Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): **MATH 2205 Multivariate Calculus (3,3,1)**

Course Aims: This course deals with calculus and functions of several variables. Students should know the basic concepts and technique of univariate calculus. Some knowledge on linear algebra, such as matrix notations and calculations, is preferred. Topics include partial derivative, multiple integral, and their theories and applications.

Prerequisite: MATH 1005 Calculus or MATH1006 Advanced Calculus I

Recommended: MATH 2207 Linear Algebra or MATH 1205 Discrete Mathematics

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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	Visualize and sketch geometrical objects in 2- and 3-dimension, to manipulate the related issues of the chosen topics as outlined in "course content."
2	Describe the basic applications of the chosen topics and their importance in the modern science
3	Develop simple mathematical models, and apply multivariate calculus techniques learned from the chosen topics to solve simple problems
4	Report and communicate effectively with others and present mathematical results in a logical and coherent fashion
5	Articulate the power and beauty of mathematics, and solve problems independently and collaboratively as part of a team

Teaching & Learning Activities (TLAs)

CILO	TLAs will include the following:
1,2,5	**Lecture and tutorial** Instructor will give simple real life problems in lectures to motivate the concepts, followed by discussions of rigorous technical details. Students will then be required to consolidate the knowledge by further reading and through discussion within lectures/tutorials.
3-5	**In-class activities, tutorial, and assignment** Instructor will provide problems in sophisticated real life situations in lectures, tutorials and assignments. In lectures the instructor will demonstrate how to formulate and solve the problems and discuss why a particular method is used. Students will then be required to attempt the tutorial and assignments questions. In tutorials they have to explain verbally how they would formula and solve the problem to the class, followed by more thorough discussions led by instructor/teaching assistants. For the assignments, they have to present their formulations and solutions in written form.

Assessment:

No.	Assessment Methods	Weighting	CILO Addressed	Remarks
1	Continuous Assessment	30%	1-4	Two 1-hour Tests and Continuous Assessment are designed to measure how well the students have learned the basic concepts and fundamental theory of function of several variables and its integrations. 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 function of several variables and its integrations.

Course Intended Learning Outcomes and Weighting:

Content	CILO No.	Teaching (in hours)
1. Coordinate Geometry in 3-dimensions	1,3-5	3
2. Partial Differentiation	1-5	12
3. Applications of Partial Derivative	1-5	6
4. Single Variable Integration	1-5	6
5. Multiple Integration	1-5	12

Textbooks: Robert A. Adams, Christopher Essex, Calculus—Single Variable 8th Ed., Pearson, 2014.
Robert A. Adams, Christopher Essex, Calculus—Several Variables 8th Ed., Pearson, 2014.

Reference: P.M. Fitzpatrick, Advanced Calculus, PWS, 1996.

Course Content in Outline:

	Topic	Hours
I.	Coordinate Geometry in 3-dimensions a. Analytic Geometry in Three Dimensions b. Planes, Lines, and Distances c. Quadric Surfaces d. Matrix, Determinant, and Linear maps	3
II.	Partial Differentiation a. Functions of Several Variables b. Limits and Continuity c. Partial Derivatives d. Higher-Order Derivatives e. The Chain Rule f. Linear Approximations, Differentiability, and Differentials g. Gradients and Directional Derivatives h. Implicit Functions i. Taylor Series and Approximations	12
III.	Applications of Partial Derivative a. Extreme Values b. Extreme Values of Functions Defined on Restricted Domains c. Lagrange Multipliers d. The Method of Least Squares	6
IV.	Single Variable Integration a. Sums and Sigma Notation b. Areas as Limits of Sums c. Definite Integral and its Properties d. Method of Substitution e. Integration by Parts f. Areas of Planar Regions	6
V.	Multiple Integration a. Double Integrals b. Improper Integrals and a Mean-Value Theorem c. Double Integrals in Polar Coordinates	12

d. Triple Integrals
e. Change of Variables in Triple Integrals
f. Applications of Multiple Integrals