SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: STRENGTH OF MATERIALS

CODE NO.: MCH 300 SEMESTER: FIVE

PROGRAM: MECHANICAL TECHNOLOGY

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APPROVED: L P Chiozutti
CHAIRPERSON

1993 - 08 - 15
DATE

CALENDAR DESCRIPTION

STRENGTH OF MATERIALS	MCH 300
Course Name	Course Number

PHILOSOPHY/GOALS:

This course prepares the student to deal with stress analysis and deflections of a more advanced nature than that of MCH 202.

METHOD OF ASSESSMENT (GRADING METHOD):

You will be tested on topic 1, 2, 3 two weeks after the completion of these topics.

You will be tested on topics 4, 5 two weeks after the completion of these topics.

You will be tested on the remainder at the end of the course.

The marking system will be "A", "B", "C" and "X", and test will be graded on logical solution, layout, sketches and tidiness.

It is expected that the student will be a regular, diligent and a punctual attender in class.

TEXTBOOK(S):

Mechanics of Materials - Levinson

STRENGTH OF MATERIALS

REFERENCE TEXTS:

Resistance of Materials - Seeley & Smith (Wiley)

Mechanics of Materials - Arges & Palmer (McGraw-Hill)

Mechanics of Materials - Lawson & Cox (Wiley)

Strength of Materials - Fitzgerald (Addison-Wesley)

Mechanics of Materials - Popov (Prentice-Hall)

TOPIC NO.	PERIODS	DESCRIPTION
1	4	Strain Measurement and Photoelasticity
2	10	Beam Deflections by Double Integral Method
3	12	Statically Indeterminate Beams
4	8	Continuous Beams
5	6	Impact Loading
6	10	Thick Walled Cylinders and Shrink Fits
7	6	Deflection of Elastic Structures by Strain-Energy Methods
8	4	Virtual Work

STRENGTH OF MATERIALS
MCH 300

Unit #1 - Strain Measurement & Photoelasticity

GENERAL OBJECTIVE:

The student will be able to understand and apply the principles of Strain Gauge stress analysis and Photoelastic stress analysis.

SPECIFIC OBJECTIVES:

1. To be able to explain the principle of operation of the bonded resistance strain gauge.

2. To be able to distinguish between general purpose strain gauges and rosettes.

3. To be able to mount a strain gauge successfully.

4. To be able to define the term gauge factor.

5. To be able to relate between the strain in the material and the change in resistance of the gauge.

6. To be able to analyze the forces in the member in order to mount the gauges in the correct position.

7. To be able to interpret strain reading found into stress values.

8. To be able to define the term polarized light.

Unit #2 - Beam Deflections by Double Integral Method

GENERAL OBJECTIVE:

The student will be able to obtain the slope and deflection of any point on a beam by this method.

SPECIFIC OBJECTIVES:

1. To be able to recall the three equations of equilibrium.

2. To be able to solve for beam reactions.

3. To be able to construct a general expression for the bending moment at any point on a loaded beam.

4. To be able to state the differential equation: $= - \frac{Mx}{EI}$

5. a) To be able to state the convention for positive slope.
   b) To be able to state the convention for positive deflection.

6. To be able to integrate the equation EI = $= - Mx$

7. To be able to integrate the equation EI = $= - Mxdx$

8. To be able to select boundary conditions to ascertain the constants of integration.

9. To be able to solve, using the above specific objectives, for the deflection and slope of any point on a beam constant moment of inertia when the beam is subjected to a system of concentrated loads, uniformly distributed loads and couples.

Unit #3 - Statically Indeterminate Beams

GENERAL OBJECTIVE:

The student will be able to solve for reactions and restraining moments and to calculate slopes and deflections of beams of varying cross section by the Mohr Cable Method or Equivalent Beam Method.

SPECIFIC OBJECTIVES:

1. To be able to recall the three equations of equilibrium.

2. To be able to calculate reactions as if the beam were simply supported.

3. To be able to draw the free Bending Moment Diagram.

4. To be able to draw the fixed Bending Moment Diagram.

5. To be able to replace the beam by an equivalent weightless cable having the same deflected form as the beam.

6. To be able to load the cable with the bending moment diagram using the positive diagram equivalent to downward load convention.

7. To be able to state that the support reactions at the end of the cable are V (vertical) and EI (horizontal).

8. To be able to explain that parts of the beam can be treated in a similar manner.

9. To be able to apply the conditions for static equilibrium for the loaded cable.

10. To be able to apply the conditions for static equilibrium for any part of the loaded cable thus solving for the slope and deflection at any point on a constant or varying moment of inertia beam, and for the reactions and restraining moments.

Unit #4 - Continuous Beams

GENERAL OBJECTIVE:

The student will be able to solve for reactions, slopes and deflections of beams of more than one span and of varying moments of inertia.

SPECIFIC OBJECTIVES:

1. The student will be able to derive Clapeyron's Theorem using the Mohr Cable Method.

2. To be able to recall the three equations of equilibrium.

3. To be able to draw the free bending moment diagrams for each span.

4. To be able to draw the fixed bending moment diagrams for each span.

5. To be able to sketch the deflected cable for the entire beam.

6. To be able to state the conventions for bending moment and deflections.

7. To be able to apply the "Mirror Image" principle for cantilevered continuous beams.

8. To be able to utilize the above specific objectives in the solution of reactions, slopes and deflections of continuous beams.

Unit #5 - Impact Loading

GENERAL OBJECTIVES:

The student will be able to solve for deformations occurring when a member or beam is subjected to impact or dynamic loading.

SPECIFIC OBJECTIVES:

1. To be able to recall the three equations of equilibrium.

2. To be able to recall Pappus' Theorem.

3. To be able to recall the flexural formula.

4. To be ale to recall the stress-strain relationship.

5. To be able to calculate deformations in members or beams subjected to static loading.

6. To be able to state the formula:

7. To be able to use the above formula in calculating dynamic loads, stresses and deformation.

Unit #6 - Thick Walled Cylinder & Shrink Fits

GENERAL OBJECTIVE:

The student will be able to solve problems dealing with stresses set up in thick walled cylinders due to externally applied pressures and shrink fits.

SPECIFIC OBJECTIVES:

1. To be able to state the Lame Equations for radial and circumferential stresses.

2. a) To be able to state the equation for radial strain.

   b) To be able to state the equation for circumferential strain.

   c) To be able to state the equation for axial strain.

3. To be able to state the convention for the algebraic sign of the interface pressure.

4. To be able to determine the position of the maximum stress.

5. To be able to show the relationship between the reduction in outside diameter of the inner cylinder and the increase in inside diameter of the outer cylinder.

6. To be able to plot the stress and distribution of the radial and circumferential stresses of the inner and outer cylinder.

7. To be able to calcualte the interface pressure set up by shrink fit conditions.

8. To be able to solve, with the aid of the above specific objectives, the type of problem shown:

   A 16 i. O.D. steel cylinder with approximately a 10 in. bore (I.D.) is shrunk onto another steel cylinder of 10 in. in O.D. with a 6 in. I.D. Initially the internal diameter of the outer cylinder was 0.01 in smaller than the external diameter of the inner cylinder. The assembly was accomplished by heating the larger cylinder in oil. For both cylinders $e = 30 \times 10^6$ psi and $= 0.3$.
   a) Determine the pressure at the boundaries between the two cylinders. (Hint: the elastic inctrease in the diameter of the outer cylinder with the elastic decrease in the diameter of the inner cylinder accommodates the initial interference between the two cylinders.)
   b) Determine the tangential and radial stresses caused by the pressure found in (a). Show the results on a plot.
   c) Determine the internal pressure to which the composite cylinder may be subjected without exceeding a tangentail stress of 20,000 psi in the inner cycle. (Hint: after assembly, the cylinders act as one unit. The initial compressive stress in the inner cylinder is released first.)
   d) Superpose the tangential stresses found in (b) with the tangential stresses resulting from the internal pressure found in (c). Show the results on a plot.

Unit #7 - Deflection of Elastic Structures by Strain Energy Methods

GENERAL OBJECTIVE:

The student will be able to calculate deformation in elastic structures subjected to Direct, Shearing, Bending and Torsional effects.

SPECIFIC OBJECTIVES:

1. a) To be able to state the formula for stress due to Direct action.
   b) To be able to state the formula for stress due to Direct action.

2. a) To be able to state the formula for stress due to Shearing action.
   b) To be able to state the formula for strain due to Shearing action.

3. a) To be able to state the formula for stress due to Bending action.
   b) To be able to state the formula for strain due to Bending action.

4. a) To be able to state the formula for stress due to Torsion.
   b) To be able to state the formula for strain due to Torsion.

5. To be able to calculate the Strain Energy due to Direct action.

6. To be able to calculate the Strain Energy due to Shearing action.

7. To be able to calculate the Strain Energy due to Torsion.

8. To be able to calculate the Strain Energy due to Bending action.

9. To be able to calculate the Total Strain energy due to the combined effects of the above forces.

10. To be able to calculate deflections from the formula:
    1/2 WF = Strain Energy.

Unit #8 - Virtual Work

GENERAL OBJECTIVE:

The student will be able to obtain, by means of the method of virtual work, the deflection of any paint on a body caused by any loading in any desired direction.

SPECIFIC OBJECTIVES:

1. To be able to apply to an unloaded body, an imaginary or virtual unit force in the direction of the desired deflection.

2. To be able to apply the actual or real forces, with the virtual force remaining on the body.

3. To be able to state the relationship between internal work and external work.

4. To be able to calculate the deformations due to the real forces.

5. To be able to state the conventions for deformations.

6. To be able to state the virtual work equation for direct action.

7. To be able to state the virtual work equration for bending action.

8. To be able to apply the above specific objectives in the solution of problems dealing with the deflections of beams and structures.