UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Abbreviated Syllabi (2013)

1. **Mathematics Modules for BSc Programmes**
2. **Mathematic Modules for BEng Programmes**

Mathematics Modules for BSc Programmes

(WTW 114) Calculus 114 (16 credits) (4 lectures and 1 tutorial of 3 hours)
This module serves as preparation for students majoring in Mathematics (including all students who intend to enrol for WTW 218 and WTW 220). Students will not be credited for more than one of the following modules for their degree: WTW 114, WTW 158, WTW 134.
Functions, limits and continuity. Differential calculus of single variable functions, rate of change, graph sketching, applications. The mean value theorem, the rule of L'Hospital. Definite and indefinite integrals. Evaluating definite integrals using anti-derivatives, the substitution rule.
Language of instruction: Both Afr and Eng
Prerequisite: Refer to Regulation 1.2

(WTW 115) Discrete Structures 115 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
Propositional logic: truth tables, logical equivalence, implication, arguments. Mathematical induction and well-ordering principle. Introduction to set theory. Counting techniques: elementary probability, multiplication and addition rules, permutations and combinations, binomial theorem, inclusion-exclusion rule.
Language of instruction: Both Afr and Eng
Double Medium
Prerequisite: Refer to Regulation 1.2

(WTW 123) Numerical Analysis 123 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
Non-linear equations, numerical integration, initial value problems for differential equations, systems of linear equations. Algorithms for elementary numerical techniques are derived and implemented in computer programmes. Error estimates and convergence results are treated.
Language of instruction: Both Afr and Eng
Prerequisite: [WTW114 GS]

(WTW 126) Linear Algebra 126 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
This module serves as preparation for students majoring in Mathematics (including all students who intend to enrol for WTW 211).
Vector algebra with applications, matrix algebra, systems of linear equations, the vector space R^n, bases, determinants. Mathematical induction. Complex numbers and factorisation of polynomials. Students will not be credited for more than one of the following modules for their degree: WTW 126, WTW 161.
Language of instruction: Both Afr and Eng
Prerequisite: Refer to Regulation 1.2

(WTW 128) Calculus 128 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
This module serves as preparation for students majoring in Mathematics (including all students who intend to enrol for WTW 218 and WTW 220). Students will not be credited for more than one of the following modules for their degree: WTW 128, WTW 168.
Applications of integration. The formal definition of a limit. The fundamental theorem of Calculus and applications. Parametric and polar equations. Vector functions of one variable, quadratic curves. Introduction to functions of several variables and partial derivatives.
Language of instruction: Both Afr and Eng
Prerequisite: [WTW114 GS]

(WTW 133) Precalculus 133 (8 credits) (5 lectures, 1 tutorial of 2 hours and 1 computer session of 1 hour)
Real numbers, elementary set notation, exponents and radicals. Algebraic expressions, fractional expressions, linear and quadratic equations, inequalities. Coordinate geometry: lines, circles. Functions: definition, notation, piecewise defined functions, absolute value, domain and range, graphs, transformations of functions, symmetry, even and odd functions, combining functions, one-to-one functions and inverses, polynomial functions and zeros.
Sequences, summation notation, arithmetic, geometric sequences, infinite geometric series, annuities and instalments. Degrees and radians, unit circle, trigonometric functions, fundamental identities, trigonometric graphs, trigonometric identities, double-angle, half-angle formulae, inverse trigonometric functions, trigonometric equations, applications.
Language of instruction: English
Prerequisite: As for Four-year programme

(WTW 134) Mathematics 134 (16 credits) (4 lectures and 1 tutorial of 1½ hours)
Students will not be credited for more than one of the following modules for their degree: WTW 134, WTW 114, WTW 158. WTW 134 does not generally lead to admission to Mathematics at 200 level and is intended for students who require Mathematics at 100 level only. WTW 134 can also be taken in the second semester.
Functions, derivatives, interpretation of the derivative, rules of differentiation, applications of differentiation, integration, interpretation of the definite integral, applications of integration. Discrete probability, matrices, solutions of systems of equations. Markov chains.
Language of instruction: Both Afr and Eng
Prerequisite: Refer to Regulation 1.2

(WTW 143) Calculus 143 (8 credits) (4 lectures, 1 tutorial of 2 hours and 1 computer session of 1 hour)
Functions: exponential and logarithmic functions, natural exponential and logarithmic functions, exponential and logarithmic laws, exponential and logarithmic equations, compound interest. Limits: concept of a limit, finding limits numerically and graphically, finding limits algebraically, limit laws without proofs, squeeze theorem without proof, one-sided limits, infinite limits, limits at infinity, vertical, horizontal and slant asymptotes, substitution rule, continuity, laws for continuity without proofs. Differentiation: average and instantaneous change, definition of derivative, differentiation rules without proofs, derivatives of polynomials, chain rule for differentiation, derivatives of trigonometric, exponential and logarithmic functions, applications of differentiation: extreme values, critical numbers, monotone functions, first derivative test, optimisation.
Language of instruction: English
Prerequisite: [WTW 133]

(WTW 144) Calculus 144 (8 credits) (4 lectures, 1 tutorial of 2 hours and 1 computer session of 1 hour)
Functions: Rate of change, exponential functions, the natural logarithm, exponential growth and decay, proportionality, power functions, fitting formulas to data.
Rates of change and the derivative: Instantaneous rate of change, the derivative function, interpretations of the derivative, the second derivative.
Differentiation: Formulas and rules, applications, extremes of a function.
Integration: Accumulated change, the definite integral, antiderivatives, definite integrals, the definite integral as an area, interpretations of the definite integral.
Language of instruction: English
Prerequisite: [WTW 133]

(WTW 152) Mathematical Modelling 152 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
Introduction to the modelling of dynamical processes using difference equations. Curve fitting. Introduction to linear programming. Matlab programming. Applications to real-life situations in, amongst others, finance, economics and ecology.
Language of instruction: Both Afr and Eng
Prerequisite: Refer to Regulation 1.2

(WTW 153) Calculus 153 (8 credits) (4 lectures, 1 tutorial of 2 hours and 1 computer session of 1 hour)
Rigorous treatment of limits and continuity. Differential calculus of a single variable with proofs and applications. The mean value theorem, the rule of L'Hospital. Upper and lower sums, definite and indefinite integrals, the fundamental theorem of Calculus, the mean value theorem for integrals, integration techniques, with some proofs.
Language of instruction: English
Prerequisite: [WTW 143]

(WTW 154) Finite mathematics 154 (8 credits) (4 lectures, 1 tutorial of 2 hours and 1 computer session of 1 hour)
Probability theory: Set theory, basic principles and definitions, relative frequencies, probability models for finite sample spaces, experiments with equally likely outcomes, probability formulas, counting methods.
Matrics and systems of linear equations: Matrix addition and scalar multiplication, matrix multiplication, sytems of linear equations.
Markov chains: Transitions matrices and state vectors, regular matrices.
Language of tuition: English Credits: 8
Prerequisite: [WTW 144]

(WTW 162) Dynamical Processes 162 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
Introduction to the modelling of dynamical processes using elementary differential equations. Solution methods for first order differential equations and analysis of properties of solutions (graphs). Applications to real life situations.
Language of instruction: English
Prerequisites: [WTW114 GS]

(WTW 183) Precalculus 183 (8 credits) (5 lectures, 1 tutorial of 2 hours and 1 computer session of 1 hour)
Real numbers, elementary set notation, exponents and radicals. Algebraic expressions, fractional expressions, linear and quadratic equations, inequalities. Coordinate geometry: lines and circles. Functions: definition, notation, piecewise defined functions, absolute value, domain and range, graphs of functions, increasing and decreasing functions, average rates of change, quadratic functions, minima and maxima, symmetry, transformations of functions, even and odd functions, combining functions, polynomial functions and zeros, exponential and logarithmic functions, one-to-one functions and inverses and applications. Sequences, summation notation, arithmetic, geometric sequences, infinite geometric series. Mathematics of finance: Annuities, instalments, fractions versus percentages, etc. Introduction to limits, area problem and applications. Geometry.
Language of instruction: English
Prerequisites: As for BCom Four-year Programme (e.g. Grade 12 Mathematics level 3, etc)

(WTW 211) Linear Algebra 211 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
This is an introduction to linear algebra on R^n. Matrices and linear equations, linear combinations and spans, linear independence, subspaces, basis and dimension, eigenvalues, eigenvectors, similarity and diagonalisation of matrices, linear transformations.
Language of instruction: Both Afr and Eng
Prerequisite: [WTW126]

(WTW 218) Calculus 218 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
Calculus of multivariable functions, directional derivatives. Extrema and Lagrange multipliers. Multiple integrals, polar, cylindrical and spherical coordinates. Line integrals and the theorem of Green. Surface integrals and the theorems of Gauss and Stokes.
Language of instruction: Both Afr and Eng

Prerequisites: [WTW114] and [WTW 126] and [WTW128]

(WTW 220) Analysis 220 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
Properties of real numbers. Analysis of sequences and series of real numbers. Power series and theorems of convergence. The Bolzano-Weierstrass theorem. The intermediate value theorem and analysis of real-valued functions on an interval. The Riemann integral: Existence and properties of the interval
Language of instruction: Both Afr and Eng
Prerequisites: [WTW114] and [WTW128]

(WTW 221) Linear Algebra 221 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
Abstract vector spaces, change of basis, matrix representation of linear transformations, orthogonality, diagonalisability of symmetric matrices, some applications.
Language of instruction: Both Afr and Eng
Prerequisite: [WTW211]

(WTW 248) Vector Analysis 248 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
Vectors and geometry. Calculus of vector functions with applications to differential geometry, kinematics and dynamics. Vector analysis, including vector fields, line integrals of scalar and vector fields, conservative vector fields, surfaces and surface integrals, the Theorems of Green, Gauss and Stokes with applications.
Language of instruction: Double medium
Prerequisite: [WTW 218]

(WTW 285) Discrete Structures 285 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
Setting up and solving recurrence relations. Equivalence and partial order relations. Graphs: paths, cycles, trees, isomorphism. Graph algorithms: Kruskal, Prim, Fleury. Finite state automata.
Language of instruction: Both Afr and Eng
Prerequisite: [WTW115]

(WTW 286) Differential Equations 286 (12 credits) (2 lectures and 1 tutorial of 1½ hours)
Theory and solution methods for ordinary differential equations and initial value problems: separable and linear first-order equations, linear equations of higher order, systems of linear equations. Application to mathematical models. Qualitative analysis of linear systems.
Language of instruction: Both Afr and Eng
Prerequisites: [WTW114] and [WTW126] and [WTW128]

(WTW 310) Analysis 310 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Topology of finite dimensional spaces: Open and closed sets, compactness, connectedness and completeness. Theorems of Bolzano-Weierstrass and Heine-Borel. Properties of continuous functions and applications. Integration theory for functions of one real variable. Sequences of functions.
Language of instruction: Double medium
Prerequisite: [WTW220]

(WTW 320) Analysis 320 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Series of functions, power series and Taylor series. Complex functions, Cauchy- Riemann equations, Cauchy's theorem and integral formulas. Laurent series, residue theorem and calculation of real integrals using residues.
Language of instruction: Double medium
Prerequisites: [WTW218] and [WTW310]

(WTW 354) Financial Engineering 354 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Mean variance portfolio theory. Market equilibrium models such as the capital asset pricing model. Factor models and arbitrage pricing theory. Measures of investment risk. Efficient market hypothesis. Stochastic models of security prices
Language of instruction: Double medium
Prerequisites: [WST211] and [WTW211] and [WTW218]

(WTW 364) Financial Engineering 364 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Discrete time financial models: Arbitrage and hedging; the binomial model. Continuous time financial models: The Black-Scholes formula; pricing of options and the other derivatives; interest rate models; numerical procedures.
Language of instruction: English
Prerequisites: [WST211] and [WTW126] and [WTW218] and [WTW286]

(WTW 381) Algebra 381 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Group theory: Definition, examples, elementary properties, subgroups, permutation groups, isomorphism, order, cyclic groups, homomorphisms, factor groups. Ring theory: Definition, examples, elementary properties, ideals, homomorphisms, factor rings, polynomial rings, factorisation of polynomials. Field extensions, applications to straight-edge and compass constructions.
Language of instruction: Double medium
Prerequisite: [WTW114] and [WTW211]

WTW 382) Dynamical Systems 382 (18 credits) **(2 lectures and 1 tutorial of 1½ hours)**
Matrix exponential function: homogeneous and non-homogeneous linear systems of differential equations. Qualitative analysis of systems: phase portraits, stability, linearisation, energy method and Liapunov's method. Introduction to chaotic systems. Application to real life problems.
Language of instruction: Double medium
Prerequisites: [WTW218] and [WTW286]

(WTW 383) Numerical Analysis 383 (18 credits) (2 lectures and 1 practical of 1½ hours)
Direct methods for the numerical solution of systems of linear equations, pivoting strategies. Iterative methods for solving systems of linear equations and eigenvalue problems. Iterative methods for solving systems of nonlinear equations. Introduction to optimization. Algorithms for the considered numerical

methods are derived and implemented in computer programmes. Complexity of computation is investigated. Error estimates and convergence results are proved.
Language of instruction: Double medium
Prerequisites: [WTW114] and [WTW128] and [WTW211]

(WTW 386) Partial Differential Equations 386 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Conservation laws and modelling. Fourier analysis. Heat equation, wave equation and Laplace's equation. Solution methods including Fourier series. Energy and other qualitative methods.
Language of instruction: Double medium
Prerequisites: [WTW248] and [WTW286]

(WTW 387) Continuum Mechanics 387 (18 credits) (2 lectures and 1 tutorial of 1 ½ hours)
Kinematics of a continuum: Configurations, spatial and material description of motion. Conservation laws. Analysis of stress, strain and rate of deformation. Linear constitutive equations. Applications: Vibration of beams, equilibrium problems in elasticity and special cases of fluid motion.
This module can be presented as an elective module in 2010 subject to sufficient student enrolments. Please consult Head of Department.
Language of instruction: Double medium
Prerequisites: [WTW 248] and [WTW 286]

(WTW 389) Geometry 389 (18 credits) (2 lectures and 1 tutorial of 1½ hours)
Axiomatic development of neutral, Euclidean and hyperbolic geometry. Using models of geometries to show that the parallel postulate is independent of the other postulates of Euclid.
Language of instruction: Double medium
Prerequisite: [WTW211]

Mathematic Modules for BEng Programmes

(WTW 158) Calculus 158 (16 credits) (4 lectures and 1 tutorial of 3 hours)
(B1, C1, E1, M1, N1, P1, R1, S1, Z1)
This module is designed for 1st year engineering students. Students will not be credited for more than one of the following modules for their degree: WTW 158, WTW 114, WTW 134.
Introduction to vector algebra. Functions, limits and continuity. Differential calculus of single variable functions, rate of change, graph sketching, applications. The mean value theorem, the rule of L'Hospital. Indefinite integrals, integration.
Language of instruction: Both Afr and Eng
Prerequisite: Refer to Regulation 1.2

(WTW 161) Linear Algebra 161 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
(B1, C1, E1, M1, N1, P1, R1, S1, Z1)
This module is designed for first-year engineering students. Students will not be credited for more than one of the following modules for their degree: WTW 161, WTW 126.
Vector algebra with applications, matrix algebra, systems of linear equations, the vector space R^n, bases, determinants. Mathematical induction. Complex numbers and factorisation of polynomials. Conic sections. This module also includes a formal technique mastering programme.
Language of instruction: Both Afr and Eng
Prerequisite: Refer to Regulation 1.2

(WTW 168) Calculus 168 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
(B1, C1, E1, M1, N1, P1, R1, S1, Z1)
This module is designed for first-year engineering students. Students will not be credited for more than one of the following modules for their degree: WTW 168, WTW 128, WTW 138.
Integration techniques, improper integrals. The definite integral, fundamental theorem of Calculus. Applications of integration. Elementary power series and Taylor's theorem. Vector functions, space curves and arc lengths. Quadratic surfaces and multivariable functions.
Language of instruction: Both Afr and Eng
Prerequisite: WTW 114 GS or WTW 158 GS

(WTW 238) Mathematics 238 (16 credits) (4 lectures and 1 tutorial of 100 minutes)
(B2, C2, E2, M2, N2, P2, R2, S2, Z2)
Linear algebra, eigenvalues and eigenvectors with applications to first and second order systems of differential equations. Sequences and series, convergence tests. Power series with applications to ordinary differential equations with variable coefficients. Fourier series with applications to partial differential equations such as potential, heat and wave equations.
Language of instruction: Both Afr and Eng
Prerequisites: WTW 258 GS and WTW 258 GS

(**WTW 256) Differential Equations 256** (8 credits) (2 lectures and 1 tutorial of 1½ hours)
(B2, C2, E2, M2, N2, P2, R2, S2, Z2)
Theory and solution methods for linear differential equations as well as for systems of linear differential equations. Theory and solution methods for first order non-linear differential equations. The Laplace transform with application to differential equations. Application of differential equations to modelling problems.
Language of instruction: Both Afr and Eng
Prerequisites: WTW 158 and WTW 161 and WTW 168

(WTW 258) Calculus 258 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
(B2, C2, E2, M2, N2, P2, R2, S2, Z2)
Calculus of multivariable functions, directional derivatives. Extrema. Multiple integrals, polar, cylindrical and spherical coordinates. Line integrals and the theorem of Green. Surface integrals and the theorems of Gauss and Stokes.

Language of instruction: Both Afr and Eng
Prerequisites: WTW 158 and WTW 168

(WTW 263) Numerical Methods 263 (8 credits) (2 lectures and 1 tutorial of 1½ hours)
(B2, C2, E2, M2, N2, P2, R2, S2, Z2)
Numerical integration. Numerical methods to approximate the solution of non-linear equations, systems of equations (linear and non-linear), differential equations and systems of differential equations. Direct methods to solve linear systems of equations.
Language of instruction: Both Afr and Eng
Prerequisites: WTW 161 and WTW 168

Abbreviations:

Symbol	**Field of study**
B	Industrial Engineering
C	Chemical Engineering
E	Electrical Engineering
R	Computer Engineering
Z	Electronic Engineering
M	Mechanical Engineering
N	Metallurgical Engineering
P	Mining Engineering
S	Civil Engineering