The Hong Kong Polytechnic University

Subject Description Form

Subject Code	AMA1D05
Subject Title	Modeling the World: From Phenomena to Mathematics
Credit Value	3
Level	1
Pre-requisite / Co-requisite/ Exclusion	Nil
Objectives	This subject aims to introduce the basic background knowledge, concepts and techniques of mathematical modeling via different real life examples in natural science, engineering, economics, and social science. The main objective of this subject is to arouse students' interest in mathematical modeling. Emphasis is focused on equipping students with abilities to understand simple models and relate them to our daily life. Advanced knowledge in mathematics is not required in this subject.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. have a basic understanding of the general concepts in mathematical modeling; b. Recognize the nature and phenomena in different mathematical models; and c. have the ability to use appropriate approaches to formulate simple models and hence tackle real life problems. <u>Literacy:</u> In addition to learning from teaching materials delivered in lectures and tutorials, students are encouraged to read other relevant reference books and scientific articles related to mathematical modeling. Students are also required to understand, summarize, and analyze these reading materials when they prepare their presentation and final report. (ILO (a), and (b)) <u>Higher order thinking:</u> This is an introductory course to mathematical modeling. Students will learn the basic mathematical concepts and language, which are applicable to simple real life models. They will develop a scientific and logical thinking through the formulation of different models used in natural science, engineering, as well as social science. They will also have the opportunity to enhance their analytical and critical thinking when they analyze and solve the real life models and interpret the model solutions. Students' higher order thinking skills (e.g., logical thinking, analytical skills, critical thinking) will be enriched. (ILO (c))

	Life-long learning: The course will emphasize on equipping students' abilities to formulate, analyze, and interpret different models raised in our daily life. These abilities are important skills for everyone in his/her personal and career development as a student or as an employee. This course will give students an overview on the importance of mathematical models in real life as well as basic training for solving simple models so that students will have the ability to identify the problem and the ability to search and explore the possible techniques to analyze and solve the models themselves in the future. (ILO (a), (b) and (c))
Subject Synopsis/ Indicative Syllabus	**Overview of mathematical modeling (2 hours)** **Modeling with number (9 hours)** • Diet problem: How do you stay fit? • Ways to mix juice • How can I win without cheating? *Topics and techniques to be covered:* ✓ *Linear programming: Graphical/ Simplex method* ✓ *Game theory: Two person zero sum game, Prisoner's dilemma* **Modeling with graph (12 hours)** • Which way should I go? • How can I travel on time? • Where to place your Wi-Fi router? • Who is your perfect match? *Topics and techniques to be covered:* ✓ *Euler and Hamilton paths* ✓ *Shortest path (Dijkstra's algorithm)* ✓ *Minimal spanning tree (Prim's algorithm)* ✓ *Maximum flow (augmenting path algorithm)* **Modeling with function (9 hours)** • The safety stock level • The spread of infectious diseases • Investment annuity *Topics and techniques to be covered:* ✓ *Inventory management model: Economic ordering quantity (EOQ), Economic production quantity (EPQ)* ✓ *Predator-prey model: Newton method, Euler method* **Counting (7 hours)** • What is the best bet? • I forgot my password. Random try? • The hidden pattern in nature: Golden ratio *Topics and techniques to be covered:* ✓ *Permutations and combinations* ✓ *Recurrence relations, Difference equations*
Teaching/Learning Methodology	Lectures: This is the major teaching method used in this subject. In the lectures, the basic concepts and knowledge will be delivered to the students through practical

examples from real life problems. Students may be required to read some scientific articles or watch video clips on related topics before classes.

Tutorials:

The knowledge and concepts delivered in lectures will be further enhanced in tutorials through in-class exercises and other activities. Students are encouraged to figure out the solutions by themselves through discussions and debates.

Project and presentation:

A project with presentation will be required during the semester. Real life problems will be given. Students would have to research for literature review, and make use of the knowledge learned from the lecture materials and the literature to obtain their own findings and report their results during the presentation at the end of the semester.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c		
1. Assignments / In-class exercises	20%	✓	✓	✓		
2. Project / Presentation	20%	✓	✓	✓		
3. Examination	60%			✓		
Total	100 %					

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

There will be assignments and in-class exercises in which simple questions on concepts and theories of mathematical modeling will be set. This helps to reinforce the understanding of the knowledge and techniques covered in the lectures and tutorials, and to evaluate the progress of students' study regularly during the semester.

Project and presentation can give opportunities for students to integrate the concepts, theories, and techniques of mathematical modeling together to formulate, analyze, and interpret some real life problems. Students also have chances to summarize their findings and communicate effectively during the presentation.

Examination is conducted at the end of the semester to assess the understanding on the subject content for individual student.

Student Study Effort Expected	Class contact:	
	▪ Lecture	26 Hrs.
	▪ Tutorial	13 Hrs.
	Other student study effort:	
	▪ Self Study	39 Hrs.
	▪ Assignments	10 Hrs.
	▪ Prepare project and presentation	20 Hrs.
	Total student study effort	108 Hrs.

Reading List and References	Giordano, F.R., Fox, W.P., and Horton, S.B.	A First Course in Mathematical Modeling	Nelson Education, 2013
	Barton, J.T.	Models for Life : An Introduction to Discrete Mathematical Modeling with Microsoft Office Excel	Wiley, 2016
	Eastaway, R., Wyndham, J.	Why Do Buses Come in Threes?: The Hidden Maths of Everyday Life	Pavilion Books, 2014
	Morris, P.	Introduction to Game Theory	Springer, 1994
	Rosen, K.H.	Discrete Mathematics and its Application	McGraw-Hill, 2013