**Course:** MENG 274 – Advanced Strength of Materials, 2018
**Instructor:** Russ Rook
**Office:** TEC 113
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## Calendar Description

Students will receive an introduction to plasticity, beam shape factors, and residual stresses. The design of columns and struts will be discussed. The student will also determine how to analyze systems experiencing asymmetric bending, as well as the deflection of curved beams. Energy methods applied to strength of materials will be developed, including concepts of strain energy, the principle of virtual work, the principle of stationary potential energy, and Castigliano's theorems. As well, impact loading will be considered from an energy approach.

Only open to students in the Mechanical Engineering Technology program.

## Intended Learning Outcomes

Upon successful completion of this course a student will be able to:

- Use elastoplastic (EPP) analysis to:
  - determine the beam section shape factor
  - calculate residual stresses in sections.
- Design columns for safe working loads.
- Design sections subjected to asymmetric bending, and determine the orientation of the neutral axis.
- Calculate stresses and deflections in thin curved members.
- Formulate a definition of strain energy in terms of basic stresses, and apply the conservation of energy to analyze structures subjected to impact loading.
- Describe the application of energy principles, such as:
  - the principle of virtual work
  - the principle of stationary potential energy
  - Castigliano's first and second theorems.

## Text & References

***Mechanics of Materials***, 10th Ed., R.C. Hibbeler

## Course Content (subject to modification, if necessary)

| Week | Labs | Assignments | Course Content |
|---|---|---|---|
| **1** | - | - | Introduction to plastic deformations, inelastic bending, elastic-perfectly-plastic (EPP) material assumptions. |
| **2** | Lab 1 | - | Beam shape factors, EPP analysis, residual stresses. |
| **3** | Lab 1 Analysis | 6-158,6-163, 6-165,6-177 | Columns and buckling theory, column design equations. |
| **4** | Lab 2 | - | Offset loading of columns, the secant formula, asymmetric bending, angle to the neutral axis. |
| **5** | Lab 2 Analysis | 13-17,13-19,13-27, 13-55,6-105,6-113 | Bending of curved beams (Winkler's theory). |
| **6** | - | - | ***READING BREAK*** |
| **7** | Lab 3 | 6-137,6-139, 6-141,8-73 | Curved beam analysis, introduction to energy principles. |
| **8** | - | - | Review period, **MIDTERM exam**. |
| **9** | Lab 3 Analysis | - | External work and strain energy, stress analysis using energy principles. |
| **10** | Lab 4 | - | Conservation of energy for elastic materials, impact loading using energy principles. |
| **11** | Lab 4 Analysis | 14-3,14-7,14-9, 14-27,14-44,14-52 | The principle of virtual work with examples. |
| **12** | - | - | The principle of stationary potential energy. |
| **13** | - | 14-72,14-75,14-87, +questions on K:drive | Castigliano's first & second theorems. |
| **14** | Lab 5 | 14-123,14-214,14-128 | Course catch-up & review. |

## Labs, Assignments & Exam Evaluation

Laboratory experiments will be given throughout the semester, tentatively planned for the weeks given in the above table. Regular (non-experiment) lab sessions will typically consist of lab data analysis reviews or tutorials. Assignments will be graded based on completion, with solutions posted after the assignment is due. Assignments are due by 5:30 on the Friday of the weeks indicated in the above table, and **no late assignments will be accepted for grading**.

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|---|---|---|
| ***Labs*** | 15% | |
| ***Assignments*** | 15% | |
| ***Midterm Exam*** | 35% | (open textbook only) |
| ***Final Exam*** | 35% | (open textbook only) |

***→ You must pass the final exam to pass MENG 274***

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|---|---|---|---|
| **A+** | 90 - 100% | **B-** | 70 - 72% |
| **A** | 85 - 89% | **C+** | 65 - 69% |
| **A-** | 80 - 84% | **C** | 60 - 64% |
| **B+** | 77 - 79% | **D** | 50 - 59% |
| **B** | 73 - 76% | **F** | < 50% |