Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): **MATH 3620 NUMERICAL METHODS II (3,3,0)**

Course Aims: As a continuation of Numerical Methods I, this course covers techniques for numerical solution of mathematical problems. Students are introduced to widely-used computer software packages. At the same time the underlying ideas of algorithms are taught.

Prerequisite: MATH2140 Numerical Methods I

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Learning Outcomes (LOs):

Upon successful completion of this course, students should be:

No.	Learning Outcomes (LOs)
	Knowledge
1	Able to explain the concepts, theories and techniques of numerical methods
2	Able to develop the concepts of Fast Fourier Transform
3	Able to identify nonlinear systems equations and their corresponding solution methods
4	Able to develop the concepts of optimization
5	Able to identify initial value problems for ordinary differential equations and possible numerical approaches
6	Able to identify boundary value problems for ordinary differential equations and possible numerical approaches
	Skills
7	Able to select the appropriate numerical method to solve ordinary differential equations
8	Able to manipulate computing software, such as MATLAB, as tools in solving and analyzing solutions of problems
9	Able to show logical thinking in coding a mathematical problem in algorithmic form
	Attitude
10	Able to aware of the limitation and difficulties that may occur when solving mathematical problems numerically

Assessment:

No.	Assessment Methods	Weighting	Remarks
1	Continuous Assessment	30%	Continuous assessment is designed to measure how well the students have learned the numerical methods, algorithms and their underlying ideas.
2	Final Examination	70%	Final Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be understanding and skills based to assess the student's versatility in numerical methods.

Learning Outcomes and Weighting:

Content	LO No.	Teaching (in hours)
I. Fast Fourier Transform	1, 2, 8 - 10	7
II. Solution of Nonlinear Systems Equations	1, 3, 8 - 10	7
III. Optimization	1, 4, 8 - 10	9
IV. Initial Value Problems for Ordinary Differential Equations	1, 5, 7 - 10	10
V. Boundary Value Problems for Ordinary Differential Equations	1, 6, 7 - 10	6

Textbook: R.J. Burden and J.D. Faires, Numerical Analysis, 5th edition, PWS-Kent Publishing Company, 1993.

References: G. Lindfield and J. Penny, *Numerical Methods Using MATLAB*, Ellis Horwood Limited, 1995.
C.F. Gerald, Applied numerical analysis, 5th Ed. Addison-Wesley, 1994.
K.E. Atkinson, An Introduction to Numerical Analysis, 2nd Ed., John Wiley, 1988.
D. Kahaner, C. Moler and S. Nash, Numerical Methods and Software, Prentice-Hall, 1989.

Software: MATLAB

Course Content in Outline:

	Topic	Hours
I.	Fast Fourier Transform	7
	A. Discrete least-square approximation	
	B. Trigonometric polynomial approximation	
	C. FFT algorithm	
II.	Solution of Nonlinear Systems Equations	7
	A. Fixed points for functions of several variables	
	B. Newton's method	
	C. Quasi-Newton methods	
III.	Optimization	9
	A. Search methods for functions of one variable	
	B. Direct search methods for functions of n variables	
	C. Gradient methods	
	D. Constrained optimization	
IV.	Initial Value Problems for Ordinary Differential Equations	10
	A. Euler's method, Trapezoidal method	
	B. Multi-step methods	
	C. Runge-Kutta methods	
	D. Stability analysis	
	E. Stiff differential equations	
V.	Boundary Value Problems for Ordinary Differential Equations	6
	A. Shooting method	
	B. Finite-Difference method	
	C. Ritz-Galerkin method	