**EGR 211 – Mechanics of Materials**

**Mechanical Properties of Materials**

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| **Stage 1 – Desired Results** |
| **Established Goals:** **Course (as stated in the Course Outline on file with the college)*** To develop a clear insight into the relation between stress and strain for a wide variety of conditions and materials

**College-Wide Core Competencies (as stated in the 2011 – 2012 College Catalog)*** **Communication:** Using listening, speaking, reading, writing and visual communication skills effectively.
* **Information Literacy**: Recognizing when information is needed and locating, evaluating, and using information appropriately.
* **Quantitative Reasoning**: Applying mathematical concepts appropriately to analyze and interpret quantitative information.
* **Innovative and Critical Thinking**: Integrating knowledge to analyze problems using different modes of thinking (critical, creative and innovative).
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| **Understandings:***Student will understand that…** Mechanical properties of materials are determined by experiments.
* Multiple experimental methods exist for determining a mechanical property of a material.
* Stress-strain diagrams are created based on the results of an experiment.
* Stress-strain diagrams contain many mechanical properties (through locating key points and analysis particular features, such as linear portions of the diagram).
* Stress-strain diagrams for ductile and brittle materials will have different general shapes and analysis of the shape is one way to determine if a material is ductile or brittle.
 | **Essential Questions:** * How are mechanical properties for materials determined?
* Where do you find material properties for existing (well-established) materials?
* How can materials be compared using their mechanical properties?
* Which mechanical properties are essential to know (define) prior to using a material in a real-world application?
* How are mechanical properties established for new materials?
* What properties are use to categorize a material as “ductile” versus “brittle”? Are there any in-between states?
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| *Students will know…** Key terms: modulus of elasticity/Young’s modulus, yield strength, 0.2% offset yield strength, ultimate strength, necking, rupture, fracture strength, strain hardening, percent elongation, resilience, toughness, brittle, ductile.
* General procedures for basic mechanical test methods (tensile, compression, torsion, three-point bend, four-point bend).
* For brittle and ductile materials, which tests are most reliably used to determine mechanical properties.
 | *Students will be able to….** Given typical ductile and brittle material stress-strain diagrams, identify/calculate key properties (such as the yield strength, ultimate strength, breaking strength, elastic region, and plastic region).
* Given a set of load and elongation data from a tensile test, apply appropriate equations to calculate required values needed to create a stress-strain diagram.
* Given a set of load and deflection data from a three-point bend test, apply appropriate equations to calculate required values needed to create a stress-strain diagram.

*(continued: Students will be able to….)** Use Microsoft Excel to create stress-strain diagrams.
* Use the linear portion (the slope of the graph) of a stress-strain diagram to determine the modulus of elasticity for a material.
* Provide examples of brittle and ductile materials (from engineering or from other “real world” experiences).
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| **Stage 2 – Assessment Evidence** |
| **Performance Tasks:**Homework – Internet assignment MecMovies (<http://web.mst.edu/~mecmovie>)* M3.1 The tension test
* M3.2 The stress-strain diagram
* M3.3 Hooke’s Law – basic problems

Homework – traditional problem solving* Given a set of force and deflection data, create a stress-strain diagram using Microsoft Excel.
* Identify key properties from the diagram.
* Complete related property calculations.
* Categorize material as brittle or ductile.
 | **Other Evidence:*** In-class discussion
* Related questions on test(s)
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| **Stage 3 – Learning Plan** |
| **Learning Activities:*** Pre-lecture reading/on-line video viewing (W)
* Lecture/discussion on importance of determining properties of materials prior to using materials in real-world applications (Introduce topic) (W,H)
* Typical ductile material
* Lecture/discussion of tensile test procedure and describe data to be taken (H,E)
* YouTube video of tensile test (H)
* Show resulting stress-strain diagram (E)
* Lecture/discussion of key components on diagram and other related calculations (E,R)
* Discussion of common materials that fit into this category (E,R)
* Typical ductile material with no yield point
* Lecture/discussion of key components on graph and other related calculations (E, R)
* Show resulting stress-strain diagram (E)
* Discuss similarities/differences between the two diagrams (E,R)
* Discussion of common materials that fit into this category (E,R)
* Typical brittle material
* Discussion on difficulties with performing a tensile test on a brittle material (E,R)
* Discuss alternative testing methods for determining mechanical properties – such as a three-point bend test (E,R)
* Introduction to summer research work with dental composites (H)
* Describe data to be taken (E)
* Show YouTube video of test (H)
* Show resulting diagrams (E)
* Discussion of standards of testing methods established by ASTM and ISO (H)
* Although not a “learning activity” handouts for the lecture will be made up in advance with the stress-strain diagrams and key lecture topics/bullets already drawn so that more time can be spent by the students listening and learning rather than trying to copy everything down from the board (O)
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