

SAULT COLLEGE

of Applied Arts and Technology

Sault Ste. Marie

COURSE OUTLINE

CIVIL ENGINEERING TECHNICIAN

MECHANICS OF MATERIALS

MCH 212-3

rSVISGCJ February, 1987 by G. Freeh

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TEXT:

Applied Strength of Materials - 3rd Edition - Jensen & Chenoweth

REFERENCE TEXTS:

Mechanics of Materials - J. Levinson

Theory of Simple Structures - Shedd and Vater

Introduction to Mechanics - Levinson

Strength of Materials - Mott

| Periods | Topic Description | Reference |
|---------|--|-----------|
| 6 | <u>Review of Principles of Statics</u> a) Forces and Units b) Vectors c) Moments d) Factor of Safety e) Direct Stress Formula | |
| 10 | <u>Fundamental Stress Strain Relationship</u> a) Tensile, compressive, and shear forces b) Properties of elasticity c) Poisson's ratio d) Temperature stresses e) Thin walled cylinders | |
| 12 | <u>Connections</u> a) Bolted (riveted) b) Welded c) Thin walled cylinders | |
| 12 | <u>Shear & Bending in Statically Determinate Beams</u> a) Shear diagrams b) bending moment diagrams c) Maximum bending d) Deflection e) Flexure formula | |
| 8 | <u>Centers of Gravity and Moment of Inertia</u> a) First moment of areas b) Second moment of areas c) Inertia-Parallel axis theorem d) Radius of Gyration | |
| 6 | <u>Trusses</u> a) Bow's Notation b) Stress diagrams | |
| 4 | <u>Torsion</u> a) Torsion formulae b) Shafts c) Couplings | |

CIVIL ENGINEERING TECHNICIAN

Performance objectives of Mechanics of Materials

MCH 212-3

The general objective of the course is to develop a basic working knowledge into strength of materials. This will enable the student to work from technical reference material and to solve strength of material and structural problems at the technician level. To execute this work with technician skill, the student must complete the following successfully and be able to work examples in S.I. and Imperial units throughout the course to allow for changeover to S.I.

UNIT S-1 – Direct Stress

1. Identify the main units in engineering measurement.
2. Identify the three laws of equilibrium.
3. Identify the three kinds of stress, tension, compression and shear.
4. Identify simple direct axial stress and be able to solve for any one unknown in the direct stress formula unit stress - load/cross section area.
5. Identify ultimate stress.
6. Identify and solve factor of safety.
7. Identify working stress, being able to calculate if from factor of safety and being able to apply this relationship in design and strength of materials.

UNIT S-2 – Thin Walled Cylinders

1. Identify thin walled pressure vessels.
2. Identify stress in a longitudinal direction of the cylinder shell.
3. Be able to develop the formula for stress in the longitudinal direction of a thin walled cylinder and be able to solve for any one unknown.
4. Identify stress in a circumferential direction of the cylinder shell.
5. Be able to develop the formula for stress in the circumferential direction of a thin walled cylinder and be able to solve for any one unknown.
6. Identify the stress in the wall of a thin wall cylinder if the cylinder is a sphere.
7. Solve simple problems for stresses in either direction of circumferential or longitudinal or for any one unknown in the formula for either case.

UNIT S-3 – Stress-Strain

1. Identify strain and total deformation.
2. Distinguish between strain and stress.
3. Interpret the stress strain curve, being able to name all the parts of the curve; the relationship of elastic range, ultimate strength, permanent set.

4. Identify Hooke's Law.
5. Identify and calculate Young's Modulus (Modulus of Elasticity) the relationship of stress/strain.
6. Develop the total deformation formula from the direct stress formula and Modulus of Elasticity formula.
7. Manipulate the formula for deformation, solving for any one unknown quantity.
8. Solve the deformation formula-should there be unknowns in either the direct stress formula, the Modulus of Elasticity formula or in both.
9. Solve problems in deformation for one material under axial load.
10. Solve problems in deformation for two materials in series under axial load or two sizes of the same material in series under axial load.
11. Solve problems in deformation for two materials in parallel, deflecting equally under axial load.
12. Identify Poisson's Ratio; the relationship between axial deformation to lateral deformation.
13. Solve problems in deformation which includes Poisson's Ratio.

UNIT S-4 – Thermal Stress

1. Understand what thermal expansion or contraction is and be able to solve simple problems using standard linear coefficients of thermal expansion.
2. Identify thermal stress with direct stress being able to compare and relate the thermal formula to that of the direct stress formula.
3. Solve basic problems in temperature stress using the formula- with only one unknown quantity.

UNIT S-5 -- Shapes and Connections - Bolted, Riveted

1. Identify structural shapes.
2. Use tables of structural shapes, being able to distinguish parts, dimensions, and the design tables from detail tables.
3. Write and sketch structural shapes; the standard method of calling for; know their parts and the difference between the strong and weak axes.
4. Identify the allowable stresses for structural grades of steel and timber.
5. Identify and compare structural connectors; rivets and bolts.
6. Identify single shear and double shear in connectors.
7. Identify bearing in riveted or bolted connections.
8. Calculate shear values for different sizes of connectors.
9. Calculate bearing values for different thickness of plate on different sizes of connectors.
10. Identify the design value to use between shear and bearing and understand these two checks to make in connections.
11. Calculate the number of connectors required where the axial load is known and sizes of material being connected.

12. Calculate the capacity of a connection when working stresses and material sizes are known.
13. Identify tension members and be able to know and calculate gross area and net area.
14. Do the calculation for tension member design.

UNIT S-6 -- Welded Connections

1. Identify types of electric arc welds: square butt, prepared butt, fillet, plug and slot.
2. Calculate capacity of butt welds.
3. Identify fillet welds.
4. Sketch a fillet weld showing its parts.
5. Identify the rules for sizes of fillet welds.
6. Calculate the value of fillet welds, knowing the size and being able to use the throat area.
7. Calculate lengths of fillet welds to carry direct loads, knowing material size and working stresses.
8. Calculate lengths of fillet weld at the toe and heel of an angle welded to a plate when the load to be carried is known.
9. Calculate the amount of fillet weld to develop the full strength of a structural shape or plate.

UNIT S-7 - Centroids

1. Identify the first moment of areas (centroids).
2. Calculate centroids of simple rectangular shapes and/or irregular rectangular shapes. This will include triangles and/or circles along with the rectangle.
3. Calculate centroids of built up standard structural shapes or structural shapes and plate making use of structural tables.
- 4.

UNIT S-8 - Moment of Inertia, Section Modulus

1. Identify the moment of inertia formula for rectangular shapes, recognizing how to use the formula about either the x-x or y-y axis or both.
2. Identify the second moment of areas (Moment of Inertia) and be able to calculate moment of inertia using the transfer formula.
3. Calculate moment of inertia for built up structural shapes, using structural tables for information required in the transfer formula.
4. Identify Section Modulus and be able to calculate S from moment of Inertia knowing the meaning of distance from neutral axis to extreme fibres.
5. Identify radius of gyration being able to calculate it knowing moment of inertia.
6. Identify the flexure formula and be able to manipulate it in its different forms.

UNIT S-9 – Shear and Bending Diagrams

1. Identify point (concentrated) and uniformly distributed (U.D.L.) loads.
2. Calculate reactions for simple beams under point U.D.L. or combinations of both, by use of moments.
3. Identify simple, overhanging and cantilever beams.
4. Identify the rule for shear at any point in a beam.
5. Identify the rule for moments at any point in a beam.
6. Calculate shear at any point in simple beams.
7. Calculate bending moment at any point in simple beams.
8. Draw shear diagrams to scale for simple beams.
9. Draw bending moment diagrams to scale for simple beams.
10. Calculate maximum bending moment in a simply supported beam under simple or combination loading.
11. Calculate Section Modulus by use of the flexure formula.
12. Use the structural tables to choose the most economical beam.
13. Calculate shear and bending maximum due to moving loads.

UNIT S-10 – Truss Forces Graphically and Analytically

1. Identify and use Bow's Notation with respect to loads and truss members.
2. Draw to scale force and stress diagrams for trusses using Bow's Notation.
3. Measure stresses accurately from the stress diagram and determine whether the member(s) is in tension or compression.
4. Identify forces in a truss analytically - method of joints.
5. Calculate mathematically, stresses at panel points of a truss using laws of equilibrium, and indicate tension or compression.
- 6.

UNIT S-11 – Torque

1. Identify torque; acting and resisting.
2. Calculate and design for resisting stress in connectors and to acting torque.
3. Identify the formula for torque.
4. Identify the formula for maximum unit shearing stress due to torque
5. Identify the formula for calculating the required diameter of a shaft due to torque.
6. Identify the formula for polar moment of inertia of solid and hollow shafts.
7. Calculate torque, shearing stress, diameter, polar moment of inert of solid or hollow shafts using any of the above formulae either alone or together solving for any one unknown.
8. Identify shaft couplings and be able to calculate design whether solid or with a keyway.
9. Identify the angle of twist formula.
10. Calculate the angle of twist of a shaft and use the information al with information or calculations from the other torque formulae.