Course Title:	**CS-834, Scientific Computing**
Credit Hours:	3+0
Pre-requisites:	▪ Numerical Analysis ▪ Linear Algebra ▪ Calculus
Course Description:	Now a day's analytical solution to mathematical problems cannot be solved analytically. It is common to approximate mathematical solution using numerical methods. The goal of this course is to enable student to implement them. The course provides an overview of some of the essential numerical techniques, which are commonly, used in the scientific enterprise. This course covers topics ranging from basic mathematical principles and algorithms of numerical analysis to practical issues ranging from software reliability to performance on modern computing hardware.
Tools and Technologies:	▪ MATLAB ▪ C/C++ ▪ OpenFOAM and Sofia
Learning Outcomes:	On successful completion of this course students will be able to: 1. In general terms explain the ideas behind the numerical method that are presented in the course; 2. Evaluate methods with respect to accuracy, stability properties and efficiency; 3. Given a mathematical model, solve problems in science and engineering by structuring the problem, choose appropriate numerical method and generate solution using software and by writing programming code; 4. Identify and solve different type of PDEs 5. Use computational software and write minor programs using that software;
Tentative MS	▪ Large problem solving using high performance computing

<table>
<tr><td>Thesis:</td><td>Solve electromagnetic, fluid dynamics problems.
Numerical simulation of fluid dynamics
Implementation of numerical methods</td></tr>
<tr><td>Text Books:</td><td>E. Ward Cheney, David R. Kincaid (2008): Numerical Mathematics and Computing, sixth edition.</td></tr>
<tr><td>Reference Books:</td><td>Lennard Edsberg (2008): Introduction to Computation and Modeling for Differential Equations
Michael T. Heath (2001): Scientific Computing: An introductory survey , McGraw-Hill Scientific Engineering
Computational Science and Engineering, By G. Strang, Wellesley-Cambridge, 2007</td></tr>
<tr><td>Course Contents:</td><td>Computer representation of numbers
Binary numbers, floating point format
Finite precision, round-off, machine epsilon
Error propagation and catastrophic cancellation
Basic numerical analysis.
Taylor series as asymptotic expansions.
Asymptotic error expansions, error analysis and order of accuracy.
Extrapolation and interpolation techniques
Methods for integration on a uniform mesh: rectangle rule, trapezoid rule, midpoint rule, Simpson's rule.
Convergence study as a correctness check.
Numerical Linear Algebra.
Review of linear algebra, vector and matrix norms.
Condition number of a system of linear equations, condition number of a matrix.
Improving condition number: scaling and balancing
The LU factorization and its use for systems of linear equations.
Computing the factors by Gauss elimination.</td></tr>
</table>

	- Pivoting. - The Choleski factorization. - Band matrices. ▪ Time stepping methods for dynamical systems (ODE's). ▪ Partial differential equation - Elliptic equation - Parabolic equation - Hyperbolic equation ▪ Nonlinear equations and optimization, Newton's method. ▪ Principles of numerical software, performance and reliability - Software tools: debuggers, memory leaks, performance tools. - Understanding the hardware: prefetch, pipelining, cache. - Coding for performance. - Using open-source modeling software.