Math 505 – Numerical Methods in Differential Equations
Course Syllabus

Course description: Numerical integration, numerical solutions of initial value problems, numerical solutions of boundary value problems.

Credit hours: 3

Course Prerequisites and Corequisites: MTH 305 and 337

Course outline:	**Approximate time spent**
• **Mathematical Preliminaries**	5%
○ Review of Calculus	
○ Round off Errors and Computer Arithmetic	
○ Algorithms and Convergence	
• **Interpolation and Polynomial Approximation**	20%
○ Interpolation and the Lagrange Polynomial	
○ Divided Differences	
○ Hermite Interpolation (Optional)	
○ Cubic Spline Interpolation	
• **Initial Value Problems for Ordinary Differential Equations**	25%
○ The Elementary Theory of Initial Value Problems	
○ Euler's Method	
○ Higher Order Taylor Methods	
○ Runge-Kutta Methods	
○ Error Control and the Runge-Kutta-Fehlberg Method	
○ Multistep Methods (Optional)	
○ Variable Step-Size Multistep Methods (Optional)	
○ Extrapolation Methods (Optional)	
○ Higher-Order Equations and Systems of Differential Equations	
○ Stability	
○ Stiff Differential Equations	
• **Boundary Value Problems for Ordinary Differential Equations**	25%
○ The Linear Shooting Method	
○ The Shooting Method for Nonlinear Problems	
○ Finite-Difference Methods for Linear and Nonlinear Problems	
○ The Rayleigh-Ritz Method	
• **Numerical Solutions to Partial Differential Equations**	25%
○ Elliptic Partial Differential Equations	
○ Parabolic Partial Differential Equations	
○ Hyperbolic Partial Differential Equations	
○ An Introduction to the Finite-Element Method	

Student Learning Outcomes (SLO): At the end of MTH 505, a student who has studied and learned the material should be able to:

1. Work basic problems that make use of ideas covered in the course. [PLO: 2, 4]
2. Define all of the basic terms introduced in the course. [PLO: 1, 3]
3. Provide proofs of important theorems that were discussed in class. [PLO: 1, 3]
4. Write up their solutions of numerical approximations to IVPs and BVPs making use of good language skills. [PLO: 4, 5]
5. Present their solutions to problems they have solved to their classmates. [PLO: 3, 4, 5]

Program Learning Outcomes (PLO):

Students graduating from SFASU with a M.S. degree and a major in mathematics will:

1. **[*Critical Reasoning*]** Independently apply the principles of logic in mathematics to develop and analyze conjectures and proofs. (understanding of abstract structures, development of definitions, development and proof of conjectures)
2. **[*Skills*]** Execute advanced mathematical procedures and build upon these standard procedures. (learning of new skills, applying or extending skills in new situations)
3. **[*Concepts*]** Demonstrate knowledge of core mathematical concepts. (definitions and theorems in analysis, definitions and theorems in linear or abstract algebra, definitions and theorems in theoretical statistics)
4. **[*Problem Solving*]** Demonstrate initiative in using various mathematical tools, including technology, to formulate, represent, and solve problems. (implement algorithms or definitions, discuss algorithmic proficiency, find numerical approximations)
5. **[*Communication*]** Demonstrate proficiency in communicating mathematics in a format appropriate to expected audiences. (written, visual, oral)