EAS439 Numerical Analysis

Level: 4
Credit Units: 5 Credit Units
Language: ENGLISH
Presentation Pattern: EVERY JAN

Synopsis:

EAS439 Numerical Analysis introduces students to fundamental concepts, programming skills, and software applications of numerical analysis for solving aerospace engineering problems. The first part of the course prepares students with pre-requisite knowledge and programming skills. Fundamental concepts of linear algebra are introduced to pave the foundation. A short introduction to computer programming for numerical analysis is presented to equip students with the necessary skills for algorithm implementation. The second part of the course covers fundamental numerical methods. Topics covered include approximations and the Taylor series, numerical error analysis, numerical solution of linear systems of algebraic equations, numerical solution of nonlinear algebraic equations, regression and interpolation techniques, numerical differentiation and integration, as well as the numerical solution of boundary-value problems. This part includes laboratory tutorials for programming implementation of numerical algorithms. The third part of the course introduces numerical simulation techniques for two types of engineering problems in aerospace engineering, i.e., structural analysis and computational fluid dynamics. The finite Difference Method (FDM) is introduced in the context of model equations in fluid mechanics and thermodynamics. The finite Element Method (FEM) is introduced with the formulations of bar element, beam element, and plane stress element. Laboratory tutorials are conducted for hands-on training of solving practical engineering problems using simulation software.

Topics:

- Fundamental concepts in linear algebra
- Introduction to computer programming for numerical analysis
- Approximations, the Taylor series, and numerical error analysis
- Numerical solutions of linear system of algebraic equations
- Numerical solutions of a nonlinear algebraic equation
- Least-squares regression and interpolation for curve fitting
- Numerical integration
- Numerical differentiation
- Numerical solutions of boundary-value problems
- Laboratory tutorials of programming numerical algorithms
- Finite difference method (FDM) and fundamentals of computational fluid dynamics (CFD)
- Fundamentals of finite element method (FEM) for structural analysis
- Laboratory tutorials of numerical simulation of aerospace engineering problems

Textbooks:

Computational Fluid Dynamics 3rd Butterworth-Heinemann
ISBN-13: 9780081011270

Numerical Methods For Engineers 8th Steven Chapra and Raymond Canale McGraw-Hill
ISBN-13: 9781260571387

Learning Outcome:

- Calculate approximate solutions to mathematical problems using fundamental numerical algorithms.
- Analyse a numerical algorithm’s accuracy, efficiency and convergence properties.
- Design programming implementations for fundamental numerical algorithms.
- Formulate numerical discretization procedures using finite element method or finite difference method.
- Compose efficient, well-documented code and present numerical results in an informative way.
- Compute using simulation software for numerical analysis of aerospace engineering problems.
- Appraise Verification and Validation (V&V) of engineering numerical simulations.

Assessment Strategies - Regular Semester (Evening Class):

Components	**Description**	**Weightage Allocation (%)**
Overall Continuous Assessment	QUIZ 1	6
	TUTOR-MARKED ASSIGNMENT 1	12
	LAB REPORT 1	12
Overall Examinable Components	Written Exam	70
Total		**100**

*The information listed is subject to review and change.