

**Hong Kong Baptist University**  
**Faculty of Science**  
**Department of Mathematics**

**Title (Units):** MATH 2140 NUMERICAL METHODS I (3,3,0)

**Course Aims:** This course provides students with the ideas underlying commonly used numerical methods. It teaches students how to choose an appropriate numerical method for a particular problem and to interpret the resulting output. It also highlights important considerations on convergence and stability for numerical algorithm design.

**Prerequisite:** Year 2 standing

**Prepared by:** Prof. TANG Tao

**Learning Outcomes (LOs):**

Upon successful completion of this course, students should be:

No.	Learning Outcomes (LOs)
	<b>Knowledge</b>
1	Able to understand the computational errors and numerical stability
2	Able to apply the basic numerical methods to the solution of single nonlinear equations
3	Able to apply the basic numerical methods of interpolation
4	Able to apply the basic numerical methods of integration
5	Able to apply the basic numerical methods to the solution of linear systems of equations
	<b>Skills</b>
6	Able to select an appropriate numerical method for a particular problem of interpolation, integration, as well as for solving single nonlinear equations and linear systems of equations
7	Able to manipulate the software MATLAB and design MATLAB programs for application of basic numerical methods
8	Able to perform analysis on convergence and/or stability of basic numerical methods
	<b>Attitude</b>
9	Able to solve problems independently

**Assessment:**

No.	Assessment Methods	Weighting	Remarks
1	Continuous Assessment (assignments, test, and mini-project)	40%	A 1-hour mid-term test and continuous assignments are designed to assess how well the students can apply the basic numerical methods and perform the error analysis accordingly, as well as use the software MATLAB for applications of numerical methods.
2	Final Examination	60%	Final Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be skills and analysis based to assess the student's ability of (i) properly using numerical methods for interpolation, integration, as well as for solving single nonlinear equations and linear systems of equations; and (ii) performing error analysis accordingly.

**Learning Outcomes and Weighting:**

Contents		LO No.	Teaching (in hours)
I	Introduction to Numerical Methods	1,7,8,9	4
II	Solution of a Single Nonlinear Equation	2,6,7,8,9	6
III	Interpolation	3,6,7,8,9	8
IV	Numerical Integration	4,6,7,8,9	7
V	Linear Systems of Equations	5,6,7,8,9	8
VI	Linear Least-Squares Data Fitting	5,6,7,8,9	6

**Textbook:** R.L. Burden, J.D. Faires, Numerical Analysis, 8th edition, Thomson Brooks/Cole, 2005.

**References:** L. Fausett, Applied Numerical Analysis Using MATLAB (2<sup>nd</sup> Ed.), Pearson, 2007.

K. Atkinson, W. Han, Elementary Numerical Analysis (3<sup>rd</sup> Ed.), John Wiley, 2003

**Software:** MATLAB

**Course Content in Outline:**

	<u>Topics</u>	<u>Hours</u>
I.	Introduction A. Computer arithmetic B. Computational errors, Convergence, and stability C. Introduction to Matlab	4
II.	Solution of a Single Nonlinear Equation A. Bisection method, fixed-point method B. Newton's method, secant method C. Convergence analysis	6
III.	Interpolation A. Lagrange interpolation B. Hermite interpolation C. Splines	8
IV.	Numerical Integration A. Trapezoidal rule, Simpson's rule B. Newton-Cotes formulas C. Composite numerical integration D. Romberg method	7
V.	Linear Systems of Equations A. Gaussian elimination, pivoting and scaling B. Variants of Gaussian elimination C. Error analysis, condition number D. Iterative methods	8
VI.	Linear Least-Squares Data Fitting A. Normal equation B. Gram-Schmidt orthogonal process C. Householder transformation	6