Syllabus: Numerical Methods and Simulation

Semester: SP2025

Course Information

- Course Number and Title: EML 5040.01 Numerical Methods and Simulation
- **Credit Hours:** 3 lecture
- **Academic Term: Spring 2025**

Instructor Information

- **Instructor:** Dr. Navindra Wijeyeratne
- **Office Location: B**ARC1174
- **Office Hours**: M/W/F 9:50 PAM– 10:50 PM,
- **Other Ways to Contact**: nwijeyeratne@floridapoly.edu,

Course Details

- **Class Schedule and Location**: M/W/F, 1:00-1:50 PM, BARC 1159
- **Delivery Mode**: This is an in-person course and students are expected to participate in class meetings in person.
- **Official Catalog Course Description**:
  This course will introduce basic numerical analysis techniques with MATLAB and simulation software, which are used to solve engineering problems. It will cover a range of numerical analysis techniques related to system of equations, curve-fitting, interpolation, numerical integration and differentiation, and ordinary and partial differential equations. Students will learn how to apply Finite Element Analysis and Computational Fluid Dynamics to simulate case studies with real-world applications using computational tools such as ANSYS, COMSOL, and other commercial software.
  Students will gain hands-on experience using programs for solution of problems in stress analysis, heat transfer, strength of materials, fluid mechanics, bio-engineering, and other areas in mechanical engineering.
    - **Course Pre and/or Co-Requisites**: EGN 5471 Advanced Engineering Mathematics, COP 5090 Scientific Computation and Programming
    - **Communication/Computation Skills Requirement (6A-10.030)**: No
    - **Required Texts**: Title: Finite Element Procedures - Second Edition, Author: Klaus-Jürgen Bathe, ISBN#: 978-0979004957
    - **Equipment and Materials**: Canvas, PC/tablet with internet, Microsoft Office, MATLAB, Ansys
- **Course Objectives**:
  - Students will learn various numerical techniques for system of equations, optimization, data modeling, differentiation and integration, and differential equations. Also, students will learn numerical approaches for solving the governing differential equations in static and dynamic systems. They will learn the basics of discretization scheme, meshing, convergence, and stability. Students will learn to analyze and optimize mechanical systems using finite element method in ANSYS. They will be exposed to advanced numerical methods for computing stresses and strains to ensure that the mechanical systems can function safely.
- **Course Learning Outcomes**:

1. **Understand Fundamental Concepts:**
   - Comprehend the role of physical problems, mathematical models, and numerical solutions in engineering analysis.
   - Develop an understanding of vectors, matrices, and tensors as foundational tools in numerical methods.
2. **Apply Engineering Analysis Techniques:**
   - Demonstrate knowledge of the basic concepts of engineering analysis, including the introduction to and application of the Finite Element Method (FEM).
   - Use computational tools to solve systems of linear and nonlinear algebraic equations.
3. **Formulate Numerical Models:**
   - Learn the formulation of the Finite Element Method for linear analysis in solid and structural mechanics.
   - Build finite element models using commercial Finite Element Analysis (FEA) software.
4. **Solve Engineering Problems Using FEM:**
   - Apply the formulation and calculation of isoparametric finite element matrices to solve engineering problems.

- Use commercial FEA software to solve linear and nonlinear elastic problems, perform modal analysis, and address solid mechanics problems in mechanical systems.

5. **Critical Thinking and Problem Solving:**
   - Analyze engineering problems using numerical techniques, including matrix operations and FEM methodologies.
   - Evaluate the accuracy and efficiency of numerical models through practical assignments and exams.
6. **Integration of Theoretical and Practical Knowledge:**
   - Synthesize theoretical concepts with computational techniques in numerical simulations.
   - Develop proficiency in using commercial FEA software for real-world engineering applications.
7. **Develop Competence in Software Tools:**
   - Gain familiarity with computational tools and techniques for implementing numerical solutions in engineering applications, including solving solid mechanics problems using FEA software.

Alignment with Program Outcomes:

Course Learning Outcome	Program Learning Outcome (ABET, GenEd, Other)
The student will be able to use a computer tool for array calculations and graphics.	ABET 1
The student will be able to use a computer tool for system of linear and nonlinear algebraic equations.	ABET 1
The student will be able to use a computer tool for optimization, curve-fitting, interpolation, differentiation and integration, and ordinary differential equations.	ABET 1
The student will be able to demonstrate an understanding of the steps to convert partial differential equations of fluid systems into a numerical representation.	ABET 1
The student will be able to demonstrate an understanding of finite difference method for solving the Navier-Stokes equation.	ABET 1
The student will be able to use a commercial FEA software to build a finite element model.	ABET 1
The student will be able to use a commercial FEA software to solve linear and nonlinear elastic problems and model analysis for mechanical systems.	ABET 1
The student will be able to use a commercial FEA software to solve solid mechanics problems.	ABET 1
The student will be able to prepare a report based on results obtained from a computational analysis.	ABET 3

Academic Support Resources

(Copy and paste the following)

Academic Support Resources

(Copy and paste the following)

- **Library**: Students can access the Florida Polytechnic University Library through the University website and Canvas, on and off campus. Students may direct questions to library@floridapoly.edu.

- **Peer Learning Strategists(PLS)**: Are specially trained student leaders who help their peers strategize approaches to course content and work through solution methods. PLS work in collaboration with the courses they support so the content and methods are aligned with your instructors' expectations. Students can meet with a PLS in The Learning Center, which is located on the first floor of the Innovation, Science and Technology (IST) building in room 1019.
- **Academic Success Coaches**: All students at Florida Poly are assigned an Academic Success Coach. Your Academic Success Coach can assist you with academic success strategies. Please visit the Student Success Center on the second floor of the IST building to meet with an Academic Success Coach.
- **Writing Center**: Located on the second floor of the IST (2059/2061), the Writing Center helps students to develop their writing and presentation skills. Consultations are available in person and virtually. For more detail, visit floridapoly.edu/writingcenter.

• Civility and Collegiality (optional statement)

- Faculty and students come to the university for the same reason, which is to participate in a highly professional educational environment. To that end, both students and faculty are expected to treat each other with mutual regard and civility. Communication, written, oral and behavioral, between faculty and students must remain respectful. Within and outside of the classroom, students must refrain from derogatory comments toward the faculty member and their fellow students, and faculty as well must refrain from derogatory comments toward their students. Faculty and students should address each other with respect, in accordance with the wishes of the faculty and the students: for example, no one should be addressed by their last name alone.

- Faculty from the outset of a course can and should specify what constitutes activities and behavior that take away from, that diminish, the educational environment. An individual student's distracting behavior impedes the education of fellow students, which itself is a form of disrespect. Civility and collegiality also include respecting each other's time: for example, neither students nor faculty should arrive late to class (unless unforeseen, pressing circumstances prevail); faculty should be present at the posted office hours; and students and faculty should be punctual when meeting times are scheduled. In more general terms, collegiality means respecting the right of both faculty and students to participate fully and fairly in the educational enterprise.

Course Schedule

Week	Topic	Reading/*HW due*
1	Introduction	
	Physical Problems, Mathematical Models, and the Finite Element Solution	
2		
	Vectors, Matrices, and Tensors	*HW*
3		
	Basic Concepts of Engineering Analysis, Introduction to the Finite Element Method	
4		
	Basic Concepts of Engineering Analysis, Introduction to the Finite Element Method	HW/ Exam 1
5		
	Formulation of the Finite Element Method-Linear Analysis in Solid and Structural Mechanics	
6		
	Formulation of the Finite Element Method-Linear Analysis in Solid and Structural Mechanics	*HW*

7	*Formulation of the Finite Element Method-Linear Analysis in Solid and Structural Mechanics*	
8	*Formulation and Calculation of lsoparametric Finite Element Matrices*	HW
9	***SPRING BREAK – NO CLASS***	
10	*Formulation and Calculation of lsoparametric Finite Element Matrices*	*Exam 2*
11	*Solution of Equilibrium Equations in Static Analysis*	*Project Proposal*
12	*Solutionof Equilibrium Equations in Dynamic Analysis*	*HW*
13	*Meshing*	*HW*
14	*Analysis of Solid Mechanics Problems (Ansys*	
15	*Analysis of Dynamic Problems (Ansys)*	
16	*Design optimization*	
		Final Project/Presentation

Course Policies

Attendance

- Attendance at all class meetings is expected. University Policy reads "Students are expected to attend all of their scheduled University classes and to satisfy all academic objectives as defined by the instructor." Attendance in this environment does not, of course, mean actual physical attendance in the classroom, although it may include that.
- Absence does not excuse a student from material covered or any activity done on that day, nor does it extend a deadline.
- Students should inform the instructor as soon as possible if an absence is expected.
- The instructor should be contacted as soon as possible if an absence was due to an unforeseen emergency. Documentation may be required in either case.
- Make-ups are never given for in-class activities. Make-ups are provided for exams only if excused after valid documentation is provided

Late Work/Make-up work

Late Homework: under extreme circumstances, with a prior approval of the instructor, a late submission may be accepted for grading. Make-ups are never given for in-class activities. A missed quiz cannot be made up. Make-ups are provided for exams only if excused after valid documentation is provided.

Grading Scale

Grade	Percentage
A	100 - 93
A-	92 - 90
B+	89 - 86
B	85 - 83
B-	82 - 80
C+	79 - 76
C	75 - 70
D	69 - 60
F	59 - 0

These ranges represent the lowest grade that may be earned for a given score. The instructor reserves the right to adjust grade boundaries downward if needed to properly reflect the class performance and coursework variance (i.e., a percentage of 91 may earn an A instead of an A-). The instructor will strive to clearly inform students of their progress in the class, but final grades cannot be known until all classwork is submitted and graded.

A student who does not demonstrate proficiency on the course learning objectives listed above should not expect to pass the course.

Grades for each assignment will be posted to Canvas and students should make sure they are recorded correctly. However, there is no guarantee that the percentages or projected grades provided there are correct. The instructor will calculate final percentages and will determine final grades regardless of Canvas calculations.

Assignment/Evaluation Methods

- **Evaluation**

Activity	Percentage
HW	10
In Class Assignments	5
Exam 1	20
Exam 2	20
Project Proposal	10
Final Project and Presentation	35

  - Homework must be submitted via Canvas as a PDF file prior to the class meeting at which it is due. It is acceptable (and perhaps preferable) that you work the problems on paper, then use a mobile phone scanner app to turn this into a high-quality PDF file.
  - Quizzes will take place either in class or through Canvas. A missed quiz cannot be made up.
  - Exams are given at the end of each module.
  - Semester grade is given based on the combined score from all three modules weighed equally.
  - A student who does not demonstrate proficiency on the course learning objectives listed above should not expect to pass the course.
  - Grades for each assignment will be posted to Canvas and students should make sure they are recorded correctly. However, there is no guarantee that the percentages or projected grades provided there are correct. The instructor will calculate final percentages and will determine final grades regardless of Canvas calculations.

- **Assignment/Evaluation Methods**:
  - **Homework**
    - Completion of assignments and problems posted on Canvas.
    - Late Homework – Under extreme circumstances, with a prior approval of the instructor, a late submission may be accepted for grading.
  - **Exam**
    - Module exams are given at the end of each module.

Exam Policy: A student missing an exam will be given the opportunity to make up the exam only if he/she presents satisfactory evidence that his/her absence was unavoidable. It is the obligation of the student to notify the instructor prior to the exam or within twenty-four hours of the time of absence, at which time, arrangements will be made for a make-up exam.

Recording grades in Canvas as feedback: Grades for will be posted to Canvas for reference only, and students should make sure they are recorded correctly. However, there is no guarantee that the percentages or projected grades provided there are correct. The instructor will calculate final percentages and will determine final grades regardless of Canvas calculations.
**Changes in syllabus and assignment sheets may be modified as deemed appropriate. All changes will be announced in class and in Canvas Announcements.

University Policies

Reasonable Accommodations

The University is committed to ensuring equal access to all educational opportunities. The Office of Disability Services (ODS), facilitates reasonable accommodations for students with disabilities and documented eligibility. It is the student's responsibility to self-identify as a student with disabilities and register with ODS to request accommodations. If you have already registered with ODS, please ensure that you have requested an accommodation letter for this course through the ODS student portal, and communicate with your instructor about your approved accommodations as soon as possible. Arrangements for testing accommodations must be made in advance. Accommodations are not retroactive. If you are not registered with ODS but believe you have a temporary health condition or permanent disability requiring an accommodation, please contact ODS as soon as possible:

DisabilityServices@floridapoly.edu; (863) 874-8770; www.floridapoly.edy/disability.

Accommodations for Religious Observances, Practices and Beliefs
The University will reasonably accommodate the religious observances, practices, and beliefs of individuals in regard to admissions, class attendance, and the scheduling of examinations and work assignments. (See University Policy.)

Title IX
Florida Polytechnic University is committed to ensuring a safe, productive learning environment on our campus that prohibits sex discrimination and sexual misconduct, including sexual harassment, sexual assault, dating violence, domestic violence and stalking. Resources are available if you or someone you know needs assistance. Any faculty or staff member you speak to is required to report the incident to the Title IX Coordinator. Please know, however, that your information will be kept private to the greatest extent possible. You will not be required to share your experience. If you want to speak to someone who is permitted to keep your disclosure confidential, please seek assistance from the Florida Polytechnic University Ombuds Office, BayCare's Student Assistance Program, 1-800-878-5470 and locally within the community at Peace River Center, 863-413-2707 (24-hour hotline) or 863-413-2708 to schedule an appointment. The Title IX Coordinator is available for any questions to discuss resources and options available.

Academic Integrity
Violations of academic integrity regulation include actions such as cheating, plagiarism, use of unauthorized resources (including but not limited to use of Artificial Intelligence tools), illegal use of intellectual property, and inappropriately aiding other students. Such actions undermine the central mission of the university and negatively impact the value of your Florida Poly degree. Suspected violations will be fully investigated, possibly resulting in sanctions up to and including expulsion from the university.

Recording Lectures
Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use. Recordings may not be used as a substitute for class participation or class attendance. Recordings may not be published or shared in any way, either intentionally or accidentally, without the written consent of the faculty member. Failure to adhere to these requirements is a violation of state law (subject to civil penalty) and the student code of conduct (subject to disciplinary action). *Recording class activities including, but not limited to, lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), and invited guest speakers is* ***prohibited****.*

Academic Support Resources

- **Library**: Students can access the Florida Polytechnic University Library through the University website and Canvas, on and off campus. Students may direct questions to library@floridapoly.edu.
- **Tutoring and Learning Center**: The Tutoring and Learning Center (The TLC) provides tutoring to all Florida Poly students who may need additional academic support. The TLC is staffed by students who have excelled in the courses they tutor. They offer support by reviewing concepts and materials from class, clarifying points of confusion and providing assistance with learning strategies. While the focus of TLC is to provide support to students in freshman-level courses, upper-level courses are also tutored at the Center. The TLC is located in the IST Commons (second floor).
    - **Knack Tutoring**: Students looking for additional assistance outside of the classroom are advised to consider working with a peer tutor through Knack. Florida Polytechnic University has partnered with Knack to provide students with access to verified peer tutors who have previously aced this course. To view available tutors, visit floridapoly.joinknack.com and sign in with your student account.

- **Academic Success Coaches**: All students at Florida Poly are assigned an Academic Success Coach. Your Academic Success Coach can assist you with academic success strategies. Please visit the Student Success Center on the second floor of the IST building to meet with an Academic Success Coach.
- **Writing Center**: Located on the second floor of the IST (2059/2061), the Writing Center helps students to develop their writing and presentation skills. Consultations are available in person and virtually. For more detail, visit floridapoly.edu/writing center.