## Calculus in Higher Dimensions

Background

This topic deals with extending concepts such as limits, continuity, differentiation, and integration, studied in first year calculus, to functions of several variables. Topics covered:

- Continuity of functions of several variables.

- Limits, partial derivatives, gradients, directional derivatives, divergence, and curl and apply these concepts to problem solving.

- Nature of extrema and optimization problems using Lagrange multipliers.

- Determine double and triple integrals and use them to calculate areas and volumes.

- Determine line, surface and flux integrals and apply the theorems of Green, Stokes and Gauss, which relate these types of integrals.

The Study Guide Splits the above topics into three distinct units:  
Basic Concepts

* Preliminaries (Sets, Relations, Implications, Symbols)
* N-dimensional Euclidian space (R, dot products, Norm, Distance, Unit Vectors, Basis Vectors, Angle between vectors, Cross Product, Lines, Subsets)
* Functions (visualisation, Rn-Rp)

Differentiation

* Limits and Continuity (R-R functions, Rn-R functions, Real Valued functions, Limits along curves, Vector Valued functions, Continuity)
* Derivatives Real Valued functions (One Variable)
* Derivatives Vector Valued functions (Chain Rule, Piecewise smooth curves)
* Derivatives Real Valued functions (Several Variables) (Rn-R functions, Gradient of Rn-R functions, Differentiability of Rn-R functions, Chain Rule, Directional Derivatives Rn-R functions, Potential Functions, Higher order Partial Derivatives)
* Derivatives of Vector Field
* Taylor Polynomials (R-R functions, Rn-R functions)

Integration

* Single Integrals
* Double Integrals
* Triple Integrals
* Line Integrals
* Surface Integrals
* Flux Integrals
* Theorems (Green, Gauss, Stokes)

**Lesson 1**

Parametric Equations

A parametric equation is where the x and y coordinates are both written in terms of another letter. This is called a parameter and is usually given the letter t or . ( is normally used when the parameter is an angle, and is measured from the positive x-axis.)

A close up of a map

Description automatically generatedExample 1: Plot the graph of

*Don’t simplify further,*

Example 2: Plot the graph of

*Try write the equation in the form ,*

A close up of a map

Description automatically generated