Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): MATH2110 DIFFERENTIAL EQUATIONS (3,2,1)

Course Aims: This course aims to introduce students to the basic theory of ordinary differential equations and the modelling of diverse practical phenomena by ordinary differential equations by a variety of examples. Students will learn both quantitative and qualitative methods for solving these equations. Topics include first and second order differential equations, linear systems of first order differential equations, autonomous systems of differential equations, existence and uniqueness theorem and Laplace transform to initial value problem.

Prerequisite: MATH1111 Mathematical Analysis I, MATH1112 Mathematical Analysis II, MATH1120 Linear Algebra

Prepared by: S.L. Fung

Learning Outcomes (LOs):
Upon successful completion of this course, students should be:

No.	Learning Outcomes (LOs)
	Knowledge
1	Able to understand the basic techniques in solving first and second order differential equations
2	Able to understand the basic techniques in solving linear systems of first order differential equations
3	Able to understand the concept of the existence and uniqueness theorem
4	Able to understand the concept and the application of Laplace transform to IVP
5	Able to understand several solution methods, including separable equations, exact equations, method of undetermined coefficients, method of variation parameters and reduction of order
6	Able to understand the basic techniques in solving nonlinear autonomous systems of differential equations
	Skills
7	Able to apply the existence and uniqueness theory to the initial value problem
8	Able to apply various solution methods to differential equations
9	Able to apply Laplace transforms to initial value function
10	Able to model various real life problems
	Attitude
11	Aware of the importance of differential equations and its applications in some real-life applications

Assessment:

No.	Assessment Methods	Weighting	Remarks
1	Two 1-hour Tests and Continuous Assessment	30%	Two 1-hour Tests and Continuous Assessment are designed to measure how well the students have learned the basic concepts and fundamental theory of differential equations.
2	Final Examination	70%	Final Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be analysis and skills based to assess the student's versatility in solving problems in first and second order differential equations, linear systems of first order differential equations and nonlinear autonomous systems of differential equations.

Learning Outcomes and Weighting:

Content	LO No.	Teaching (in hours)
I. Introduction-Formulation and Classification of Differential Equations	1,10	1
II. First Order Differential Equations and Its Applications	1,3,5,7,8,10,11	9
III. Second Order Differential Equations and Its Applications	1,4,5,7-11	14
IV. Linear Systems of Differential Equations	2,5,7,8	8
V. Nonlinear Autonomous Systems of Differential Equations	6,7	8

Textbook: Boyce and DiPrima, Elementary Differential Equations and Boundary Value Problems, 5th edition, John Wiley & Sons, 1992.

References:

R.L. Borelli and C.S. Coleman, Differential Equations: A Modeling Approach, 1987.

M. Braun, Differential Equations and Their Applications: An Introduction to Applied Mathematics, 4th edition, Springer-Verlag, 1993.

D.N. Burghes & M.S. Borrie, Modelling with Differential Equations, Ellis Horwood, 1982.

E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Krieger Publication, 1985.

W.F. Lucas, ed., Modules in Applied Mathematics, Volume I: Differential Equation Models, Springer-Verlag, 1983.

J.L. Van Iwaarden, Ordinary Differential Equations with Numerical Techniques, Harcourt Brace Jovanovich, 1985.

R.C. Gonzalez and R.E. Woods, Digital Image Processing, 2nd Ed., Prentice Hall, 2002.

Course Content in Outline:

Topic	Hours
I. Introduction - Formulation and Classification of Differential Equations	1
II. First Order Differential Equations and Its Applications A. Solution methods for equations which are 1. Integrating 2. Separable 3. Exact 4. Picard iteration B. Introduction to existence and uniqueness theory C. Examples such as 1. Falling object 2. Mixing and chemical reactions 3. Escape velocity	9
III. Second Order Differential Equations and Its Applications A. Solution methods for equations which are 1. Constant coefficient equations 2. Undetermined coefficient 3. Variation of parameters 4. Reduction of order 5. Laplace transforms B. Examples such as 1. Mechanical oscillations 2. Electrical circuits	14
VI. Linear Systems of Differential Equations Solution methods for equations which are 1. Eigenvalues and eigenvectors 2. Fundamental matrices 3. Undetermined coefficients 3. Variation of parameters	8
V. Nonlinear Autonomous Systems of Differential Equations Solution methods 1. The phase plane 2. The concept of stability 3. Almost linear system	8