MI1120Q CALCULUS II

Version: 2024.1.0

Objective: *To provide students the basic knowledge about applications of differential calculus in geometry, parameter-dependent integrals, double integrals, triple integrals, line integrals, surface integrals, and vector fields. Students can understand the fundamental of computing technology and continue to study further.*

Contents: *Applications of differential calculus in geometry, parameter-dependent integrals, double integrals, triple integrals, line integrals, surface integrals, and vector fields.*

1. GENERAL INFORMATION

Course title:	Calculus II
Unit in charge	Faculty of Mathematics and Informatics
Course ID:	MI1120Q
Course Units:	3(2-2-0-6) - Lecture: 30 hours - Seminar: 30 hours
Previous module:	MI1110Q Calculus I
Prerequisites:	MI1110Q Calculus I
Companion module:	MI1130Q Calculus III

2. DESCRIPTION

This course provides some applications of differential calculus in geometry, the basic ideas and techniques of parameter-dependent integrals, double integrals and triple integrals, line integrals of scalar fields and vector fields, surface integrals of scalar fields and vector fields, and vector fields.

3. OBJECTIVES AND EXPECTED OUTCOMES

Students who complete this module have the abilities to:

Objectives	Objectives description/Expected Outcomes	Outcome standard allocated for modules/ Levels (I/T/U)
[1]	[2]	[3]
M1	**Master the basic knowledge of Caculus II and apply in practice to solve related exercises**	
M1.1	Master the basic concepts such as: double integrals, triple integrals, line integrals, surface integrals, vector fields as well as applications of differential calculus	I/T
M1.2	Be able to apply the knowledge to solve exercises	T/U
M2	**Achieve serious attitude and necessary skills for highly effective work**	
M2.1	Be skilled at analyzing and solving problems with strong	T/U

Objectives	Objectives description/Expected Outcomes	Outcome standard allocated for modules/ Levels (I/T/U)
	logical thinking; working independently and staying focused	
M2.2	Identify some practical problems that can be solved by using tools of calculus.	I/T/U
M2.3	Gain serious working attitude, proactive creativity, adaptation to highly competitive working environment	I/T

4. COURSE MATERIALS

Textbooks

[1] James Stewart (2016). *Calculus: Concepts and Contexts, eighth edition*. Thomson, Brooks/Cole Publishing Company

[2] Nguyễn Đình Trí, Trần Việt Dũng, Trần Xuân Hiển, Nguyễn Xuân Thảo (2015). *Toán học cao cấp tập 2.* NXB Giáo dục.

References

[1] Trần Bình (2005). *Giải tích II*. NXB Khoa học và Kỹ thuật.

[2] Nguyễn Đình Trí, Trần Việt Dũng, Trần Xuân Hiển, Nguyễn Xuân Thảo (2017). *Bài tập Toán học cao cấp tập 2.* NXB Giáo dục.

[3] Trần Thị Kim Oanh, Phan Xuân Thành, Lê Chí Ngọc, Nguyễn Thị Thu Hương (2022), *Giải tích II: Hàm số nhiều biến số (bài giảng dành cho sinh viên các trường kĩ thuật)*, NXB Bách Khoa Hà Nội.

[4] Khoa Toán – Tin (2023): *Slides bài giảng Giải tích II* (tài liệu lưu hành nội bộ).

5. ASSESSMENT

Components	Evaluation method	Description	Rated outcome standards	Proportion
[1]	[2]	[3]	[4]	[5]
A1. Attendance point	Learning attitude and attendance of the students during the course	Learning attitude of the students		**20%**
A2. Periodic test mark (*)	**A2.1. 1st periodic test** (KT1 mark, 15 scale) (Content: From the 1st week to the 5th week)	Quizzes	M1.1, M1.2, M2.1, M2.2, M2.3	**30%**
	A2.2. 2nd periodic test (KT2 mark, 15 scale) (Content: From the 6th week to the 10th week)			
A3. Final exam mark	**Final exam**	Essay	M1.1,	**50%**

			M1.2, M2.1, M2.2, M2.3	

(*) Periodic test mark (DKTDK) is calculated according to the formula DKTDK =1/3(KT1+KT2) and will be adjusted by adding points for the performance of students during the course which vary from –1 to +1 according to the Rule of Faculty of Mathematics and Informatics accompanied with the Regulations of Higher Education of Hanoi University of Science and Technology.

6. COURSE PLAN

Week	Topics	Objective	Activities	Exercises
[1]	[2]	[3]	[4]	[5]
1	**Chapter 1: Applications of differential calculus in geometry** 1.1. Applications in plane geometry - Normal vector and equations for tangent lines and normal lines of a curve at a point. - Curvature: mean curvature, curvature at a point, formula of curvature at a point (no proof) and examples. - Envelope of a family of parametric curves: definition, formula, examples. 1.2. Applications in spatial geometry - Vector functions, derivative of vector functions ($\vec{r}(t) = x(t)\vec{i} + y(t)\vec{j} + z(t)\vec{k}$) and properties.	M1.1 M1.2 M2.1 M2.3	Lecturer: - Self-introduce - Introduce the course outline - Explain teaching and learning methods; and forms of subject assessment - Lecture, exchange questions and answers with students during the lecture Student: - Read in advance the next lesson - Master the basic concepts and apply to solve exercises according to the content and progress of the subject	A1, A2.1, A3
2	- Curves: equations of tangent lines and normal planes at a point of curves, curvature at a point of curves (formulas). - Surfaces: equations of tangent planes	M1.1 M1.2 M2.1 M2.3	Lecturer - Lecture, exchange questions and	A1, A2.1, A3

Week	Topics	Objective	Activities	Exercises
[1]	[2]	[3]	[4]	[5]
	and normal lines at a point of surfaces (formulas). **Chapter 2. Multiple integrals** 2.1. Double integrals - Definition, geometric meaning, properties. - Calculations of double integrals in the Cartesian coordinate system.		answers with students during the lecture Student: - Read in advance the next lesson - Master the basic concepts and apply to solve exercises according to the content and progress of the subject	
3	- Change of variables in double integrals: general change of variables formula, change of variables in polar coordinate system.	M1.1 M1.2 M2.1 M2.3		A1, A2.1, A3
4	- Applications of double integrals: Calculate the volume of an object, the area of a plane domain, the area of a surface (formulas and examples). 2.2. Triple integrals - Definition, geometric meaning, properties.	M1.1 M1.2 M2.1 M2.2 M2.3		A1, A2.1, A3
5	- Calculations of triple integrals in the Cartesian coordinate system. - Change of variables in triple integrals: general change of variables formula, change of variables in cylindrical coordinate system, change of variables in spherical coordinate system.	M1.1 M1.2 M2.1 M2.3		A1, A2.1, A3
6	- Applications: Calculate the volume of an object. **Chapter 3. Parameter Dependent Intergrals** 3.1. Definite Intergrals depending on parameters - Definition - Theorems on continuity.	M1.1 M1.2 M2.2 M2.1 M2.3		A1, A2.2, A3
7	- Theorems on differentiation under integral sign, integration under integral sign. 3.2. Improper Integrals depending on parameters - Definition - Uniform convergence, Weierstrass theorem.	M1.1 M1.2 M2.1 M2.3		A1, A2.2, A3
8	- Properties: continuity, differentiation	M1.1		A1, A2.2,

Week	Topics	Objective	Activities	Exercises
[1]	[2]	[3]	[4]	[5]
	under integral sign, integration under integral sign. 3.3. Euler's integrals - Introduce Gamma function ($\Gamma(p)$) and properties: definiteness, continuity, infinite differentiability. $\Gamma(p+1) = p\Gamma(p) \quad \forall p > 0,$ $\Gamma(p)\Gamma(1-p) = \frac{\pi}{\sin(p\pi)} \quad (0 < p < 1)$ (no proof). - Beta function: Introduce Beta function ($\mathrm{B}(p,q)$) with its two types and properties (no proof): symmetry. $\mathrm{B}(p,q) = \frac{p}{p+q-1}\mathrm{B}(p,q-1),$ $\mathrm{B}(p,q) = \frac{\Gamma(p)\Gamma(q)}{\Gamma(p+q)}.$	M1.2 M2.1 M2.3		A3
9	**Chapter 4. Line Integrals** 4.1. Line integrals of scalar fields - Definition - Calculation 4.2. Line integrals of vector fields - Definition, physical meaning. - Properties	M1.1 M1.2 M2.1 M2.2 M2.3	- Lecture, exchange questions and answers with students during the lecture Student: - Read in advance the next lesson - Master the basic concepts and apply to solve exercises according to the content and progress of the subject	A1, A2.2, A3
10	- Relation of line integrals of scalar fields and line integrals of vector fields. - Calculation - Green's Theorem (proof for the case of a simple region).	M1.1 M1.2 M2.1 M2.3		A1, A2.2, A3
11	- Path independence of line integrals (no proof); find a function $u(x,y)$ such that $du = Pdx + Qdy$. **Chapter 5. Surface integrals** 5.1 Surface integrals of scalar fields - Definition - Calculation	M1.1 M1.2 M2.1 M2.3		A1, A3
12	5.2 Surface integrals of vector fields - Definition, properties. - Relation of surface integrals of scalar fields and surface integrals of vector fields.	M1.1 M1.2 M2.1 M2.3		A1, A3

Week	Topics	Objective	Activities	Exercises
[1]	[2]	[3]	[4]	[5]
	- Calculation			
13	- Ostrogradsky's Theorem, Stoke's Theorem (no proof). **Chapter 6.** Field Theory 6.1 Scalar Fields - Notions of scalar fields and level surfaces. - Directional derivative: Definition, Theorem on relation between directional derivative and partial derivative.	M1.1 M1.2 M2.1 M2.3		A1, A3
14	- Gradient: Definition of vector $\overrightarrow{\text{grad}u}$ and theorem $\frac{\partial u}{\partial \vec{\ell}} = ch_{\vec{\ell}}\overrightarrow{\text{grad}u}$ (no proof) and properties. 6.2 Vector Fields - Notions of vector fields and flow lines, system of differential equations of flow lines. - The flux, div, incompressible fields: the flux of a vector field across oriented surface *S*, div (divergence), properties, incompressible fields, source (point), sink (point).	M1.1 M1.2 M2.1 M2.2 M2.3		A1, A3
15	- Circulation and curl vector: the circulation of a vector field around an oriented closed curve, curl vector, curly point. - Conservative vector fields: notions of conservative vector fields $\vec{F}$, the potential function for $\vec{F}$, conditions for a vector field to be conservative, conditions for an expression to be the total differential, path independence of spatial line integrals.	M1.1 M1.2 M2.1 M2.2 M2.3		A1, A3
16	**Summary**			A1, A3

7. **RULES OF THE MODULE**
(Regulations of the course if any)

8. **DATE OF APPROVAL:**

Faculty of Mathematics and Informatics