Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): MATH 3980/MATH7120 Special Topics in Mathematics (3,3,0)

Subtitle: Introduction to Dynamics and Chaos

Course Aims: This course treats the basic concepts and techniques for dynamical systems. The application of the theory to physics, biology, chemistry and engineering is also emphasized.

Prerequisite: MATH 2110 Differential Equations

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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)
	Knowledge
1	Understand the basic concepts and techniques in Dynamical systems
	Skills
2	Apply the phase portraits to analyze the one-dimensional flows
3	Apply various techniques to analyze two-dimensional dynamical systems
4	Analyze discrete maps and its chaotic behaviors
	Attitudes
5	Appreciate the study and application of the theory of Dynamical systems.

Teaching & Learning Activities (TLAs)

CILO	TLAs will include the following:
1-4	Lectures will be used to introduce the subjects of the course's materials, and examples will be given to aid the learning of the subjects.
1-4	Programming assignments allow students to apply the various techniques learnt in the lecture, and help students fully understand them.
1-4	Quizzes, midterm and final examination allow students to measure their progress in learning the subjects of the course.

Assessment:

No.	Assessment Methods	Weighting	CILO Addressed	Remarks
1	Continuous Assessment (assignments, and mid-term test)	30%	1-5	Assignments are designed to measure students understanding of the basic concepts and fundamental theory of dynamical systems. The mid-test is designed to see the progress of the students.
2	Final Examination	70%	1-5	Final Examination is designed to see how far students have achieved their intended learning outcomes in the Knowledge and Skill domain.

Course Intended Learning Outcomes and Weighting:

Content	CILO No.	Teaching (in hours)
Introduction	1-5	2
1-dimensional dynamical flows	1-5	10
2-dimensional dynamical systems	1-5	12
1-dimensional discrete maps	1-5	10
Strange attractor and chaos	1-5	5

Textbook: Steven Strogatz, Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering.

References: Robinson, R. Clark, An introduction to dynamical systems: continuous and discrete. Pearson Prentice Hall, NJ, 2004.
Arrowsmith, D. K.;Place, C. M. An introduction to dynamical systems. Cambridge University Press, Cambridge, 1990.

Software: Being familiar with Maple will be an asset.

Course Content in Outline:

	Topic	Hours
I .	Introduction and Overview A. Chaos, Fractal and dynamical systems B. The importance of being nonlinear C. A dynamical view of the world	2
II.	Flows on the line A. Fixed points and stability B. Linear stability analysis C. Existence and uniqueness D. Potential	5
III.	Bifurcation of 1-dimensional flows A. Saddle-Node Bifurcation B. Transcritical Bifurcation C. Pitchfork Bifurcation	5
IV.	Two-Dimensional Flows A. Linear systems B. Phase plane analysis C. Limit cycle D. Bifurcation revisited	12
V.	One-Dimensional Maps A. Fixed Points and Cobwebs B. Logistic Map C. Periodic Windows and Liapunov Exponent	10
VI.	Lorenz Equations A. Lorenz Equations B. Strange attractors	5