learning Outcome 1: Identify and calculate the state of stresses and strains in engineering components as a result of different loading conditions.** | | | |
| Introduce the concept of determining stresses and strains from the member forces. | 1 | 1 | Weekly homework and quizzes. |
| Provide the principles of normal and shearing stresses and how to determine the principal stresses. | 1 | 1, 2 | Weekly homework and quizzes. |
| **Student Learning Outcome 2: Analyze structural members under axial loads, bending, shear, and torsion.** | | | |
| Provide the basic concepts and effects of axial loads, bending, shear, and torsion on structural components. | 1 | 1 | Weekly homework, quizzes and lab experiments. |
| Introduce the methods used to solve determinate and indeterminate problems. Compare analytical work with results from MD Solids software program. | 1 | 1, 6 | Weekly homework, quizzes and review of assigned problems. |
| **Student Learning Outcome 3: Identify the behavior of various engineering materials, their performance under loads, and design needs.** | | | |
| Introduce a state of the art analysis with Instron testing apparatus. | 1, 7 | 1, 2, 6 | Homework and lab experiments. |

**CEE Mission, Program Educational Objectives and Student Outcomes**

The mission of the Department of Civil and Environmental Engineering is:
- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

2 – Professional Growth: Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

3 – Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Revised: 2/13/18, 5/18/18