

Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): MATH3830 NUMERICAL LINEAR ALGEBRA (3,3,0)

Course Aims: This course aims to provide a thorough discussion of the advanced topics and state of art development in numerical linear algebra. This subject emphasizes on both the theoretical analysis and the computer applications of numerical linear algebra in various areas.

Prerequisite: MATH1120 Linear Algebra, MATH2140 Numerical Methods I

Prepared by: Michael Ng

Learning Outcomes (LOs):

Upon successful completion of this course, students should be:

No.	Learning Outcomes (LOs)
	Knowledge
1	Able to understand the basic theory and techniques in numerical linear algebra
2	Able to understand the algorithms for matrix factorizations
3	Able to understand the algorithms for solving systems of linear equations (direct and iterative methods)
4	Able to understand the algorithms for solving linear least squares problems
5	Able to understand the algorithms for solving eigenvalue problems and singular value problems
	Skill
6	Able to manipulate the matrix computation software (e.g. Matlab)
7	Able to implement basic numerical linear algebra programs
8	Able to design and implement efficient solvers for systems of linear equations, linear least squares problems and eigenvalue problems
	Attitude
9	Able to solve problems independently

Assessment:

No.	Assessment Methods	Weighting	Remarks
1	Continuous Assessment (assignments, test, and mini-project)	40%	Continuous Assessment is designed to measure students understanding of the theory and techniques in numerical linear algebra. Continuous assessment is to measure students' skills in solving numerical linear algebra problems using the matrix computation software (e.g. Matlab).
2	Final Examination	60%	Final Examination is designed to see how far students have achieved their intended learning outcomes especially in the Knowledge domain. Students should have a thorough understanding of the knowledge and apply them correctly in different context to do well in the exam.

Learning Outcomes and Weighting:

Content	LO No.	Teaching (in hours)
I. Conditioning, Stability and Efficiency	1,5	4
II. Matrix Factorizations	2,6,7,8,9	7
III. Solving Systems of Equations (Direct and Iterative Methods)	3,6,7,8,9	14
IV. Solving Linear Least Squares Problems	4,6,7,8,9	5
V. Solving Eigenvalue and Singular Value Problems	5,6,7,8,9	10

- References:**
- L.N. Trefethen and D. Bau III, Numerical Linear Algebra, SIAM, 1997.
 - G. Golub and C. Van Loan, Matrix Computation, 3rd Ed., Johns Hopkins University Press, 1996.
 - J.W. Demmel, Applied Numerical Linear Algebra, SIAM, 1997.
 - N.J. Higham, Accuracy and Stability of Numerical Algorithms, SIAM, 1996.
 - P.E. Gill, W. Murray and M.H. Wright, Numerical Linear Algebra and Optimization, Vol. 1, Addison-Wesley, 1991.
 - W. Hager, Applied Numerical Linear Algebra, Prentice Hall, 1988.

Software: Matlab and other related matrix computation software

Course Content in Outline:

<u>Topic</u>	<u>Hours</u>
I. Fundamentals	4
A. Vector Space and Matrix, Norms	
B. Eigenvalues and Jordan Canonical Form	
C. Singular Value Decomposition	
D. Conditioning and Stability	
II. Matrix Factorization	7
A. Projectors	
B. QR Factorization and Gram-Schmidt Orthogonalization	
C. Householder Triangularization	
D. LU Factorization and Cholesky Factorization	
III. Systems of Equations	14
A. Gaussian Elimination	
B. Pivoting	
C. Stability Analysis	
D. Iterative Methods	
E. Preconditioning	
IV. Least Squares Problems	5
A. Applications	
B. Overdetermined Least Squares Problems	
C. Underdetermined Least Squares Problems	
V. Eigenvalues	10
A. Supplementary Knowledge of Eigenvalues Problem	
B. Reduction to Hessenberg or Tridiagonal Form	
C. Rayleigh Quotient, Inverse Iteration	
D. QR Algorithm	
E. Computing the SVD	