

# Mathematics

## The fall/winter semester

Course	Type of class		ECTS
Mathematics	Lecture	Chalkboard practice	10
Numbers of hours per week	3	3	

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**Department of Physical Chemistry and Technology of Polymers**

## Contents

### UNIT 1. Introduction

Sets of numbers. Induction. The idea of function. Simple algebraic functions. The inverse function. Exponential functions. The logarithm function. Trigonometrical functions. Inverse trigonometrical functions. Hyperbolic functions. Parametric representation of curves. One-sided limits. Rules for calculating limits. Limits at infinity and infinite limits. Testing for continuity.

### UNIT 2. Rates of change and differentiation

Defining rate of change. Average rate of change. Instantaneous rate of change. Differentiation of some standard functions. Differentiation of  $x^n$ . Differentiation of  $\sin x$  and  $\cos x$ . Differentiating the exponential and logarithm functions. Basic rules for differentiation. Sums, products and quotients of functions. The chain rule. Higher-order derivatives. Maxima and minima. The differentiation of functions of two or more variables: a preview. The partial derivative.

### UNIT 3. Applications of Derivatives

Tangent and Normal. Curvature and radius of curvature. L'Hôpital's rule. Rolle's theorem. Lagrange mean value theorem. Cauchy's mean value theorem. Asymptotes. The first derivative test. The second derivative test. Sketching the graph of a function.

### UNIT 4. Multivariable Functions and Their Derivatives

Functions of several variables. Limits and continuity in higher dimensions. Partial derivatives. The chain rule. Directional derivatives, gradient vectors, and tangent planes. Linearization and differentials. The tangent approximation. Some further uses of the tangent approximation. The Newton-Raphson method. Reformulating the tangent approximation. The differential of a function of two variables: preview. Some discussion of the idea of a differential. Differential forms: pffafians and exact differentials.

### UNIT 5. Sequences, Series, Power series

Limits of sequences of numbers. Applying the limit laws. Series and partial sums. Infinite series. Geometric series. Testing for convergence. Series of nonnegative terms. Harmonic series. Comparison tests. Ratio and root tests. Alternating series. Absolute and conditional convergence. Power series. The radius and interval of convergence. The Maclaurin series. The Taylor series.

## **UNIT 6. Integration**

Antiderivatives. Basic properties of Integrals. Methods for evaluating integrals. Rearrangement of the integrand. The substitution method. A useful result. Integrals involving rational polynomial functions. Use of partial fractions. Integration by parts

## **UNIT 7. Definite Integral**

Riemann sums and the integral. Properties of the definite integral. A mean-value theorem for integrals. The fundamental theorem of calculus. Substitution in definite integrals. Iteration by parts. Improper integrals. Numerical determination of definite integrals. Areas of plane regions. Arc length and surface area of revolution. Volumes by slicing and rotation about an axis.

## **UNIT 8. Fourier series**

Coefficients in the Fourier series expansion. Fourier series. Even extension: Fourier Cosine series and odd extension: Fourier Sine series.

## **UNIT 9. System of Linear Equations and Matrices**

Some notations. Determinants. Some properties of determinants. Special forms of matrices. Matrix algebra. Inverse matrix. Solving systems of linear equations using matrices – Cramer's rule and inverse matrix method. Eigenvalues and eigenvectors. Determination of eigenvalues and eigenvectors.

### **References**

1. Ross L.Finney, Maurice D.Weir, Frank R.Giordano „Thomas' CALCULUS”, Addison Wesley 2003
2. Bronshtein, I.N.; Semendyayev, K.A.; Musiol, G.; Muehling, H. Handbook of Mathematics, Springer - Verlag 2004
3. Kazimierz Kuratowski “Introduction to calculus”, Pergamon Press, 1962
4. G.Doggett, B.T.Sutcliffe, “Mathematics for Chemistry”, Longman 1999.
5. S.L.Salas, E.Hille, “Calculus – one and several variables”, 6<sup>th</sup> ed. John Wiley, NY 1994.
6. Włodzimierz Wrona „Matematyka” tom I i II, PWN 1966
7. Włodzimierz Krysicki, Lech Włodarski, Analiza matematyczna w zadaniach, PWN 2007