CE 526: FINITE ELEMENT METHODS IN STRUCTURAL ENGINEERING

(Spring 2025)

Class time:	11:45 AM –1:00 PM, Mondays and Wednesdays
Location:	MRC 136
Instructor:	**Dr. Murthy N. Guddati**, FWH 3341
Office Hours:	1:10 – 2:00 PM Mondays and Wednesdays (in office, zoom for DE students) 5:00 – 6:00 PM Fridays (only zoom, with preference to distance students)
Website:	Moodle at **https://wolfware.ncsu.edu/**
Asking Questions:	For on-campus students, the *most appropriate venue for asking questions is the classroom*, as it benefits both in-class and distance students. Outside the classroom, both on-campus and distance *students are strongly encouraged to* ***post your questions on the discussion board on Moodle*** – this will also help fellow students with same/similar questions. I will check the discussion board at least once every two business days, perhaps once every day. Given this, except in unusual circumstances, *please refrain from using individual e-mails* to us with technical questions. Of course, on-campus students *should visit me during the office hours*. Distance students can use zoom to visit me virtually.
Prerequisites:	Solid mechanics, advanced engineering mathematics, matrix structural analysis (all at NCSU undergraduate level)
Objectives:	By the conclusion of the course, you will be able to use finite element method in an intelligent manner to obtain the solution of linear static problem at any desired level of accuracy, while recognizing any limitations of your analysis in relation to real physical problem. You will also be able to read literature and extend your knowledge related to dynamic and nonlinear finite element analysis.
Optional book:	Concepts and Applications of Finite Element Analysis, RD Cook, DS Malkus, ME Plesha and RJ Witt, 4th edition (ISBN: 9780471356059).

Grading:		
	Homework	20 %
	Projects	40 %
	Midterm 1 (**Wednesday, February 19**)	20 %
	Midterm 2 (**Wednesday, April 02**)	20 %

Homework:	There will be several homework assignments throughout the semester. Your solutions should either be typed or written on high quality paper, preferably scaled engineering paper. Homework must be submitted through Moodle.
Projects:	An important part of the course is computer modeling. Multiple projects will be assigned and you are expected to solve them using simple coding using MATLAB or using commercial finite element software ANSYS. A brief tutorial will be provided to get you started. You are expected to follow a systematic procedure to solve these modeling problems and write a professional project report.

Exams:	Midterm examinations will cover all the topics discussed prior to the exam date and roughly divided into 1D and higher dimensional FEM concepts.
Attendance:	On-campus students are expected to attend all classes. Any absence must be e-mailed to the instructor before the class. Distance students are expected to view the lectures by the end of that week.
Late Homework:	Late submissions will not be accepted, unless an extension is given by the instructor to the entire class.
Students with Disabilities:	Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG 02.20.01).
NCSU Polices, Regulations, Rules (PRR):	Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: http://policies.ncsu.edu/policy/pol-04-25-05 (Equal Opportunity and Non-Discrimination Policy Statement), http://policies.ncsu.edu/policy/pol-11-35-01 (Code of Student Conduct), http://policies.ncsu.edu/regulation/reg-02-50-03 (Grades and Grade Point Average).

TENTATIVE OUTLINE

1. Introduction to 1D FEM: direct statement for bars, principle of virtual work (PVW); Galerkin approximation; finite element discretization; comparison with direct stiffness method; stress computation, convergence requirements; practical implications of convergence analysis; higher order discretization; bending problem.
2. FEM for Elasticity: review of 2D and 3D elasticity; principle of virtual work; finite element discretization in 2D; continuity, compatibility and completeness in 2D; constant strain triangle and associated problems; bilinear rectangle and shear locking; stiffness matrices and consistent load vectors; stiffening effect of approximation; quadratic triangles; quadratic rectangles; stress calculation; 3D finite elements.
3. Modeling strategies: symmetry, anti-symmetry and asymmetry; static condensation and super elements; penalty method; numerical errors and implications.
4. Isoparametric formulation: bar element; Gauss quadrature; bilinear quadrilateral element; higher order elements; continuity, compatibility and completeness; stress computation; full integration; reduced quadrature and spurious modes; selective reduced integration.