Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): **MATH 3405 Ordinary Differential Equations (3,3,0)**

Course Aims: This course aims to introduce students to the basic theory of linear ordinary differential equations (ODE) with constant and variable coefficients and the modeling of diverse practical phenomena by ODE. Students will learn both quantitative and qualitative methods for solving these equations. Topics include first and second order scalar ODE, systems of first order ODE, autonomous systems of ODE, existence and uniqueness theorem, Laplace transform for initial value problems, and nonlinear differential equations.

Prerequisite: MATH2215 Mathematical Analysis or MATH2217 Advanced Calculus II and MATH2207 Linear Algebra

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Course Intended Learning Outcomes (CILOs):

Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
1	Describe the underlying theory (including existence and uniqueness) of both scalar and system of linear ODE and autonomous systems of nonlinear ODE and solve the differential equations with classical solution techniques.
2	Apply classical numerical methods for solving ODE.
3	Model certain real-life problems mathematically into system of ODE and apply classical solution techniques to find their solutions.
4	Articulate the importance of differential equations and its applications in real-life applications.

Teaching & Learning Activities (TLAs)

CILO	TLAs will include the following:
1,2,3	**Lecture** Instructor will introduce the topics of the course's materials in the lectures and ample of examples will be given in order to aid the learning of the topics. Students will consolidate the knowledge through discussion within lectures/tutorials.
1,2,3	**Assignments** Instructor will give assignments.

Assessment:

No.	Assessment Methods	Weighting	CILO Address	Remarks
1	Two 1-hour Tests and Continuous Assessment	30%	1,2,3	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 (2 Hours)	70%	1,2,3	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

No.	Assessment Methods	Weighting	CILO Address	Remarks
				equations, linear systems of first order differential equations and nonlinear autonomous systems of differential equations.

Course Intended Learning Outcomes and Weighting:

Content	CILO No.	Teaching (in hours)
I. Introduction	1	2
II. First Order Differential Equations	1,3,4	9
III. Systems of First Order Linear Differential Equations	1,3,4	9
IV. Linear Differential Equations	1,3,4	4
V. Existence, Uniqueness, and Dependence on Parameters	1,3,4	9
VI. Laplace Transforms for Initial Value Problems	1,2,3,4	3
VII. Nonlinear Autonomous Systems of Differential Equations	1,3,4	4

Textbook

1. Boyce and DiPrima, Elementary Differential Equations and Boundary Value Problem, 5th edition, John Wiley & Sons, 1992.

References

1. R.L. Borelli and C.S. Coleman, Differential Equations: A Modeling Approach, 987.
2. M. Braun, Differential Equations and Their Applications: An Introduction to Applied Mathematics, 4th edition, Springer-Verlag, 1993.
3. D.N. Burghes and M.S. Borrie, Modeling with Differential Equations, Ellis Horwood, 1982.
4. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Krieger Publication, 1985.
5. W.F. Lucas, ed., Modules in Applied Mathematics, Volume I: Differential Equation Models, Springer-Verlag, 1983.
6. J.L. Van Iwaarden, Ordinary Differential Equations with Numerical Techniques, Harcourt Brace Jovanovich, 1985.
7. R.C. Gonzalez and R.E. Woods, Digital Image Processing, 2nd Ed., Prentice Hall, 2002.
8. R.L. Burden and J.D. Faires, Numerical Analysis, 8th edition, Brooks/Cole, 2005.

Course Contents in Outline:

	Topics	Hours
I	Introduction	2
	A Formulation and Classification of Differential Equations	
II	First Order Differential Equations	9
	A Linear equations and method of integrating factors	
	B Separable equations	
	C Exact equations and integrating factors	
	D Existence and uniqueness theorem	
III	Systems of First Order Linear Differential Equations	9
	A Existence and uniqueness theorem	

	Topics	Hours
	B Fundamental matrices and matrix potential	
	C Homogeneous linear system with constant coefficients	
	D Methods of undetermined coefficients	
	E Variation of parameters	
IV	Linear Differential Equations	4
	A Solutions of linear homogeneous and non-homogeneous equations	
	B The Wronskian	
	C Method of Undetermined coefficient	
	D Variation of Parameters	
	E Reduction of Order	
V	Existence, Uniqueness, and Dependence on Parameters	9
	A Existence theorem (Cauchy-Peano)	
	B Continuation of solutions	
	C Uniqueness	
	D Dependence on initial data and parameters	
	E Variation of parameters	
VI	Laplace Transforms for Initial Value Problems	3
	A Solution of initial value problems	
	B Solution of equations with discontinuous forcing functions	
VII	Nonlinear Autonomous Systems of Differential Equations	4
	A Autonomous systems and stability	
	B Lyapunov functions	

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