Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Leonard Huang
Course Author Email	leonard.huang@ntu.edu.sg
Course Title	Calculus III
Course Code	MH2100
Academic Units	4
Contact Hours	52
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH1101 or MH1802 or MH1805
Co-requisites	
Pre-requisite to	
Mutually exclusive to	MH1803, MH2800, CY1602
Replacement course to	
Remarks (if any)	

Course Aims

Calculus III is a core Mathematics course that generalizes the concepts and techniques developed in Calculus I and II to the setting of real-valued functions of several real variables. In other words, the concepts and techniques developed in Calculus I and II are again covered but this time in a higher-dimensional setting.

In this course, the notions of limits, continuity, derivatives, and integrals shall be defined and developed for real-valued and vector-valued functions of several real variables. For the most part, the extension of these familiar notions from one real variable to several real variables requires some degree of ingenuity, so the content covered in Calculus I and II needs to be spiced up with a little bit of geometry and linear algebra. The techniques learned in Calculus III are essential for economics, financial analysis, engineering, chemistry, physics, and higher-level mathematics.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	parametrize curves and their tangent lines;
ILO 2	linearly approximate and optimize multivariable functions;
ILO 3	apply the Chain Rule to multivariable functions;
ILO 4	compute the volumes of geometrical solids in higher dimensions;
ILO 5	parametrize surfaces and their tangent planes;
ILO 6	recognize when it is appropriate to use cylindrical or spherical coordinates;
ILO 7	compute the divergence and the curl of a vector field and learn the physical interpretation of these quantities;
ILO 8	apply Stokes' Theorem and its various specializations to simplify and then solve relevant problems in vector calculus;
ILO 9	apply multivariable calculus to solve 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.
- Course review.

Reading and References (if applicable)

Title: Calculus (Metric Version, 9th Edition)

Author: James Stewart

Print year: 2023

ISBN-13: 978-0-357-11346-2

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Parametric curves and tangent lines	1	10.1 (Curves Defined by Parametric Equations) 10.2 (Calculus with Parametric Curves)	In-person	Lectures and tutorial
2	Limits, continuity, and partial derivatives	2	14.1 (Functions of Several Variables) 14.2 (Limits and Continuity) 14.3 (Partial Derivatives)	In-person	Lectures and tutorial
3	Partial derivatives and the classification of extreme points	2	14.7 (Maximum and Minimum Values)	In-person	Lectures and tutorial
4	Tangent spaces and differentiability	5	14.4 (Tangent Planes and Linear Approximations)	In-person	Lectures and tutorial
5	The Chain Rule and directional derivatives	3, 9	14.5 (The Chain Rule) 14.6 (Directional Derivatives and the Gradient Vector)	In-person	Lectures and tutorial
6	Lagrange multipliers	2, 9	14.8 (Lagrange Multipliers)	In-person	Lectures and tutorial
7	Double integrals	4	15.1 (Double Integrals over Rectangles) 15.2 (Double Integrals over General Regions) 15.3 (Double Integrals in Polar Coordinates)	In-person	Lectures and tutorial
8	Multiple integrals and substitution, Midterm Exam	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)	In-person	Lectures and tutorial
9	Vector fields and line integrals	7	16.1 (Vector Fields) 16.2 (Line Integrals) 16.3 (The Fundamental Theorem for Line Integrals) 16.5 (Curl and Divergence)	In-person	Lectures and tutorial

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
10	Green's Theorem and surface integrals	7, 8	16.4 (Green's Theorem) 16.6 (Parametric Surfaces and Their Areas) 16.7 (Surface Integrals)	In-person	Lectures and tutorial
11	Stokes' Theorem	8	16.8 (Stokes' Theorem)	In-person	Lectures and tutorial
12	The Divergence Theorem	8	16.9 (The Divergence Theorem)	In-person	Lectures and tutorial
13	Course review	1, 2, 3, 4, 5, 6, 7, 8, 9		In-person	Lectures and tutorial

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Derivation and demonstration: - Helps students understand the motivation behind mathematical notions and ideas in multivariable calculus. - Presents systematic ways to solve problems in multivariable calculus. Problem solving: - Develops competence in solving problems related to multivariable calculus. Peer instruction: - Develops communication skills and strengthens mathematical skills.
Tutorials	Derivation and demonstration: - Helps students understand the motivation behind mathematical notions and ideas in multivariable calculus. - Presents systematic ways to solve problems in multivariable calculus. Problem solving: - Develops competence in solving problems related to multivariable calculus. Peer instruction: - Develops communication skills and strengthens mathematical skills.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment(Online homework)	1, 2, 3, 4, 5, 6, 7, 8, 9		20	Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Class Participation(In-lecture quizzes)	1, 2, 3, 4, 5, 6, 7, 8, 9		5	Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(Midterm Exam (short-answer problems))	1, 2, 3, 4, 5, 6		25	Individual	Analytic	Multistructural
4	Summative Assessment (EXAM): Final exam(Final Exam (short-answer problems))	1, 2, 3, 4, 5, 6, 7, 8, 9		50	Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

The online homework, administered by WebAssign, is designed to assess the following:
- Your understanding of course concepts, demonstrated by your ability to recall and apply standard definitions and theorems of multivariable calculus that are required to solve a particular problem in multivariable calculus.
- Your skill in performing calculations in multivariable calculus accurately.

The in-lecture quizzes, administered by Wooclap, is designed to assess the following:
- Your understanding of course concepts, demonstrated by your ability to recall and apply standard definitions and theorems of multivariable calculus that are required to solve a particular problem in multivariable calculus.

The Midterm Exam is designed to assess the following:
- Your understanding of course concepts, demonstrated by your ability to rapidly recall and apply standard definitions and theorems of multivariable calculus that are required to solve a particular problem in multivariable calculus.
- Your skill in performing calculations in multivariable calculus quickly and accurately.

The Final Exam is designed to assess the following:
- Your overall understanding of course concepts, demonstrated by your ability to rapidly recall and apply standard definitions and theorems of multivariable calculus that are required to solve a particular problem in

multivariable calculus.
- Your skill in performing calculations in multivariable calculus quickly and accurately.

Formative Feedback

Formative feedback on your performance in this course is provided in the following manner:
1. Feedback on your individual performance on the online homework is provided by WebAssign.
2. Feedback on your understanding of tutorial problems is provided by your tutor during your tutorial sessions.
3. Feedback on your individual performance on the Midterm Exam is provided by written remarks on your exam script.
4. Feedback on the general performance on the Midterm Exam is provided by an Examiner's Report on common mistakes.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Creative Thinking	Basic
Digital Fluency	Basic
Problem Solving	Basic

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to diligently attend all lectures and tutorial sessions. While you are not expected to complete all assigned tutorial problems prior to a tutorial session, please be aware of the topics that will be covered and participate wholeheartedly in discussions with your tutor.

Policy (Absenteeism)

If you are feeling unwell and thus unable to sit for the common Midterm Exam, then please take the following three actions:
1. Send an email to the course instructor regarding your absence from the exam.
2. Seek approval for a short leave of absence (LoA) from your home school.
3. Submit a copy of an original medical certificate (MC), to your home school, that validates your medical condition.
Remark: The MC should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

If you miss the common Midterm Exam due to a medical condition validated by an MC, then you shall be required to sit for a common Make-Up Midterm Exam; no further make-up exams shall be scheduled for you on an individual basis.

If you are required to sit for the common Make-Up Midterm Exam but are unable to do so, then only the following five reasons shall be accepted for missing it:
1. Childbirth; life-saving surgery or recovery from life-saving surgery; or hospitalization for a serious medical condition (in which case a letter from the admitting hospital must be produced).
2. The sudden demise of a member of your immediate family (in which case an official death certificate must be produced).
3. A scheduled court appearance (in which case a Writ of Summons must be produced).
4. Incarceration for the commitment of a crime (in which case a letter from the Singapore Police Force or the Singapore Prison Service must be produced).
5. Detention against your will (in which case a letter from the Singapore Police Force must eventually be produced).

Policy (Others, if applicable)

Diversity and Inclusion Policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honors your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion, or ability.

To help accomplish this,

- if you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- if you feel like your performance in the class is being impacted by your experiences outside of class;
- if something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

then please speak to your teaching team, our school pastoral officer, or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honor the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others' opinions and actively making that sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. If you witness something that goes against this or have any other concerns, then please speak to your instructors or a faculty member.

Appendix 1: Assessment Rubrics

Rubric for online homework (20%)
Point-based marking.

Rubric for in-lecture quizzes (5%)
Point-based marking.

Rubric for Midterm Exam (25%)
Point-based marking.

Rubric for Final Exam (50%)
Point-based marking.