Course: MENG 275 – Computational Methods & Finite Element Analysis, 2018
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Calendar Description

Students will be introduced to computational methods, including the Newton-Raphson method. Numerical integration and differentiation as applied to physical systems of interest in engineering will be investigated. The Finite Element Method (FEM) applied to case studies in structural problems will be developed and implemented using commercial software. 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 commercial software to solve:
  - The Newton-Raphson method for solution of nonlinear equations of one variable
- Construct a reasonable interpolation and polynomial approximation to a given set of data, and apply an appropriate computational method to solve applied differential equations found in mechanical engineering practice.
- Understand the history and limitations of the finite element method (FEM).
- Identify and apply the basic steps of the FEM to bar elements, and the constant strain triangle.
- Correctly use commercial FEM software to analyze structural members subjected to steady state loads.
- Verify FEM results using basic strength of materials theory.

Text & References

Numerical Analysis, 10th Ed., R.L. Burden, J.D. Faires, A.M. Burden (***Optional***)
A First Course in the Finite Element Method, 5th Ed., D.L. Logan (***Optional***)

Course Outline (subject to modification, if necessary)

Week	Lab	Assignments	Course Content
1	-	-	Introduction to matrix algebra and notation, systems of equations, matrix inversion.
2	Lab 1	-	Calculus review, Introduction to the finite element method (FEM), history, and limitations, FEM notation, stiffness matrices.
3	-	Assign. 1	Introduction to the finite element method (FEM), history, and limitations, FEM notation, stiffness matrices.
4	Lab 2		Interpolation functions, bar elements.
5		Assign. 2	Transformation of bar elements, bar element examples.
6	Lab 3		Stresses and displacements within bar elements, stress recovery.
7		Assign. 3	FEM applications in solid mechanics for plane stress and strain, the constant strain triangle (CST).
8	Lab 4	**MIDTERM 1**	CST examples, Review**, MIDTERM 1 exam**
9		Assign. 4	CST examples.
10	Lab 5		Verification of FEA results and practical considerations.
11	-	Assign. 5	Numerical solution of equations of one variable, the bisection method, the Newton-Raphson method.
12	Lab 6		Interpolation and polynomial approximations, cubic spline interpolation, Numerical differentiation and integration
13	-	Assign. 6 **Project Due**	Examples within mechanical engineering technology, including the vibrational response of a system to an input.
14	Lab 7	**MIDTERM 2** Assign. 7	Review, **MIDTERM 2 exam**

Assignments & Evaluation

Lab sessions will consist of tutorials and lab exercises according to the schedule given in the table above, where students can work on assignments and learn finite element analysis (FEA) using commercial software. Assignments are graded on completion, with solutions posted after the due date. **No late assignments will be accepted for grading. You should pass the midterm exams to pass the course.**

Lab Exercises	15%
Assignments	20%
Midterm 1	20%
Midterm 2	20%
Final Exam	25%

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%