

# University of Pretoria Yearbook 2018

## BSc Physics (02133203)

**Minimum duration of study** 3 years

**Total credits** 428

### Admission requirements

- The following persons will be considered for admission: a candidate who is in possession of a certificate that is deemed by the University to be equivalent to the required Grade 12 certificate with university endorsement; a candidate who is a graduate from another tertiary institution or has been granted the status of a graduate of such an institution; and a candidate who is a graduate of another faculty at the University of Pretoria.
- Life Orientation is excluded in the calculation of the Admission Point Score (APS).
- Grade 11 results are used for the provisional admission of prospective students. Final admission is based on the Grade 12 results.

Minimum requirements												
Achievement level												
Afrikaans or English				Mathematics				Physical Science				APS
NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	
5	3	C	C	5	3	C	C	5	3	C	C	32

- Candidates who do not comply with the minimum admission requirements for BSc (Physics), may be considered for admission to the BSc - Extended programme for the Physical Sciences. The BSc - Extended programme takes place over a period of four years instead of the normal three years.

### BSc - Extended programme for the Physical Sciences:

Minimum requirements													
Achievement level													
	Afrikaans or English				Mathematics				Physical Science				APS
	NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	NSC/IEB	HIGCSE	AS-Level	A-Level	
BSc - Extended programme for the Physical Sciences	4	3	D	D	4	3	D	D	4	3	D	D	26

### Other programme-specific information

A student must pass all the minimum prescribed and elective module credits as set out at the end of each year within a programme as well as the total required credits to comply with the particular degree programme. Please refer to the curricula of the respective programmes. At least 144 credits must be obtained at 300-/400-level, or otherwise as indicated by curriculum. The minimum module credits needed to comply with degree requirements is set out at the end of each study programme. Subject to the programmes as indicated a maximum of 150 credits will be recognised at 100-level. A student may, in consultation with the Head of Department and subject to the permission by the Dean, select or replace prescribed module credits not indicated in BSc three-year study programmes to the equivalent of a maximum of 36 module credits.

It is important that the total number of prescribed module credits is completed during the course of the study programme. The Dean may, on the recommendation of the Head of Department, approve deviations in this regard. Subject to the programmes as indicated in the respective curricula, a student may not register for more than 75 module credits per semester at first-year level subject to permission by the Dean. A student may be permitted to register for up to 80 module credits in a the first semester during the first year provided that he or she obtained a final mark of no less than 70% for grade 12 Mathematics and achieved an APS of 34 or more in the NSC.

Students who are already in possession of a bachelor's degree, will not receive credit for modules of which the content overlap with modules from the degree that was already conferred. Credits will not be considered for more than half the credits passed previously for an uncompleted degree. No credits at the final-year or 300- and 400-level will be granted.

The Dean may, on the recommendation of the programme manager, approve deviations with regard to the composition of the study programme.

Please note: Where elective modules are not specified, these may be chosen from any modules appearing in the list of modules.

It remains the student's responsibility to ascertain, prior to registration, whether they comply with the prerequisites of the modules they want to register for.

The prerequisites are listed in the Alphabetical list of modules.

## Promotion to next study year

A student will be promoted to the following year of study if he or she passed 100 credits of the prescribed credits for a year of study, unless the Dean on the recommendation of the head of department decides otherwise. A student who does not comply with the requirements for promotion to the following year of study, retains the credit for the modules already passed and may be admitted by the Dean, on recommendation of the head of department, to modules of the following year of study to a maximum of 48 credits, provided that it will fit in with both the lecture and examination timetable.

### General promotion requirements in the faculty

All students whose academic progress is not acceptable can be suspended from further studies.

- A student who is excluded from further studies in terms of the stipulations of the abovementioned regulations, will be notified in writing by the Dean or Admissions Committee at the end of the relevant semester.
- A student who has been excluded from further studies may apply in writing to the Admissions Committee of the Faculty of Natural and Agricultural Sciences for re-admission.

- Should the student be re-admitted by the Admissions Committee, strict conditions will be set which the student must comply with in order to proceed with his/her studies.
- Should the student not be re-admitted to further studies by the Admissions Committee, he/she will be informed in writing.
- Students who are not re-admitted by the Admissions Committee have the right to appeal to the Senior Appeals Committee.
- Any decision taken by the Senior Appeals Committee is final.

## Pass with distinction

A student obtains his or her degree with distinction if all prescribed modules at 300-level (or higher) are passed in one academic year with a weighted average of at least 75%, and obtain at least a subminimum of 65% in each of the relevant modules.

# Curriculum: Year 1

**Minimum credits: 140**

**Minimum credits:**

Fundamental = 12

Core = 64

Electives = 64

**Additional information:**

Students who do not qualify for AIM 102 must register for AIM 111 and AIM 121.

Second majors that may be combined with physics are: Mathematics, Applied Mathematics, Statistics, Chemistry, Geology and Meteorology. These will all allow students to postgraduate studies in the second major. Physics can also be combined with Astronomy and Computer Science, but these options do not offer the option of postgraduate studies outside of Physics.

Students must select elective modules with a total number of at least 64 credits according to the following streams. (Deviations allowed with permission from the head of department):

- **Mathematics as second major:** Due to the modules prescribed for the BSc (Physics) module, taking mathematics as a second major in 3<sup>rd</sup> year is possible for all options. Please select one of the options below.
- **Second major in applied mathematics or mathematical statistics:** WTW 115, WTW 152, WTW 162, WTW 123, WST 111, WST 121 (64 credits)
- **Second major in chemistry or applied mathematics:** CMY 117, CMY 127, WTW 162, WTW 123, WTW 115, WTW 152 (64 credits)
- **Second major in chemistry or mathematical statistics:** CMY 117, CMY 127, WST 111, WST 121 (64 credits)
- **Second major in chemistry or geology:** CMY 117, CMY 127, GLY 155, GLY 163 (64 credits)
- **Second major in chemistry or meteorology:** CMY 117, CMY 127, WKD 155, WTW 123, WTW 162 (64 credits).
- **Second major in chemistry with interest in biophysics:** CMY 117, CMY 127, MLB 111, GTS 161, BOT 161 (64 credits)
- **Second major in chemistry with interest in astronomy:** CMY 117, CMY 127, WTW 162, WTW 123, SCI 154 (64 credits)
- **Second major in applied mathematics with an interest in astronomy:** WTW 115, WTW 152, WTW 162, WTW 123, SCI 154, COS 132 (64 credits) **note: semesters unbalanced – Year credits: S1:80, S2: 48**
- **Computational physics:** WTW 123, COS 132, COS 110, COS 122, COS 151 (64 credits **note: semesters unbalanced – Year credits: S1:56, S2: 72**)

## Fundamental modules

### Academic information management 102 (AIM 102)

**Module credits** 6.00

**Service modules**

Faculty of Education  
Faculty of Economic and Management Sciences  
Faculty of Humanities  
Faculty of Law  
Faculty of Health Sciences  
Faculty of Natural and Agricultural Sciences  
Faculty of Theology and Religion  
Faculty of Veterinary Science

**Prerequisites** No prerequisites.

**Contact time** 2 lectures per week

**Language of tuition** Separate classes for Afrikaans and English

**Department** Information Science

**Period of presentation** Semester 2

### Module content

Find, evaluate, process, manage and present information resources for academic purposes using appropriate technology. Apply effective search strategies in different technological environments. Demonstrate the ethical and fair use of information resources. Integrate 21st-century communications into the management of academic information.

## Academic information management 111 (AIM 111)

**Module credits** 4.00

**Service modules**

- Faculty of Engineering, Built Environment and Information Technology
- Faculty of Education
- Faculty of Economic and Management Sciences
- Faculty of Humanities
- Faculty of Law
- Faculty of Health Sciences
- Faculty of Natural and Agricultural Sciences
- Faculty of Theology and Religion

**Prerequisites** No prerequisites.

**Contact time** 2 lectures per week

**Language of tuition** Separate classes for Afrikaans and English

**Department** Information Science

**Period of presentation** Semester 1

### Module content

Find, evaluate, process, manage and present information resources for academic purposes using appropriate technology.

## Academic information management 121 (AIM 121)

**Module credits** 4.00

**Service modules**

- Faculty of Engineering, Built Environment and Information Technology
- Faculty of Education
- Faculty of Economic and Management Sciences
- Faculty of Humanities
- Faculty of Law
- Faculty of Health Sciences
- Faculty of Natural and Agricultural Sciences
- Faculty of Theology and Religion
- Faculty of Veterinary Science

**Prerequisites** No prerequisites.

**Contact time** 2 lectures per week



**Language of tuition** Separate classes for Afrikaans and English

**Department** Informatics

**Period of presentation** Semester 2

### Module content

Apply effective search strategies in different technological environments. Demonstrate the ethical and fair use of information resources. Integrate 21st-century communications into the management of academic information.

## Language and study skills 110 (LST 110)

**Module credits** 6.00

**Service modules** Faculty of Natural and Agricultural Sciences  
Faculty of Veterinary Science

**Prerequisites** No prerequisites.

**Contact time** 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Unit for Academic Literacy

**Period of presentation** Semester 1

### Module content

The module aims to equip students with the ability to cope with the reading and writing demands of scientific disciplines.

## Academic orientation 102 (UPO 102)

**Module credits** 0.00

**Language of tuition** Afrikaans and English are used in one class

**Department** Natural and Agricultural Sciences Deans Office

**Period of presentation** Year

## Core modules

### First course in physics 114 (PHY 114)

**Module credits** 16.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education

**Prerequisites** A candidate must have passed Mathematics and Physical Science with at least 60% in the Grade 12 examination

**Contact time** 1 discussion class per week, 1 practical per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 1

### Module content

SI-units. Significant figures. Waves: intensity, superposition, interference, standing waves, resonance, beats, Doppler. Geometrical optics: Reflection, refraction, mirrors, thin lenses, instruments. Physical optics: Young-interference, coherence, diffraction, polarisation. Hydrostatics and dynamics: density, pressure, Archimedes' principle, continuity, Bernoulli. Heat: temperature, specific heat, expansion, heat transfer. Vectors. Kinematics of a point: Relative, projectile, and circular motion. Dynamics: Newton's laws, friction. Work: point masses, gasses (ideal gas law), gravitation, spring, power. Kinetic energy: Conservative forces, gravitation, spring. Conservation of energy. Conservation of momentum. Impulse and collisions. System of particles: Centre of mass, Newton's laws. Rotation: torque, conservation of angular momentum, equilibrium, centre of gravity.

## First course in physics 124 (PHY 124)

**Module credits** 16.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education

**Prerequisites** WTW 114 GS and PHY 114 GS

**Contact time** 1 discussion class per week, 1 practical per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 2

### Module content

Simple harmonic motion and pendulums. Coulomb's law. Electric field: dipoles, Gauss' law. Electric potential. Capacitance. Electric currents: resistance, resistivity, Ohm's law, energy, power, emf, RC-circuits. Magnetic Field: Hall-effect, Bio-Savart. Faraday's and Lenz's laws. Oscillations: LR-circuits. Alternating current: RLC-circuits, power, transformers. Introductory concepts to modern physics. Nuclear physics: Radioactivity.

## Calculus 114 (WTW 114)

**Module credits** 16.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education  
Faculty of Economic and Management Sciences  
Faculty of Humanities

**Prerequisites** Refer to Regulation 1.2. Mathematics 60% Grade 12.

**Contact time** 1 tutorial per week, 4 lectures per week

**Language of tuition** Separate classes for Afrikaans and English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1



## Module content

\*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, WTW 165.

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.

## Mathematics 124 (WTW 124)

**Module credits** 16.00

**Prerequisites** WTW 114

**Contact time** 1 tutorial per week, 4 lectures per week

**Language of tuition** Separate classes for Afrikaans and English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

## Module content

\*Students will not be credited for more than one of the following modules for their degree:

WTW 124, WTW 146, WTW 148 and WTW 164. This module serves as preparation for students majoring in Mathematics (including all students who intend to enrol for WTW 218, WTW 211 and WTW 220).

The vector space  $R^n$ , vector algebra with applications to lines and planes, matrix algebra, systems of linear equations, determinants. Complex numbers and factorisation of polynomials. Integration techniques and applications of integration. The formal definition of a limit. The fundamental theorem of Calculus and applications. Vector functions, polar curves and quadratic curves.

## Elective modules

### General chemistry 117 (CMY 117)

**Module credits** 16.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education  
Faculty of Health Sciences  
Faculty of Veterinary Science

**Prerequisites** A candidate must have Mathematics for at least 60% and 60% for Physical Sciences.

**Contact time** 1 practical per week, 4 lectures per week

**Language of tuition** Separate classes for Afrikaans and English

**Department** Chemistry

**Period of presentation** Semester 1





## Module content

General introduction to inorganic, analytical and physical chemistry. Atomic structure and periodicity. Molecular structure and chemical bonding using the VSEOR model. Nomenclature of inorganic ions and compounds. Classification of reactions: precipitation, acid-base, redox reactions and gas-forming reactions. Mole concept and stoichiometric calculations concerning chemical formulas and chemical reactions. Principles of reactivity: energy and chemical reactions. Physical behaviour gases, liquids, solids and solutions and the role of intermolecular forces. Rate of reactions: Introduction to chemical kinetics.

## General chemistry 127 (CMY 127)

**Module credits** 16.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education  
Faculty of Health Sciences  
Faculty of Veterinary Science

**Prerequisites** Natural and Agricultural Sciences students: CMY 117 GS or CMY 154 GS Health Sciences students: none

**Contact time** 1 practical per week, 4 lectures per week

**Language of tuition** Separate classes for Afrikaans and English

**Department** Chemistry

**Period of presentation** Semester 2

## Module content

Theory: General physical-analytical chemistry: Chemical equilibrium, acids and bases, buffers, solubility equilibrium, entropy and free energy, electrochemistry. Organic chemistry: Structure (bonding), nomenclature, isomerism, introductory stereochemistry, introduction to chemical reactions and chemical properties of organic compounds and biological compounds, i.e. carbohydrates and aminoacids. Practical: Molecular structure (model building), synthesis and properties of simple organic compounds.

## Exploring the universe 154 (SCI 154)

**Module credits** 16.00

**Prerequisites** Prohibited combination SCI 164

**Contact time** 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 1

## Module content

Students from all faculties are welcome to join us in our exploration of the universe from an earth-bound perspective. We reflect on the whole universe from the sub microscopic to the vast macroscopic and mankind's modest position therein. To what degree is our happiness determined by stars? Echoes from ancient firmaments - the astronomy of old civilisations. The universe is born with a bang. Stars, milky ways and planets are formed. Life is breathed into the landscape on earth, but is there life elsewhere? The architecture of the universe - distance measurements, structure of our solar system and systems of stars. How does it look like on neighbouring planets? Comets and meteorites. Life cycles of stars. Spectacular exploding stars! Exotica like pulsars and black holes.

## Discrete structures 115 (WTW 115)

**Module credits** 8.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education  
Faculty of Economic and Management Sciences

**Prerequisites** Refer to Regulation 1.2: A candidate must have passed Mathematics with at least 50% in the Grade 12 examination

**Contact time** 1 tutorial per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

## Module content

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.

## Numerical analysis 123 (WTW 123)

**Module credits** 8.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology

**Prerequisites** WTW 114 GS

**Contact time** 1 tutorial per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

## Module content

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.

## Mathematical modelling 152 (WTW 152)

<b>Module credits</b>	8.00
<b>Service modules</b>	Faculty of Engineering, Built Environment and Information Technology
<b>Prerequisites</b>	Refer to Regulation 1.2
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 1

### Module content

Introduction to the modelling of dynamical processes using difference equations. Curve fitting. Introduction to linear programming. Matlab programming. Applications to real-life situations in, among others, finance, economics and ecology.

## Dynamical processes 162 (WTW 162)

<b>Module credits</b>	8.00
<b>Prerequisites</b>	WTW 114 GS
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

### Module content

\*Students will not be credited for more than one of the following modules for their degree: WTW 162 and WTW 264.

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.

## Curriculum: Year 2

**Minimum credits: 144**

**Minimum credits:**

Core = 96

Elective = 48

**Additional information:**

Students must select elective modules with a total number of at least 48 credits according to the following streams (deviations allowed with permission from the head of department):

- **Mathematics as second major:** Due to the modules prescribed for the BSc (Physics) module, taking mathematics as a second major in 3<sup>rd</sup> year is possible for all options.
- **Second major applied mathematics:** WTW 285, WTW 286, WTW 221 (36 credits – an additional 12 credits will have to be taken in 2<sup>nd</sup> or 3<sup>rd</sup> year. PHY 353, PHY 363 or additional 3<sup>rd</sup> year mathematics module recommended).
- **Second major statistics:** WST 211, WST 221 (48 credits)
- **Second major in chemistry:** CMY 282, CMY 283, CMY 284, CMY 285 (48 credits).
- **Second major in geology:** GLY 253, GLY 255, GLY 261, GLY 262 (48 credits).
- **Second major in meteorology:** WKD 261, WKD 263, WKD 254 (TDH Required), WTW 286 (48 credits). (Q: GMA 220 instead of WKD 254)
- **Interest in astronomy:** PHY 210, WTW 221, WTW 286 (48 credits Unbalanced: Year credits S1: 60, S2: 84)
- **Interest in computational physics:** COS 210, COS 212, COS 226, COS 284 (56 credits) 24 + 32 = 56 credits = excess of 8 credits in second semester.

## Core modules

### Waves, thermodynamics and modern physics 255 (PHY 255)

<b>Module credits</b>	24.00
<b>Service modules</b>	Faculty of Education
<b>Prerequisites</b>	[PHY114 and PHY124] or [PHY171] or [PHY143 and PHY153 and PHY163] and [WTW211#] and [WTW218#]
<b>Contact time</b>	1 practical per week, 2 discussion classes per week, 4 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Physics
<b>Period of presentation</b>	Semester 1

## Module content

Vibrating systems and waves (14 lectures)

Simple harmonic motion (SHM). Superposition (different frequencies, equal frequencies). Perpendicular vibrations (Lissajous figures). Damped SHM. Forced oscillations. Resonance. Q-value. Transverse wave motion. Plane wave solution using method of separation of variables. Reflection and transmission at a boundary. Normal and eigenmodes. Wave packets. Group velocity.

Modern physics (30 lectures)

Special relativity: Galilean and Lorentz transformations. Postulates. Momentum and energy. 4 vectors and tensors. General relativity. Quantum physics. Failure of classical physics. Bohr model. Particle-wave duality. Schrödinger equation. Piece-wise constant potentials. Tunneling. X-rays. Laser. Nuclear physics: Fission. Fusion. Radioactivity.

Heat and thermodynamics (12 lectures)

Heat. First Law. Kinetic theory of gases. Mean free path. Ideal, Clausius, Van der Waals and virial gases. Entropy. Second Law. Engines and refrigerators. Third Law. Thermodynamic potentials: Enthalpy Helmholtz and Gibbs free energies, Chemical potential. Legendre transformations (Maxwell relations). Phase equilibrium. Gibbs phase rule.

Modelling and simulation (7 practical sessions)

Introduction to programming in a high level system: Concept of an algorithm and the basic logic of a computer programme. Symbolic manipulations, graphics, numerical computations. Applications: Selected illustrative examples.

Error Analysis (7 practical sessions)

Experimental uncertainties. Propagation of uncertainties. Statistical analysis of random uncertainties. Normal distribution. Rejection of data. Least-squares fitting. Covariance and correlation.

## General physics 263 (PHY 263)

**Module credits** 24.00

**Service modules** Faculty of Education

**Prerequisites** PHY 255 GS and WTW 218 GS and WTW 220# and WTW 248#

**Contact time** 1 practical per week, 2 discussion classes per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 2

## Module content

Classical mechanics (28 lectures)

Fundamental concepts, energy and angular momentum, calculus of variations and Lagrangian mechanics, conservative central forces and two body problems, scattering, mechanics in rotating reference frames, many body systems.

Physical Optics (14 lectures)

Maxwell's equations, wave equation and plane wave solution, coherence, interference, diffraction, polarisation.

Physics of Materials (14 lectures)

Classification of materials. Atomic bonding. Crystallography. Defects. Material strength.

Phase diagram's, Ceramics. Polymers. Composites. Fracture. Electrical and magnetic properties. Semiconductors. Smart materials Nanotechnology.

Experiments (14 sessions)

## Linear algebra 211 (WTW 211)

**Module credits** 12.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education  
Faculty of Economic and Management Sciences

**Prerequisites** WTW 124

**Contact time** 1 tutorial per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

## Module content

This is an introduction to linear algebra on  $\mathbb{R}^n$ . Matrices and linear equations, linear combinations and spans, linear independence, subspaces, basis and dimension, eigenvalues, eigenvectors, similarity and diagonalisation of matrices, linear transformations.

## Calculus 218 (WTW 218)

**Module credits** 12.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology  
Faculty of Education  
Faculty of Economic and Management Sciences

**Prerequisites** WTW 114 and WTW 124

**Contact time** 1 tutorial per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

### Module content

Calculus of multivariable functions, directional derivatives. Extrema and Lagrange multipliers. Multiple integrals, polar, cylindrical and spherical coordinates.

## Analysis 220 (WTW 220)

**Module credits** 12.00

**Service modules** Faculty of Education  
Faculty of Economic and Management Sciences

**Prerequisites** WTW 114 and WTW 124, WTW 211 and WTW 218

**Contact time** 1 tutorial per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

### Module content

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.

## Vector analysis 248 (WTW 248)

**Module credits** 12.00

**Service modules** Faculty of Education

**Prerequisites** WTW 218

**Contact time** 1 discussion class per week, 2 lectures per week

**Language of tuition** Afrikaans and English are used in one class

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

### Module content

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.

## Elective modules

### Physical chemistry 282 (CMY 282)

**Module credits** 12.00

**Service modules** Faculty of Education

**Prerequisites** CMY 117 and CMY 127

**Contact time** 1 tutorial per week, 2 practicals per week, 4 lectures per week



**Language of tuition** Module is presented in English

**Department** Chemistry

**Period of presentation** Quarter 2

**Module content**

Theory: Classical chemical thermodynamics, gases, first and second law and applications, physical changes of pure materials and simple compounds. Phase rule: Chemical reactions, chemical kinetics, rates of reactions.

### Analytical chemistry 283 (CMY 283)

**Module credits** 12.00

**Service modules** Faculty of Education

**Prerequisites** CMY 117 and CMY 127

**Contact time** 1 tutorial per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Chemistry

**Period of presentation** Quarter 3

**Module content**

Theory: Statistical evaluation of data, gravimetric analysis, aqueous solution chemistry, chemical equilibrium, precipitation-, neutralisation- and complex formation titrations, redox titrations, potentiometric methods, introduction to electrochemistry.

### Organic chemistry 284 (CMY 284)

**Module credits** 12.00

**Service modules** Faculty of Education

**Prerequisites** CMY 117 and CMY 127

**Contact time** 1 tutorial per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Chemistry

**Period of presentation** Quarter 1

**Module content**

Theory: Resonance, conjugation and aromaticity. Acidity and basicity. Introduction to  $^{13}\text{C}$  NMR spectroscopy. Electrophilic addition: alkenes. Nucleophilic substitution, elimination, addition: alkyl halides, alcohols, ethers, epoxides, carbonyl compounds: ketones, aldehydes, carboxylic acids and their derivatives.

### Inorganic chemistry 285 (CMY 285)

**Module credits** 12.00

**Service modules** Faculty of Education

**Prerequisites** CMY 117 and CMY 127





<b>Contact time</b>	1 tutorial per week, 2 practicals per week, 4 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Chemistry
<b>Period of presentation</b>	Quarter 4

#### Module content

Theory: Atomic structure, structure of solids (ionic model). Coordination chemistry of transition metals: Oxidation states of transition metals, ligands, stereochemistry, crystal field theory, consequences of d-orbital splitting, chemistry of the main group elements, electrochemical properties of transition metals in aqueous solution, industrial applications of transition metals. Fundamentals of spectroscopy and introduction to IR spectroscopy.

### Process geomorphology 252 (GGY 252)

**Module credits** 12.00

**Service modules** Faculty of Education  
Faculty of Humanities

**Prerequisites** GGY 166 or GLY 155

**Contact time** 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Quarter 2

#### Module content

Physical processes that influence the earth's surface and management. Specific processes and their interaction in themes such as weathering; soil erosion; slope, mass movement and fluvial processes. Practical laboratory exercises are based on the themes covered in the module theory component.

### Geomorphology of the built environment 265 (GGY 265)

**Module credits** 12.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology

**Prerequisites** No prerequisites.

**Contact time** 4 lectures per week

**Language of tuition** Afrikaans and English are used in one class

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Quarter 3

## Module content

\*This module is for Architecture and Landscape Architecture students only.

The theory component covers geomorphological aspects of the built environment including landscape identification; weathering or deterioration of natural stone and application to design and preservation of buildings and monuments; slope hydrology and stability conditions; soil erosion processes and construction impacts; drainage modification in urban areas; wetland identification, human impacts and rehabilitation; recreational impacts and management. In addition to the theory a field-based project is undertaken.

## City structure, environment and society 266 (GGY 266)

**Module credits** 24.00

**Service modules** Faculty of Education  
Faculty of Humanities

**Prerequisites** No prerequisites.

**Contact time** 1 practical per week, 3 lectures per week

**Language of tuition** Module is presented in English

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Semester 2

## Module content

An urbanising world. Urban structure and land use. Urban processes. The urban environment. Social structure and change in cities. Living in the city. Economy, society and politics in the city. Third-world cities and South African cities. Urban futures.

## Geographic data analysis 220 (GIS 220)

**Module credits** 14.00

**Service modules** Faculty of Engineering, Built Environment and Information Technology

**Prerequisites** GMC 110 and (STK 110 OR BME 120)

**Contact time** 1 practical per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Semester 2

## Module content

The nature of geographical data and measurement. Application of statistics in the geographical domain. Probability, probability distributions and densities, expected values and variances, Central Limit theorem. Sampling techniques. Exploratory data analysis, descriptive statistics, statistical estimation, hypothesis testing, correlation analysis and regression analysis.

## Physical meteorology 261 (WKD 261)

**Module credits** 12.00

<b>Prerequisites</b>	WTW 114
<b>Contact time</b>	1 tutorial per week, 4 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Geography Geoinformatics and Meteorology
<b>Period of presentation</b>	Quarter 1

#### Module content

Conservative forces and conservation laws. Basic thermodynamic laws for dry and humid air. The equation of state. Adiabatic processes and temperature lapse rates. The Clausius-Clapeyron equation. Calculation of the wet adiabat.

### Introduction to dynamic meteorology 263 (WKD 263)

<b>Module credits</b>	12.00
<b>Prerequisites</b>	WTW 126 and WTW 128 (students should simultaneously be enrolled for WTW 218).
<b>Contact time</b>	1 tutorial per week, 4 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Geography Geoinformatics and Meteorology
<b>Period of presentation</b>	Quarter 2

#### Module content

Vector algebra, curl of a vector, total and partial derivatives, second law of motion. Spherical coordinates Acceleration in rotating co-ordinates, fundamental forces, momentum equation. Three dimensional flow balance, conservation of mass, heat equation, thermodynamic energy equation. Introduction to finite difference methods. Numerical estimation of the geostrophic wind, vorticity and divergence. Advection of temperature. Development of a two-dimensional temperature advection model.

### Linear algebra 221 (WTW 221)

<b>Module credits</b>	12.00
<b>Service modules</b>	Faculty of Education Faculty of Economic and Management Sciences
<b>Prerequisites</b>	WTW 211 and WTW 218
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

#### Module content

Abstract vector spaces, change of basis, matrix representation of linear transformations, orthogonality, diagonalisability of symmetric matrices, some applications.

## Differential equations 256 (WTW 256)

<b>Module credits</b>	8.00
<b>Service modules</b>	Faculty of Engineering, Built Environment and Information Technology
<b>Prerequisites</b>	WTW 158 and WTW 164
<b>Contact time</b>	1 discussion class per week, 2 lectures per week
<b>Language of tuition</b>	Separate classes for Afrikaans and English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 1

### Module content

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.

## Discrete structures 285 (WTW 285)

<b>Module credits</b>	12.00
<b>Service modules</b>	Faculty of Engineering, Built Environment and Information Technology Faculty of Education
<b>Prerequisites</b>	WTW 115
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

### Module content

Setting up and solving recurrence relations. Equivalence and partial order relations. Graphs: paths, cycles, trees, isomorphism. Graph algorithms: Kruskal, Prim, Fleury. Finite state automata.

## Differential equations 286 (WTW 286)

<b>Module credits</b>	12.00
<b>Service modules</b>	Faculty of Economic and Management Sciences
<b>Prerequisites</b>	WTW 114, WTW 124 and WTW 162
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 1

## Module content

\*Students will not be credited for more than one of the modules for their degree: WTW 264, WTW 286

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. Numerical methods applied to nonlinear systems. Qualitative analysis of linear systems.

## Curriculum: Final year

**Minimum credits: 144**

**Minimum credits:**

Core = 72

Elective = 72

**Additional information:**

Students must select elective modules with a total number of at least 72 credits from the following streams (deviations allowed with permission from the head of department):

- **Mathematics as second major:** WTW 310, WTW 320, WTW 381 and WTW 389 (72 credits).
- **Applied Mathematics as second major:** WTW 310, WTW 382, WTW 383 and WTW 386 and WTW 387 (90 credits)\*.
- **Mathematical statistics as second major:** WST 311, WST 312, WST 321, STK 353 (79 credits) Unbalanced: 36 + 43
- **Chemistry as second major:** CMY 382, CMY 383, CMY 384, CMY 385 (72 credits).
- **Geology as second major:** GLY 365, GLY 366 and GLY 367 (72 credits)
- **Meteorology as second major:** WKD 352, WKD 361, WKD 366 (72 credits) Unbalanced S1: 0, S2: 72
- **Astronomy, astrophysics and high energy physics:** PHY 300, PHY 310, WTW 383 (72 credits)
- **Interest in computational physics:** COS 314, COS 344, COS 333, COS 330 (72 credits).

\* All 5 modules are required if a student wishes to continue with BSchHons Applied Mathematics, otherwise a selection of modules with a total number of 72 credits may be made.

## Core modules

### Electronics, electromagnetism and quantum mechanics 356 (PHY 356)

<b>Module credits</b>	36.00
<b>Service modules</b>	Faculty of Education
<b>Prerequisites</b>	PHY 255 GS and PHY 263 GS and WTW 211 GS and WTW 218 GS and WTW 248 GS
<b>Contact time</b>	1 practical per week, 2 discussion classes per week, 4 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Physics
<b>Period of presentation</b>	Semester 1

## Module content

Electronics (14 lectures)

Thévenin and Norton equivalent circuits, superposition principle, RC, LC and LRC circuits. Semiconductor diode. Bipolar transistor. Operational amplifiers. Computer controlled instrumentation.

Electromagnetism (21 lectures)

Electrostatics: Coulomb's law, divergence and curl of  $E$ , Gauss' law, Laplace's equation, image charge problems, multipole expansion.

Magnetostatics: Lorenz force, Biot-Savart law, divergence and curl of magnetic field strength, Ampère's law, magnetic vector potential, multipole expansion, boundary conditions.

Electrodynamics: Electromotive force, electromagnetic induction, Maxwell's equations, wave equation.

Electric and magnetic fields in matter: Polarisation, electric displacement and Gauss's law in dielectrics, linear dielectrics. Magnetisation (diamagnets, paramagnets, ferromagnets), auxiliary field  $H$  and Ampère's law in magnetised materials, linear and nonlinear media.

Quantum mechanics (28 lectures)

The Schrödinger equation, the statistical interpretation of the wave function, momentum, the uncertainty principle, the time-independent Schrödinger equation, stationary states, the infinite square well potential, the harmonic oscillator, the free particle, the Delta-Function potential, the finite square well potential, Hilbert spaces, observables, eigen functions of a Hermitian operator, Dirac notation, the Schrödinger equation in spherical coordinates, the hydrogen atom, angular momentum spin.

## Statistical mechanics, solid state physics and modelling 364 (PHY 364)

**Module credits** 36.00

**Service modules** Faculty of Education

**Prerequisites** PHY 356 and WTW 211 and WTW 218 and WTW 248 GS

**Contact time** 2 discussion classes per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 2



## Module content

Statistical mechanics (28 lectures)

Isolated systems in thermodynamical equilibrium. Systems in equilibrium with a heat bath: the canonical ensemble, Gibbs' entropic formula, classical statistical mechanics, energy equipartition theorem, thermodynamic potentials, paramagnetism.

The classical limit of perfect gases: non-distinguishable character of quantum particles, the equation of state of the classical ideal gas. Quantum perfect gases: Black body radiation, the grand canonical ensemble, Fermi-Dirac distribution, the free electron gas in metals, the Bose-Einstein distribution, Bose-Einstein condensation.

Solid state physics (28 lectures)

Crystal structures, the reciprocal lattice, x-ray diffraction, lattice vibration, the Debye model, characteristics of solids, the free electron model, Pauli paramagnetism, electronic heat capacity, the relaxation time, electrical conduction, the classical Hall effect, thermal conduction in metals, failures of the free electron model, the independent electron model, band theory of solids.

Computational Physics and modelling. Assessment will be done through a portfolio of project reports. The topics for the projects will be selected from various sub-disciplines of Physics.

## Elective modules

### Physical chemistry 382 (CMY 382)

**Module credits** 18.00

**Service modules** Faculty of Education

**Prerequisites** CMY 282, CMY 283, CMY 284 and CMY 285

**Contact time** 1 discussion class per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Chemistry

**Period of presentation** Quarter 4

#### Module content

Theory: Molecular quantum mechanics. Introduction: Shortcomings of classical physics, dynamics of microscopic systems, quantum mechanical principles, translational, vibrational and rotational movement. Atomic structure and spectra: Atomic hydrogen, multiple electron systems, spectra of complex atoms, molecular structure, the hydrogen molecule ion, diatomic and polyatomic molecules, structure and properties of molecules. Molecules in motion: Viscosity, diffusion, mobility. Surface chemistry: Physisorption and chemisorption, adsorption isotherms, surface tension, heterogeneous catalytic rate reactions, capillarity.

### Analytical chemistry 383 (CMY 383)

**Module credits** 18.00

**Service modules** Faculty of Education

**Prerequisites** CMY 282, CMY 283, CMY 284 and CMY 285

**Contact time** 1 discussion class per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English





**Department** Chemistry

**Period of presentation** Quarter 1

**Module content**

Theory: Separation methods: Extraction, multiple extraction, chromatographic systems. Spectroscopy: Construction of instruments, atomic absorption and atomic emission spectrometry, surface analysis techniques. Mass spectrometry. Instrumental electrochemistry.

**Organic chemistry 384 (CMY 384)**

**Module credits** 18.00

**Service modules** Faculty of Education

**Prerequisites** CMY 282, CMY 283, CMY 284 and CMY 285

**Contact time** 1 discussion class per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Chemistry

**Period of presentation** Quarter 3

**Module content**

Theory: NMR spectroscopy: applications. Aromatic chemistry, Synthetic methodology in organic chemistry. Carbon-carbon bond formation: alkylation at nucleophilic carbon sites, aldol and related condensations, Wittig and related reactions, acylation of carbanions (Claisen condensation).

**Inorganic chemistry 385 (CMY 385)**

**Module credits** 18.00

**Service modules** Faculty of Education

**Prerequisites** CMY 282, CMY 283, CMY 284 and CMY 285

**Contact time** 1 discussion class per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Chemistry

**Period of presentation** Quarter 2

**Module content**

Theory: Structure and bonding in inorganic chemistry. Molecular orbital approach, diatomic and polyatomic molecules, three-centre bonds, metal-metal bonds, transition metal complexes, magnetic properties, electronic spectra, reactivity and reaction mechanisms, reaction types, acid-base concepts, non-aqueous solvents, special topics.

**Human environmental interactions 301 (ENV 301)**

**Module credits** 18.00

**Service modules** Faculty of Education  
Faculty of Humanities

<b>Prerequisites</b>	No prerequisites.
<b>Contact time</b>	1 practical per week, 4 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Geography Geoinformatics and Meteorology
<b>Period of presentation</b>	Quarter 2

#### Module content

The module focuses on contemporary environmental issues in southern Africa. Recent and future impacts of human pressures on natural resources, the state of the environment in South Africa, management of critical resources, population trends, biodiversity loss, pollution, water scarcity, desertification, climate change, waste accumulation and management, environmental management tools, environmental education and environmental management legislation.

### Sustainable development 356 (GGY 356)

<b>Module credits</b>	18.00
<b>Service modules</b>	Faculty of Education Faculty of Humanities
<b>Prerequisites</b>	No prerequisites.
<b>Contact time</b>	1 practical per week, 3 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Geography Geoinformatics and Meteorology
<b>Period of presentation</b>	Quarter 1

#### Module content

The module conceptually integrates environmental, economic, and social components of sustainable development. Other topics covered include changing perceptions on development and environment, development paradigms, challenges of sustainable development, actors and actions in sustainable development, rural and urban livelihoods, and a Third World assessment of sustainable development in the developing world.

### Development frameworks 366 (GGY 366)

<b>Module credits</b>	18.00
<b>Service modules</b>	Faculty of Education Faculty of Humanities
<b>Prerequisites</b>	No prerequisites.
<b>Contact time</b>	1 practical per week, 3 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Geography Geoinformatics and Meteorology
<b>Period of presentation</b>	Quarter 3

### Module content

Classic development frameworks. Spatial development history and legacy in South Africa. Overview of contemporary environmental legislation in South Africa. Rural development strategy. Rural and agricultural reconstruction. Land reform. Urban development and strategy. Urban spatial reconstruction. National spatial development frameworks.

## Observational astronomy 300 (PHY 300)

**Module credits** 36.00

**Prerequisites** PHY 255 and PHY 263

**Contact time** 2 discussion classes per week, 2 practicals per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 1

### Module content

Structure of the universe, navigation of the sky, spherical geometry, optical, radio and high energy physics and sources, instruments, practical observational skills, data recording, analysis, interpretation (signal and image processing, noise, calibration, error analysis). Project: A selected project in either optical or radio astronomy, resulting in a formal report and a presentation.

## Particle and astroparticle physics 310 (PHY 310)

**Module credits** 18.00

**Prerequisites** PHY 255 and PHY 263 and PHY 356

**Contact time** 1 discussion class per week, 1 practical per week, 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 2

### Module content

Relativistic kinematics, fundamentals of elementary particle physics, the four forces of nature and the Standard Model, beyond the Standard Model, early universe cosmology (inflation, baryogenesis), the Cosmic Microwave Background, high-energy astronomy (cosmic rays, gamma rays and neutrinos), gravitational waves, dark matter (evidence, candidates, detection), dark energy and the Standard Cosmological Model.

## Physics project 353 (PHY 353)

**Module credits** 12.00

**Prerequisites** TDH

**Contact time** 3 practicals per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 1

### Module content

\*Cannot be used as substitute for other Physics 300 modules to obtain admission to the BSc(Hons) in Physics. A student is required to complete a project under guidance of the lecturer. The nature of the project is determined jointly by the student, lecturer and the head of department.

## Physics project 363 (PHY 363)

**Module credits** 12.00

**Prerequisites** TDH

**Contact time** 3 practicals per week

**Language of tuition** Module is presented in English

**Department** Physics

**Period of presentation** Semester 2

### Module content

\*Cannot be used as substitute for other Physics 300 modules to obtain admission to the BSc(Hons) in Physics. A student is required to complete a project under guidance of the lecturer. The nature of the project is determined jointly by the student, lecturer and the head of department.

## Atmospheric vorticity and divergence 352 (WKD 352)

**Module credits** 18.00

**Prerequisites** WKD 263 GS and WTW 248 GS

**Contact time** 1 tutorial per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Quarter 3

### Module content

Scale analyses and simplification of the basic equations. The geostrophic, thermal and gradient wind. The vorticity equation and divergence.

## Quasi-geostrophic analysis 361 (WKD 361)

**Module credits** 18.00

**Prerequisites** WKD 352 GS and WKD 254

**Contact time** 1 practical per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Quarter 4

### Module content

Tendency and Omega equations. Model of a baroclinic system. Introduction to numerical models. Application in meteorological display and analysis software.

## Fundamentals of weather forecasting 366 (WKD 366)

**Module credits** 36.00

**Prerequisites** WKD 155, WKD 261, WKD 254 (students should simultaneously be enrolled for WKD 361)

**Contact time** 1 practical per week, 4 lectures per week

**Language of tuition** Module is presented in English

**Department** Geography Geoinformatics and Meteorology

**Period of presentation** Semester 2

### Module content

Meteorological observations data codes. Weather applications software and computing environments of meteorological analysis and weather forecasting techniques. Applications of remote sensing in weather forecasting. Aerological diagrams. Applications of numerical weather prediction, and types of weather forecasts. Integration of information to describe the current state of the atmosphere and to predict a future state of the atmosphere.

## Analysis 310 (WTW 310)

**Module credits** 18.00

**Service modules** Faculty of Education  
Faculty of Economic and Management Sciences  
Faculty of Humanities

**Prerequisites** WTW 220

**Contact time** 1 tutorial per week, 2 lectures per week

**Language of tuition** Afrikaans and English are used in one class

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

### Module content

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.

## Complex analysis 320 (WTW 320)

**Module credits** 18.00

**Service modules** Faculty of Education

**Prerequisites** WTW 218 and WTW 220

<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Afrikaans and English are used in one class
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

#### Module content

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.

### Dynamical systems 382 (WTW 382)

<b>Module credits</b>	18.00
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<b>Service modules</b>	Faculty of Education Faculty of Economic and Management Sciences
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<b>Prerequisites</b>	WTW 218 and WTW 286/264
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<b>Contact time</b>	1 tutorial per week, 2 lectures per week
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<b>Language of tuition</b>	Afrikaans and English are used in one class
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<b>Department</b>	Mathematics and Applied Mathematics
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<b>Period of presentation</b>	Semester 1
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#### Module content

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.

### Numerical analysis 383 (WTW 383)

<b>Module credits</b>	18.00
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<b>Service modules</b>	Faculty of Engineering, Built Environment and Information Technology Faculty of Economic and Management Sciences Faculty of Humanities
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<b>Prerequisites</b>	WTW 114, WTW 123 WTW 124 and WTW 211
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<b>Contact time</b>	1 practical per week, 2 lectures per week
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<b>Language of tuition</b>	Afrikaans and English are used in one class
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<b>Department</b>	Mathematics and Applied Mathematics
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<b>Period of presentation</b>	Semester 2
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#### Module content

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.

## Partial differential equations 386 (WTW 386)

<b>Module credits</b>	18.00
<b>Service modules</b>	Faculty of Education
<b>Prerequisites</b>	WTW 248 and WTW 286/264
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Afrikaans and English are used in one class
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 1

### Module content

Conservation laws and modelling. Fourier analysis. Heat equation, wave equation and Laplace's equation. Solution methods including Fourier series. Energy and other qualitative methods.

## Continuum mechanics 387 (WTW 387)

<b>Module credits</b>	18.00
<b>Service modules</b>	Faculty of Education
<b>Prerequisites</b>	WTW 248 and WTW 286/264
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Afrikaans and English are used in one class
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

### Module content

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.

## Geometry 389 (WTW 389)

<b>Module credits</b>	18.00
<b>Service modules</b>	Faculty of Engineering, Built Environment and Information Technology Faculty of Education Faculty of Humanities
<b>Prerequisites</b>	WTW 211
<b>Contact time</b>	1 tutorial per week, 2 lectures per week
<b>Language of tuition</b>	Afrikaans and English are used in one class
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

### Module content

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.

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The information published here is subject to change and may be amended after the publication of this information. The [General Regulations \(G Regulations\)](#) apply to all faculties of the University of Pretoria. It is expected of students to familiarise themselves well with these regulations as well as with the information contained in the [General Rules](#) section. Ignorance concerning these regulations and rules will not be accepted as an excuse for any transgression.