# MA2508: MULTI-VARIABLE CALCULUS

**Effective Term**
Semester A 2022/23

## Part I Course Overview

**Course Title**
Multi-variable Calculus

**Subject Code**
MA - Mathematics
**Course Number**
2508

**Academic Unit**
Mathematics (MA)

**College/School**
College of Science (SI)

**Course Duration**
One Semester

**Credit Units**
4

**Level**
B1, B2, B3, B4 - Bachelor's Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
Grade B or above in MA1201 Calculus & Basic Linear Algebra II and subject to approval from MA must be obtained; or
Grade C- or above in MA1301 Enhanced Calculus & Linear Algebra II; or
Grade C- or above in both MA1508 Calculus and MA1503 Linear Algebra with Applications

**Precursors**
Nil

**Equivalent Courses**
Nil

**Exclusive Courses**
Nil

# Part II Course Details

**Abstract**

This course introduces fundamental mathematical methods and analysis in advanced calculus. It will help students to understand the basic concepts, fundamental theory and identify the applications of multi-variable calculus. It trains students in the ability to think quantitatively and analyze problems critically.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | evaluate limits, partial derivatives, and multiple integrals for functions of several variables. | 30 | | x | |
| 2 | compute line and surface integrals. | 20 | | x | |
| 3 | apply integral theorems of vector analysis to describe some physical problems. | 10 | x | | x |
| 4 | explain basic concepts of multi-variable calculus, create and construct mathematical models through multi-variable calculus and vector analysis, and properly apply to some problems in science and engineering. | 20 | x | x | x |
| 5 | the combination of CILOs 1-4 | 20 | x | x | x |

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

**Teaching and Learning Activities (TLAs)**

| | TLAs | Brief Description | CILO No. | Hours/week (if applicable) |
|---|---|---|---|---|
| 1 | Lectures | Learning through teaching is primarily based on lectures. | 1, 2, 3, 4, 5 | 39 hours in total |
| 2 | Tutorials | Learning through tutorials is primarily based on interactive problem solving allowing instant feedback. | 1 | 4 hours |
| 3 | Tutorials | Learning through tutorials is primarily based on interactive problem solving allowing instant feedback. | 2 | 4 hours |

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|---|---|---|---|---|
| 4 | Tutorials | Learning through tutorials is primarily based on interactive problem solving allowing instant feedback. | 3 | 2 hours |
| 5 | Tutorials | Learning through tutorials is primarily based on interactive problem solving allowing instant feedback. | 4 | 3 hours |
| 6 | Assignments | Learning through take-home assignments helps students understand basic mathematical concepts and fundamental theory of multi-variable calculus, and apply mathematical methods and analysis from advanced calculus to some applications. | 1, 2, 3, 4, 5 | after-class |
| 7 | Online applications | Learning through online examples for applications helps students create and formulate mathematical models and apply to some problems in science and engineering. | 4 | after-class |
| 8 | Math Help Centre | Learning activities in Math Help Centre provides students extra help. | 1, 2, 3 | after-class |

**Assessment Tasks / Activities (ATs)**

| | **ATs** | **CILO No.** | **Weighting (%)** | **Remarks (e.g. Parameter for GenAI use)** |
|---|---|---|---|---|
| 1 | Test + Quizzes | 1, 2, 3 | 24 | Questions are designed for the first part of the course to see how well the students have learned the basic concepts, fundamental theory and recognized the applications of multi-variable calculus. |
| 2 | Hand-in assignments | 1, 2, 3, 4 | 0 | These are skills based assessment to enable students to demonstrate the basic concepts and fundamental theory of multi-variable calculus and identify the applications. |

| | | | | |
|---|---|---|---|---|
| 3 | Formative take-home assignments | 1, 2, 3, 4 | 6 | The assignments provide students chances to demonstrate their achievements on multi-variable calculus learned in this course. |

**Continuous Assessment (%)**

30

**Examination (%)**

70

**Examination Duration (Hours)**

3

**Additional Information for ATs**

30% Coursework
70% Examination (Duration: 3 hours, at the end of the semester)

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

**Assessment Rubrics (AR)**

**Assessment Task**

1. Test

**Criterion**

ABILITY to APPLY and EXPLAIN the methodology of limits, partial derivatives and multiple integrals for functions of several variables

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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**Assessment Task**

2. Hand-in assignments

**Criterion**

CAPACITY to evaluate limits, partial derivatives and multiple integrals for functions of several variables

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**
Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**
Not even reaching marginal levels

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**Assessment Task**
3. Formative take-home assignments

**Criterion**
CAPACITY for SELF-DIRECTEDLEARNING to apply principles of multi-variable calculus to some problems in science and engineering

**Excellent (A+, A, A-)**
High

**Good (B+, B, B-)**
Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**
Not even reaching marginal levels

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**Assessment Task**
4. Examination

**Criterion**
ABILITY to DEVELOP mathematical models through multi-variable calculus and SOLVE problems with various methods

**Excellent (A+, A, A-)**
High

**Good (B+, B, B-)**
Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**

Not even reaching marginal levels

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# Part III Other Information

**Keyword Syllabus**

- Three-dimensional coordinate systems, equations for lines and planes, quadric surfaces
- Definitions of multi-variable functions, concepts of limit and continuity, partial derivatives of multi-variable functions, calculations of partial derivatives and their applications (e.g., maximum and minimum)
- Definitions of double integrals and triple integrals, evaluations of double and triple integrals in rectangular and other coordinates, applications of double and triple integrals (e.g., mass of a plate)
- Definition of vector fields, curl and divergence, definitions and evaluations of line and surface integrals, Green's theorem, Stokes' theorem and Gauss’ s theorem

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | J. Stewart, “Multivariate Calculus”, fifth ed., Brooks/Cole, 2003. |

**Additional Readings**

| | Title |
|---|---|
| 1 | W. Rudin, Principles of mathematical analysis, New York: McGraw-Hill, c1976. |
| 2 | M.P. do Carmo, Differential geometry of curves and surfaces, Englewood Cliffs, N.J.: Prentice-Hall, c1976. |
| 3 | M. Spivak, Calculus on manifolds: a modern approach to classical theorems of advanced calculus, New York: W.A. Benjamin, 1965. |