MATH 2011 Introduction to Multivariable Calculus L2-L3

Course Outline – Spring Term 2024/2025

1. Instructor: (L2-L3) Dr ***Hai Zhang***

Email: haizhang@ust.hk **Office**: Room 3449 (near Lifts 25/26)

Office hours: Mo, Wed 3PM-4PM or by appointment.

2. Lecture/Tutorial Hours and Venues:

Instructor/Email	Section	Date/Time		Venue
Hai Zhang/haizhang	L2 and L3	Tue/Thu	12PM-1:20PM 1:30PM-2:50PM	Rm2306 Rm 2463
CHOY, Ka Hei/khchoyab	T2A	Tue	12:00PM - 12:50PM	Rm 4502
GU, Yanwu/ygubg	T2B	Mon	12:00PM - 12:50PM	Rm 1032, LSK Bldg
HUANG, Yuntong/yhuanggu	T2C	Tue	09:30AM-10:20AM	Rm 2407
LI, Meng/mlieh	T3A	Mon	09:30AM -10:20AM	Rm 2463
WEI, Xuchen/xweiav	T3B	Tue	10:30AM -11:20AM	Rm 4504
ZHOU, Rijiang/rzhouau	T3C	Thu	03:30PM - 04:20PM	Rm 1027, LSK Bldg

3. COURSE DESCRIPTION

Credits: 3

Vectors and Curves, Functions of Several Variables, Multiple Integration, Vector Calculus.

Exclusion: MATH 2010, MATH 2021, MATH 2023

Pre-requisite: A passing grade in AL Pure Mathematics / AL Applied Mathematics; OR MATH 1014; OR MATH 1018; OR MATH 1020; OR MATH 1024 (*for appropriate knowledge in one-variable calculus*)

4. INTENDED LEARNING OUTCOMES (ILOs)

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

1	Understand the basic *concepts* and know the basic *techniques* of differential and integral calculus of functions of several variables;

2	Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids;
3	Solve problems involving maxima and minima, line integral, and vector calculus;
4	Develop mathematical maturity to undertake higher level studies in mathematics and related fields.

5. ASSESSMENT SCHEME

15%: WeBWorK, Course ILOs: 1, 2, 3, 4,

10%: Assigned problems for each chapter. After each chapter, 5-10 problems will be assigned on canvas. Students are required to solve all these problems and submit their solution on canvas before the specified deadline. Please note that for each chapter only 2 problems out of those assigned will be graded. Un-attempted problems may also result in deduced marks. Course ILOs: 1, 2, 3, 4,

25% Midterm exam. ONE hour exam, March 26 (Wednesday), 7pm-8pm. Coverage: chapter 1-2. Course ILOs: 1, 2

50% Final Exam. Two-hour exam, To be arranged by ARO, Course ILOs: 1, 2, 3, 4

Final exam is comprehensive, i.e., all the materials taught in the whole semester will be tested.

All exams are Closed-book, no notes and no calculators. More information will be given prior to the exams. No make-up exams for midterm exam.

Letter Grades will be assigned based on the total marks achieved in the above four assessments.

Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	The student has mastered almost all concepts and techniques of multivariable calculus taught in the course, has excellent understanding of the deepest content of the subject, and acquired workable knowledge for further studies of analysis, differential and partial differential equations, Riemannian geometry, optimization and related fields.
B	Good Performance	The student has mastered most computational techniques of multivariable calculus taught in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.
C	Satisfactory Performance	The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject, yet some concepts were not clearly understood.
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

6. Student Learning Resources

Main reference: Lecture slides prepared by instructors.

Study Reference: 1. *Vector Calculus,* by Suan J. Colley*;*

2. *Calculus for Scientists and Engineers: Early Transcendentals* – Briggs, Cochran and Gillett. Pearson New International Edition.

3. *Calculus* – James Stewart. BROOKS/COLE

All learning materials will be posted on canvas.

7. Teaching and learning Activities

Scheduled activities: 4 hours (Lecture for 3 hours & Tutorial for 1 hour) each week

8. Tentative TEACHING SCHEDULE for 25 classes in total

Topic 1. **Vectors and Curves:** Class 1-6

1. Vectors in the plane and three dimensions
2. Dot products and Cross products
3. Lines and planes in space
4. Parametric curves
5. Calculus of vector-valued functions
6. Motion in space
7. Length and arclength parameterization of curves
8. Curvature of curves

Topic 2. **Functions of Several Variables**: Class 7–12

1. Graphs and level curves, surfaces
2. Limits and continuity
3. Partial derivatives
4. The chain rule
5. Directional derivatives and the gradient
6. Tangent planes and linear approximation
7. Maximum/minimum problems
8. Lagrange multiplier

Topic 3. **Multiple Integration:** Class 13-20

1. Double integrals over rectangular regions
2. Double integrals over general regions
3. Polar coordinates
4. Double integrals in polar coordinates
5. Triple integrals
6. Cylindrical and spherical coordinates
7. Triple integrals in cylindrical and spherical coordinate.

Topic 4. **Vector Calculus:** Class 21 – 25

1. Vector fields
2. Line integrals

3. Conservative vector fields
4. Green's theorem

9.Course AI Policy

Students are allowed to consult any person (including the instructor, TA, classmates, friends outside HKUST) in any homework for ideas and hints, but are required to write up the solutions by themselves. You are required to list the persons and references you have consulted in every homework.
The use of ChatGPT or other generative AI is allowed, and they are regarded as "persons" you have consulted, and therefore must be listed in your homework.
However, please be warned that at the current stage of development of AI, the response to problems in advanced courses — may not be reliable. Students should
be critical of the response generated by AI and do not blindly copy the generated responses to your homework.

10.Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.