

**Hong Kong Baptist University**  
**Faculty of Science**  
**Department of Mathematics**

**Title (Units):** MATH 3980 Special Topic in Mathematics (3,3,0)

**Subtitle:** Combinatorics

**Course Aims:** This is an advance level enumerative combinatorics course. This course introduces a systematic coverage of enumeration of configurations with specified properties. Some combinatorics objects and some advanced techniques for counting, such as recurrence relation, generating function, Burnside's theorem, cyclic index and Pólya's theorem, will be introduced.

**Prerequisite:** Year 2 or above standing

**Recommend:** MATH 3760 Abstract Algebra

**Prepared by:** W.C. Shiu

**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 basic counting knowledge such as permutations and combinations, principle of pigeonhole, principle of inclusion and exclusion and group action.
2	Recognize the concept of generating functions
3	Employ the counting techniques on counting patterns.
4	Use generating function technique to solve recurrence relations and to study the Stirling numbers
5	Articulate the power of generating functions and application group theory

## Teaching & Learning Activities (TLAs)

<b>CILO</b>	<b>TLAs will include the following:</b>
1-4	Lectures will be used to introduce the topics of the course's materials and examples will be given in order to aid the learning of the topics. Students will consolidate the knowledge through discussion within lectures/tutorials. Open-ended problems will be introduced in class
1-5	Weekly tutorial sessions will be available to students to have their questions regarding the homework and lectures answered individually
1-5	Assignments will allow students to apply the skill learnt in the lecture and to solidify their understanding of the theorems. Open-ended questions will be designed in assignments
1-5	Midterm and final examination will allow students to measure their progress in learning the topics of the course.

## Assessment:

<b>No.</b>	<b>Assessment Methods</b>	<b>Weighting</b>	<b>CILO Addressed</b>	<b>Remarks</b>
1	Continuous Assessment (assignments and test)	30%	1-5	A 1-hour Test and Continuous Assessment are designed to measure how well the students have learned the fundamental concepts and theory. This may involve, but not limited to, in class discussions of rigorous technical problems and their solutions.
2	Final Examination	70%	1-5	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 combinatorics.

### Course Intended Learning Outcomes and Weighting:

Content	CILO No.	Teaching (in hours)
I. Permutations and Combinations	1	2
II. Algebraic Counting Techniques	1, 2, 3, 4, 5	24
III. Counting Patterns	1, 3, 5	10
IV. Stirling Numbers	4	3

**Textbook:** M. Bona, *Introduction to Enumerative Combinatorics*, 1<sup>st</sup> Ed., 2007.  
A. Slomson, *An Introduction to Combinatorics*, Chapman and Hall, 1991.

**References:** K.P. Bogart, *Introductory Combinatorics*, Pitman, 1983.  
R.A. Brualdi, *Introductory Combinatorics*, 3<sup>rd</sup> ed., Prentice-Hall, 1999.  
C.A. Charalambides, *Enumerative Combinatorics*, Chapman and Hall/CRC, 2002.  
C.C. Chen and K.M. Koh, *Principles and Techniques in Combinatorics*, World Scientific, 1992.  
D.I.A. Cohen, *Basic Techniques of Combinatorial Theory*, John Wiley & Son, 1978.  
J.H. van Lint and R.M. Wilson, *A Course in Combinatorics*, Cambridge, 1992.  
C.L. Liu, *Elements of Discrete Mathematics*, 2nd ed., McGraw-Hill, 1986.  
R. Merris, *Combinatorics*, PWS Pub. Co., 1996.  
R. Skvarcus and W.B. Robinson, *Discrete Mathematics with Computing Science Applications*, Benjamin/Cummings (Addison Wesley), 1986.

**Course Content in Outline:**

<u>Topic</u>	<u>Hours</u>
I. Permutations and Combinations	2
A. Permutations	
B. Combinations	
II. Algebraic Counting Techniques	24
A. Pigeonhole principle: simple and strong forms	
B. The principle of inclusion and exclusion	
C. Partitions and Stirling's approximation	
D. Permutations with fixed points and succession	
D. Generating functions	
E. Difference equations (recurrence relations)	
III. Counting Patterns	10
A. Permutation group	
B. Group actions	
C. Burnside's theorem	
D. Cyclic index and Pólya's theorem.	
IV. Stirling Numbers	3
A. Stirling numbers of the first and second kind	
B. Explicit expressions and recurrence relations	