

## COURSE OUTLINE: MH2100

Course Title	<b>Calculus III</b>		
Course Code	<b>MH2100</b>		
Offered	Study Year 2, Semester 1		
Course Coordinator	Gary Greaves (Dr)	<a href="mailto:gary@ntu.edu.sg">gary@ntu.edu.sg</a>	6513 8652
Pre-requisites	MH1101 or MH1802 or MH1805		
Mutually exclusive	MH1803, MH2800, CY1602		
AU	4		
Contact hours	Lectures: 39, Tutorials: 13		
Approved for delivery from	AY 2022/23 semester 1		
Last revised	27 Nov 2022, 19:36		

### Course Aims

Calculus III is a core Mathematics course that extends concepts and techniques developed in Calculus I and Calculus II to the case of functions of several real variables. In other words, we try to do the same things as in Calculus I and II, but in higher dimensions. In this course, we shall discuss the notions of limits, continuity, derivatives and integrals of real-valued and vector-valued functions of many variables. Most of the time, extending these familiar notions from one to several variables requires some degree of ingenuity, and we are going to have to spice up the material from Calculus I and II with a little bit of geometry and linear algebra. Techniques learned in Calculus III are essential for financial analysts, engineers, and for further study in mathematics.

### Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Parametrise curves and their tangents;
2. Approximate and optimise multivariate functions;
3. Apply the chain rule to multivariate functions;
4. Find volumes of geometrical objects in higher dimensions;
5. Parametrise surfaces and their tangent planes;
6. Recognise when it is appropriate to use cylindrical and spherical coordinates;
7. Determine the div and curl of a vector field and recognise the physical interpretations of these quantities;
8. Apply Stokes' theorem and its specialisations to simplify relevant problems;
9. Apply multivariate calculus to real-world problems.

### Course Content

Parametric curves and tangent lines

Limits, continuity, and partial derivatives

Partial derivatives and the classification of extreme points

Tangent spaces and differentiability

The chain rule and directional derivatives

Lagrange multipliers

Double integrals  
 Multiple integrals and substitution  
 Vector fields and line integrals  
 Green's theorem and surface integrals  
 Stokes' theorem  
 The divergence theorem  
 Summary

## Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
<b>Continuous Assessment</b>					
<b>Mid-semester Quiz</b>					
Short Answer Questions 1	1, 2	1. a, b 3. a	25	individual	See Appendix for rubric
Short Answer Questions 2	2, 3, 4, 5, 6	1. a, b 3. a	25	individual	See Appendix for rubric
<b>Examination (2 hours)</b>					
Short Answer Questions	1, 2, 3, 4, 5, 6, 7, 8, 9	1. a, b 2. c 3. a	50	individual	See Appendix for rubric
<b>Total</b>			<b>100%</b>		

These are the relevant SPMS-MAS Graduate Attributes.

### 1. Competence

- a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
- b. Formulate mathematical statements precisely using rigorous mathematical language

### 2. Creativity

- c. Develop new applications of existing techniques

### 3. Communication

- a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience

## Formative Feedback

Mid Term Quiz: formative feedback is written in the students' midterm scripts, which are returned to the students. Students will also receive formative feedback for all learning outcomes (including LO 7-9 tested in the final exam) during weekly tutorial classes from Week 2-Week 13.

## Learning and Teaching Approach

<b>Lectures</b> (39 hours)	Derivation and demonstration: Helps students understand the motivation behind mathematical notions and ideas. Presents systematic ways to solve problems.  Problem solving: Develops competence in solving problems related to multivariate calculus.  Peer Instruction: Develops communication skills and strengthens mathematical skill.
<b>Tutorials</b> (13 hours)	Derivation and demonstration: Helps students understand the motivation behind mathematical notions and ideas. Presents systematic ways to solve problems.  Problem solving: Develops competence in solving problems related to multivariate calculus.  Peer Instruction: Develops communication skills and strengthens mathematical skill.

## Reading and References

James Stewart, Calculus (8th edition) ISBN-10:1285740629

## Course Policies and Student Responsibilities

Absence due to medical or other reasons

If you are sick and unable to attend a midterm you must:

1. Send an email to the instructor regarding the absence.
2. Submit the original Medical Certificate\* to an administrator.

\*The Medical Certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

## Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the [Academic Integrity website](#) for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

## Course Instructors

Instructor	Office Location	Phone	Email
Gary Greaves (Dr)	MAS-05-03	6513 8652	<a href="mailto:gary@ntu.edu.sg">gary@ntu.edu.sg</a>

## Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Parametric curves and tangent lines	1	10.1 (Curves Defined by Parametric Equations) 10.2 (Calculus with Parametric Curves)
2	Limits, continuity, and partial derivatives	2	14.1 (Functions of Several Variables), 14.2 (Limits and Continuity), and 14.3 (Partial Derivatives)
3	Partial derivatives and the classification of extreme points	2	Section 14.7 (Maximum and Minimum Values)
4	Tangent spaces and differentiability	5	Section 14.4 (Tangent Planes and Linear Approximations)
5	The chain rule and directional derivatives	3, 9	Section 14.5 (The Chain Rule), 14.6 (Directional Derivatives and the Gradient Vector)
6	Midterm 1 Lagrange multipliers	2, 9	14.8 (Lagrange Multipliers)
7	Double integrals	4	15.1 (Double Integrals over Rectangles), 15.2 (Double Integrals over General Regions), 15.3 (Double Integrals in Polar Coordinates)
8	Multiple integrals and substitution	4, 6	15.6 (Triple Integrals), 15.7 (Triple Integrals in Cylindrical Coordinates), 15.8 (Triple Integrals in Spherical Coordinates), 15.9 (Change of Variables in Multiple Integrals)
9	Vector fields and line integrals	7	16.1 (Vector Fields), 16.2 (Line Integrals), 16.3 (The Fundamental Theorem for Line Integrals), and 16.5 (Curl and Divergence)
10	Green's theorem and surface integrals	7, 8	16.4 (Green's Theorem), 16.6 (Parametric Surfaces and Their Areas), and 16.7 (Surface Integrals)
11	Midterm 2 Stokes' theorem	8	16.8 (Stokes' Theorem)
12	The divergence theorem	8	16.9 (The Divergence Theorem)
13	Summary	7, 8	

## Appendix 1: Assessment Rubrics

### Rubric for Mid-semester Quiz: Short Answer Questions 1 (25%)

*Point-based marking (not rubrics based)*

### Rubric for Mid-semester Quiz: Short Answer Questions 2 (25%)

*Point-based marking (not rubrics based)*

### Rubric for Examination: Short Answer Questions (50%)

*Point-based marking (not rubrics based)*