**Approval: 5th Senate Meeting**

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| Course Name | : Numerical Linear Algebra |
| Course Number | : MA-709 |
| Credits | : 2-0-2-3 (L-T-P-C) |
| Prerequisites | : MA-607 or equivalent, MA-609 or equivalent and IC-111 or equivalent. |
| Intended for | : M.S./Ph.D. |
| Distribution | : Elective |
| Semester | : Even/Odd |

**Preamble:** Problems in linear algebra arise in a wide variety of scientific and engineering applications including the design of structures, the analysis of electrical networks, and the modeling of chemical processes. This perhaps is the reason that Numerical linear algebra is in greatest need, when working with discredited partial differential equations and with network problems. This course is a continuation of "MA-607: Numerical Analysis" and "MA:-609: Numeric's of partial differential Equations". Basically, in this course, student will learn how to solve system of linear equations (AX = B) through advance Matrix operations using efficient Numerical Algorithms. Students have learned about Numerical Analysis in MA-607 and about the numerical discretization of Partial Differential equations arising from different real-life problems in MA-609. Now through this course they will learn how to solve this algebraic system of equations (AX=B) using advance matrix algorithms.

**Course Outline:** This course will cover the analysis and implementation of algorithms used to solve linear algebra problems in practice.This course will also describe how actual matrices and vectors can be handled in a stable, fast, and accurate manner. The motivation of the course is to emphasize some important computational aspects (through Computer Lab classes) of matrix theory which are often neglected by linear algebra courses at all levels, and yet which (in the real world) comprise the essence of the subject. At the end of this course students will be able to understand and apply the ideas and algorithms of numerical linear algebra.

**Modules:**

Unit 1: Fundamentals - Overview of matrix computations, norms of vectors and matrices, stability and ill-conditioning, Condition number of a matrix and its applications. [Number of total classes including Lab class: 6]

Unit 2: Systems of Linear Equations – Gaussian eliminations with and without Pivoting, Gauss-Seidel, Successive-over-relaxation methods, LU factorization, Cholesky factorization, stability and sensitivity analysis. [Number of total classes including Lab class: 9]

Unit 3: Eigen value Problem - Properties of the eigen decomposition, Power's Method, The LR and QR algorithms, Rayleigh quotient iteration, inverse iteration. [Number of total classes including Lab class: 10]

Unit 4: Eigen values of Symmetric Matrices - Orthogonal Matrices, Jacobi Method, Givens Method, Gram-Schmidt Process, Householder Method. [Number of total classes including Lab class: 9]

Unit 5: Singular Value Decomposition-Properties of the singular value decomposition, Methods for the singular value decomposition. [Number of total classes including Lab class: 8]

Lab Class (2 hours): Each week the lab class will flow the corresponding lecture classes of that week.

**Textbooks:**

1. David S. Watkins, Fundamentals of Matrix Computations, 2nd ed. John Wiley & Sons, 2002.
2. L. N. Trefethen and David Bau, Numerical Linear Algebra, SIAM, 1997.
3. C. T. Kelly, Iterative Methods for Linear and Nonlinear Equations, SIAM, Philadelphia, 1995.

**References:**


1. G. H. Golub and C.F.Van Loan, Matrix Computation,3rd Edn., Hindustan book agency, 2007.
2. B. N. Datta, Numerical Linear Algebra and Applications, 2nd Edn., SIAM, 2010.
3. O. Axelsson, Iterative Solution Methods, Cambridge University Press, 1994.
4. D. J. Higham and N.J. Higham, Matlab Guide, SIAM, (recommended as a Matlab reference).