Department of Mathematics

College of Science

Salahaddin University-Erbil

Subject: Vector Calculus

Course Book: Second year (Second Course)

Lecturer's name: Fuad W. Khdhr

Academic Year: 2023-2024

Course Book

1. Course name	Multivariable Calculus
2. Lecturer in charge	Fuad Wahid Khdhr
3. Department/ College	Mathematics / Science
4. Contact	e-mail: fuad.khdhr@su.edu.krd Tel: +9647504493156
5. Time (in hours) per week	For example Theory: 3 Practical: 2
6. Office hours	
7. Course code	**SMC1 201**
8. Teacher's academic profile	"My name is **Fuad Wahid Khdhr**, I born in Erbil, Iraq in 1981. I graduated from mathematics Department / College of Science in Salahaddin University-Erbil in 2004-2005, in Erbil, Iraq. I got Master of Science in mathematics (Numerical Analysis) in 2010. I got PhD in mathematics (Numerical Analysis) in 2021. I am working as a lecturer in mathematics department / college of science / Salahaddin University-Erbil".
9. Keywords	

10. Course overview:

Multivariable Calculus extends the concepts of single-variable calculus to functions of multiple variables. This course covers the following key topics:

Functions of Several Variables: Understanding how to represent and visualize functions with two or more inputs, including level curves and surfaces.

Partial Derivatives: Learning how to compute and interpret partial derivatives, the gradient vector, and applications such as tangent planes and linear approximations.

Multiple Integrals: Extending integration to multiple dimensions, covering double and triple integrals in Cartesian, polar, cylindrical, and spherical coordinates. Applications include calculating volumes, surface areas, and other physical quantities.

Vector Calculus: Exploring vector fields, line integrals, and surface integrals. Key theorems such as Green's Theorem, stokes' Theorem, and the Divergence Theorem are introduced and applied.

Optimization: Techniques for finding local and global extrema of multivariable functions, including methods using Lagrange multipliers for constrained optimization problems.

11. Course objective:

By the end of this course, students will be able to:

Understand and Represent Multivariable Functions: Grasp the concept of functions with several variables, and be able to visualize these functions through level curves, contour plots, and 3D surface plots.

Compute and Interpret Partial Derivatives: Calculate partial derivatives of multivariable functions, understand their geometric and physical interpretations, and apply them to find tangent planes and linear approximations.

Evaluate Multiple Integrals: Perform double and triple integrals in various coordinate systems (Cartesian, polar, cylindrical, and spherical), and apply these integrals to compute volumes, areas, and other physical properties.

Apply Vector Calculus Concepts: Analyze vector fields, compute line and surface integrals, and utilize fundamental theorems of vector calculus, including Green's Theorem, Stokes' Theorem, and the Divergence Theorem.

Solve Optimization Problems: Find local and global extrema of multivariable functions, both constrained and unconstrained, using techniques such as the method of Lagrange multipliers.

Apply Theoretical Knowledge to Practical Problems: Use the principles and techniques of multivariable calculus to solve real-world problems in fields such as physics, engineering, and economics.

Develop Analytical and Problem-Solving Skills: Enhance their ability to think analytically and solve complex problems involving multiple variables, preparing them for advanced studies and professional applications.

12. Student's obligation

- **a.** Students must come on time and remain in the classroom for the duration of scheduled classes and Labs.
- **b.** Students own an obligation to write tests and final examinations at the times scheduled by the teacher or the College.

13. Forms of teaching

I give hard copy of My lecture notes to students before coming lecturer time. first I remember students about previous lecture, and then I start new lecture. At the end of the lecture give a homework for the next lecture. During this proses I am use presentation and whiteboard.

14. Assessment scheme

1. ***Toturial:*** 15% Toturial and quizzes in Lab.
2. ***Theoretical:*** 25% (Midterm exams and other activities).
3. ***Final Exam: Theoretical:*** 40% .

15. Student learning outcome:

Upon successful completion of this course, students will be able to:

- **a.** **Describe and Visualize Multivariable Functions**: Clearly explain the properties of functions with multiple variables and create accurate visual representations, including level curves and 3D surface plots.
- **b.** **Calculate Partial Derivatives and Gradients**: Accurately compute partial derivatives and gradients, and use them to analyze the behavior of multivariable functions, including identifying tangent planes and performing linear approximations.
- **c.** **Evaluate and Apply Multiple Integrals**: Solve double and triple integrals in Cartesian, polar, cylindrical, and spherical coordinates, and apply these integrals to compute volumes, surface areas, and other physical quantities.
- **d.** **Analyze and Interpret Vector Fields**: Evaluate vector fields and compute line integrals and surface integrals. Apply major theorems of vector calculus, such as Green's Theorem, Stokes' Theorem, and the Divergence Theorem, to solve related problems.

e. **Solve Optimization Problems**: Identify and solve problems involving the optimization of multivariable functions, both with and without constraints, using methods like Lagrange multipliers.

f. **Apply Calculus Concepts to Real-World Scenarios**: Utilize multivariable calculus principles to address and solve practical problems in various fields such as physics, engineering, and economics.

g. **Demonstrate Analytical and Problem-Solving Skills**: Exhibit enhanced analytical thinking and problem-solving abilities, specifically in the context of multivariable calculus, preparing for advanced studies and professional challenges.

h. .

16. Course Reading List and References:

[1] Ahmed M. S., Hardi N. O.. (2023) "Advanced Calculus", Hawler, Kurdistan Region – Iraq.

[2] Stewart, J. (2015). *Calculus: Early Transcendentals*. Cengage Learning.

[3] Thomas, G. B., Weir, M. D., & Hass, J. (2018). *Thomas' Calculus*. Pearson.

[4] Colley, S. J. (2011). *Vector Calculus*. Pearson.

17. The Topics:	Lecturer's name
First Course **Chapter One: Vector and the Geometry space** Vector, Dot and Cross Products Orthogonal and Perpendicular vectors Equation of Line and Planes Functions and Surfaces **Chapter Two: Directional Derivatives** Directional Derivatives Gradient vector Tangent plane Extreme value and saddle points Lagrange multipliers **Chapter Three: Multiple Integrals** Double Integrals Triple Integrals Change of Variables Area Volume	14 week (3 hours)

18. Examinations:

Questions in the examination will be arranged the matching mode by way of the examples and exercises that I give delivered in the lecture notes.
Sometimes will be have extra mark in examination for worthy students.

20. Extra notes:

Answers of examination will be find in the board's declaration mathematics department after every examination.