2 Module Contents

2.1 Explanation of numbering system and abbreviations

The example below shows how the module descriptions in the next section are organised. This section was taken from the University Calendar and is therefore written in the second person.

Example:
The entry for the module normally referred to as **Engineering Mathematics 145**, is as follows:

> **38571 Engineering Mathematics**
>
> **145 (15) Further Differential and Integral Calculus (5L; 2T)**
> Complex numbers; transcendental functions; integration techniques; improper integrals; conic sections; polar coordinates; partial derivatives; introduction to matrices and determinants.
>
> *Home department: Mathematical Sciences*
>
> *Method of Assessment: Flexible Assessment*
>
> *Required modules:*
> *P Engineering Mathematics 115*

Explanation of terms in the example:

- **Five-digit subject number and name – 38571 Engineering Mathematics**
  - The subject number in the example is **38571** and it is associated with the subject name **Engineering Mathematics**.
- **Module code – 145 (15) Further Differential and Integral Calculus**
  The module code consists of a three-digit number that is unique to the specific module that resorts under the particular subject. The module code of this module is **145** and has the following meaning:
- **Credit value – 145 (15) Further Differential and Integral Calculus**
  - The number between brackets after the module code indicates the credit value of the module. According to the example you can therefore obtain **15 credits** by passing Engineering Mathematics 145.
- **Module topic – 145 (15) Further Differential and Integral Calculus**
  - **Further Differential and Integral Calculus** indicates the topic that will be dealt with in this specific module.
- **Teaching load – (5L; 2T)**
  - The teaching load of a module gives you both the teaching load and the type of teaching per week that you can expect in a particular module. For the module Engineering Mathematics 145 you can expect **five lectures and two tutorials** per week for the duration of the module. The following abbreviations are used for the teaching load:
    - **L** – Lectures lasting 50 minutes each, for example 5L
    - **P** – Practical periods lasting 50 minutes, for example 1P, 2P, 3P
    - **T** – Tutorials lasting 50 minutes, for example 1T, 2T
    - **S** – Seminars lasting 50 minutes, for example 1S
- **Method of assessment**
  - The method of assessment normally appears after the content description of each module. If no method of assessment appears, then the default method applies, that is Examination with P=0,4K+0,6E. The symbols in the formula for final mark, which is indicated with some modules, have the following meaning:
    - P = final mark
    - K = class mark
    - E = examination mark
- **Required modules**
  - The required modules indicate the modules that are required before you may register for a particular module. There are three requirement categories: prerequisite pass, prerequisite and corequisite modules, as indicated below by the letters **PP**, **P** and **C**:
    - **PP** – Prerequisite pass module
      A prerequisite pass module is a module that you must pass before you can take the module(s) for which it is a prerequisite pass module.
    - **P** – Prerequisite module
      A prerequisite module is a module in which you must obtain a class mark of at least 40 (for modules

where the method of assessment is "examination"), or a final mark of at least 40 (for modules using other assessment methods rather than examination, like "flexible assessment"), before you can take the module for which it is a prerequisite module.

- **C** – Corequisite module
  A corequisite module is a module that you must take in the same academic year as the module for which it is a corequisite, or in an earlier academic year. You must pass the corequisite module before you can obtain the relevant degree or diploma.

- For certain modules you must also first have departmental approval before you may register for that module. Various requirements may be considered by a departmental chairperson (or his/her delegate) before granting such approval and you should not assume that approval will always be granted. For example, the Department of Industrial Engineering must judge that you have a reasonable chance to graduate in a particular year (in other words, you must be admitted to the final year) before you may register for Industrial Project 498 in that year.

2.2 Module details

The details of modules given below are provisional. For the final versions, please refer to the parts of the 2020 Calendar for the Faculty of Engineering, the Faculty of Science and the Faculty of Economic and Management Science.

20753 Applied Mathematics B

124 (15) Statics (4L; 2T)

Vectors; forces; sum of forces at a point; direction cosines and direction angles; components and component vectors; scalar products; vector products; moment of a force; force systems on rigid bodies; equivalent force systems; couples; line of action of the resultant; equilibrium of a rigid body; friction; centre of mass; centroid; volumes; definite integration; moment of inertia of areas.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

154 (15) Dynamics (4L; 2T)

Kinematics in one and two dimensions; relative velocities; the equations of motion; rectilinear motion with constant forces; forces in a plane; parabolic motion; circular motion; the principle of work and energy; power; conservation laws; impulse and momentum; angle impulse and angle momentum; kinetics of particle systems.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
C Engineering Mathematics 115
P Applied Mathematics B 124

224 (15) Dynamics of Rigid Bodies (3L; 3T)

Plane kinetics of rigid bodies; rotation and translation; absolute motion; relative motion; instantaneous centre of zero velocity. Properties of rigid bodies; definite and multiple integrals; Cartesian, polar, cylindrical and spherical coordinate systems; areas, volumes, centres of mass and moments of inertia. Plane kinetics of rigid bodies; Newton's laws; energy methods. Introduction to three-dimensional dynamics of rigid bodies. Vibrations of rigid bodies.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
P Applied Mathematics 144 or P Applied Mathematics B 154

13362 Complementary Studies (Eng)

441 (8) Community Interaction and Leadership Development (2L; 3T)

Community interaction in the context of Stellenbosch University and South Africa. Contextual leadership themes, challenges and opportunities. Intercultural competencies.

[Presented by the Department of Mechanical and Mechatronic Engineering (50%) and by the Engineering (Admin) (50%)]

Home department: Mechanical and Mechatronic Engineering

Method of Assessment: Project

Required modules:
Must be in at least third year of registration in BEng programme

30317 Computer Programming

143 (12) Computer Programming (3L; 2P)

Introduction to computer systems. Introduction to a programming environment; expressions; conditional statements; iterative structures; data types; static and dynamic data structures; file handling; abstract data types; objects; structured program design. Emphasis is placed on modular programming for engineering applications.

[Presented by the Department of Electrical and Electronic Engineering (75%) and by the Department of Mechanical and Mechatronic Engineering (25%)]

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

18139 Computer Science

314 (16) Concurrency (3L, 3P)

Introduction to programming techniques and principles of concurrent systems, from operating systems to application programs. This includes communication, synchronisation, scheduling and load balancing. Several parallel and distributed architectures will be covered.

Home department: Mathematical Sciences

Method of assessment: Flexible assessment

Required modules:
P Computer Science 214 and 244
or
P Computer Science E 214 and Computer Systems 245

315 (16) Machine Learning (3L; 3T)

Dimension reduction techniques; machine-learning techniques based on maximum-likelihood, maximum-posterior and expectation-maximization estimates; modelling using logistic regression, Gaussian mixtures and hidden Markov models.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
PP Computer Science 144 or P Computer Science E 214
P Mathematical Statistics 244 or P Systems and Signals 344

334 (16) Databases and Web Centric Programming (3L; 3P)

Introduction to relational databases. Mapping relational model onto object model. Implementing a database application in the context of the web. Web services. Server-side scalability. Virtualization. Cloud Computing.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
P Computer Science 214
P Computer Science 244

For programmes in Engineering:
P Computer Science E 214
P Computer Systems 245

59536 Computer Science E

214 (15) Object-Oriented Programming (3L; 3P)

Formulation and solution of problems by means of computer programming in an object-oriented set-up; principles of testing and debugging; key concepts in object orientation: abstraction, encapsulation, inheritance and polymorphism; design patterns as abstractions for the creation of reusable object-oriented designs; searching and sorting algorithms; complexity theory for the analysis of algorithms; fundamental methods in the design of algorithms; dynamic data structures.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
PP Computer Programming 143
P Engineering Mathematics 115
P Engineering Mathematics 145

414 (15) Machine Learning (3L; 3T)

This module is identical Machine Learning 799.

Prominent machine learning concepts and tasks. Selected feature extraction or dimensionality reduction techniques. Introduction to probabilistic modelling and latent variable models. Fundamental paradigms in parameter estimation.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
P Computer Science E 214 or Added Computer Science 144
P (Mathematical Statistics 245 and Mathematical Statistics 246) or Systems and Signals 344

36153 Computer Systems

214 (15) Introduction to Computer Systems (3L; 2P; 1T)

Boolean algebra; combinational and sequential circuit analysis and design; state machines; central processing unit; assembler language programming.

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

Required modules:
C Computer Programming 143

245 (15) Microprocessors (3L; 3P)

Microprocessor programming; basic microprocessor architecture; bus, memory and input-output systems.

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

Required modules:
C Computer Systems 214

13856 Data Analytics (Eng)

344 (15) Data Analytics Applications in Industrial Engineering (3L; 2P; 1T)

The need for data analytics; formal data analytics processes, including CRISP-DM and KDD; data cleaning and data transformation with dimension reduction; supervised learning: regression, k-nearest neighbours, decision trees, random forests; unsupervised learning: k-means; data-driven decision-making; group project.

[From 2021: presented by the Department of Industrial Engineering (78%) and by the Department of Mechanical and Mechatronic Engineering (22%)]

Home department: Industrial Engineering

Method of Assessment: Flexible Assessment

Required modules:
PP Engineering Mathematics 214
P Engineering Statistics 314 or Modelling 334 2021 or later

xxxxx Data Engineering

245 (12) Big Data Platforms (3L; 1P; 1T)

The various technologies and infrastructure required to support effective decision making based on big data, including databases for big data, data warehouses, data platforms, data streams, data fusion, and data visualisation.

Home department: Industrial Engineering

Method of Assessment: Flexible Assessment

Required modules:
P Computer Programming 143

344 (15) Fundamentals of Deep Learning (3L; 1,5P; 1,5T)

Fundamentals of neural networks and their application in engineering problems. Limitations of neural networks. Design of feed-forward neural networks, auto-encoders, convolutional neural networks and recurrent neural networks. A major design assignment that also involves experiments for validation, culminating in a report.

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

Required modules:
P Engineering Mathematics 214
P Systems and Signals 344 or Mathematical Statistics 214.

424 (15) Probabilistic Graphical Models for Machine Learning (3L; 1P; 1T)

Representation: reasoning patterns, Bayes nets, Markov random fields, templates and temporal models, Inference: elimination, sum product, max product, max sum and junction tree algorithms. Learning: maximum likelihood, maximum posterior, Bayesian learning. Designing algorithms to implement the aforementioned.

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

Required modules:
P Systems and Signals 344 or Mathematical Statistics 245

xxxxx Data Science

141 (16) Data Science (4L; 2P)

Fundamental data science concepts; Data-analytic thinking; Types of data; The data cyle; CRISP data mining process; Describing a dataset numerically; Describing a dataset graphically; Organising data; File formats; Data manipulation in Excel; Introduction to predictive modelling; Overfitting; Data leakage; Model evaluation; Other data science tasks and techniques; Data ethics; Communicating results.

Home department: Statistics and Actuarial Science

Method of Assessment: Flexible Assessment (EMS rules)

46833 Design (E)

314 (15) Digital Design (1L; 3P)

Design philosophy; design techniques; milestones; data interpretation; development of simple software and hardware in order to demonstrate a small functional microprocessor system; debugging of digital circuits; report writing.

Home department: Electrical and Electronic Engineering

Method of Assessment: Project

Required modules:
C Computer Systems 245

12599 Electrotechnique

143 (15) Introduction to Circuit Theory (3,5L; 1P; 2T)

Introduction to basic circuit terminology and elements, including dependent sources; Ohm's law, Kirchhoff's laws; node-voltage analysis and mesh-current analysis; superposition; Thévenin and Norton equivalents; basic DC power and energy concepts; introduction to capacitors and inductors; first-order RC and RL circuit steady-state and transient analysis; modelling of physical systems using RL and RC circuits; introduction to magnetic circuits.

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

49484 Engineering Chemistry

123 (15) Chemistry for Engineering Students (4L; 2T)

Basic concepts, units and dimensions, significant figures, conversion between unit systems; components of matter, atomic structure, the periodic table and chemical bonding; stoichiometry; chemical reactions (acid-base, precipitation and redox); properties of mixtures and solutions; chemical equilibrium; electrochemistry; gas laws, state functions and (T, P, V) relationships; introduction to basic engineering applications.

Home department: Process Engineering

Method of Assessment: Flexible Assessment

Required modules:
C Engineering Mathematics 115

38571 Engineering Mathematics

115 (15) Introductory Differential and Integral Calculus (5L; 2T)

Any student who wishes to take this module must have achieved a mark of at least 6 (or 70%) for Mathematics in the NSC or the IEB's school-leaving certificate or must have successfully completed the first year of a suitable extended degree programme.

Mathematical induction and the binomial theorem; functions; limits and continuity; derivatives and rules of differentiation; applications of differentiation; the definite and indefinite integral; integration of simple functions.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

145 (15) Further Differential and Integral Calculus (5L; 2T)

Complex numbers; transcendental functions; integration techniques; improper integrals; conic sections; polar coordinates; partial derivatives; introduction to matrices and determinants.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
P Engineering Mathematics 115

214 (15) Differential Equations and Linear Algebra (4L; 2T)

Ordinary differential equations of first order; linear differential equations of higher orders; Laplace transforms and applications. Matrices: linear independence, rank, eigenvalues.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
PP Engineering Mathematics 115 or PP Engineering Mathematics 145
P Engineering Mathematics 145

242 (8) Series and Partial Differential Equations (2L; 1T)

Infinite series and Taylor series; Fourier series; introduction to partial differential equations; Fourier transforms.

Home department: Mathematical Sciences

Method of Assessment: Flexible Assessment

Required modules:
PP Engineering Mathematics 145 or PP Engineering Mathematics 214
P Engineering Mathematics 214

59420 Engineering Physics

113 (8) Physics for Engineering Students (2L; 0,5P; 0,5T)

Introduction to physics and physical quantities, including: macro- and micro-descriptions of nature; molecular and atomic structure of matter; crystalline and amorphous solids; crystal structures, defects and applications; oscillatory motion; introduction to wave motion; superposition and standing waves; sound waves; Doppler effect; wave optics (diffraction, interference, polarization); introduction to nuclear physics.

Home department: Physics

Method of Assessment: Flexible Assessment

59455 Entrepreneurship (Eng)

444 (15) Entrepreneurship (Eng) (3L; 3T)

Business strategy: business as a system; life cycles; competitiveness forecasts; entry into the market; portfolio decisions; long-term profitability; marketing management; introduction to the theory of organisation. Financial management: time-value of money, basic discounting concepts; economic analysis of investment proposals; introduction to financing and dividend decisions.

Home department: Electrical and Electronic Engineering

Method of Assessment: Project

50431 Environmental Engineering

442 (8) Engineering and the Environment (3L; 2T)

Energy and the environment; environmental engineering principles, including sustainable development, ethical elements of environmental management and socio-ecological factors in decision-making; environmental assessments and management, including pollution control and abatement, environmental impact and risk assessments, environmental auditing, environmental management systems and ISO 14000 standards; environmental governance and related legislation.

Home department: Process Engineering

Method of Assessment: Flexible Assessment

Required modules:
Prerequisite for Engineering students: All the prescribed modules for the first two years of the relevant BEng programme
Prerequisite for AgriSciences students: All the modules for the first two years of the Wood Products Science programme

22853 Mathematical Statistics

214 (16) Distribution Theory and Introduction to Statistical Inference (4L, 2P)

Continuous stochastic variables; expected value and variance of a continuous stochastic variable; important continuous distributions; uniform, normal, exponential, gamma, beta. Moments and moment-generating functions for discrete and continuous distributions. Bivariate probability distributions; marginal and conditional distributions; the multinomial and bivariate normal distribution; determining the distribution of functions of variables. The central limit theorem (without proof). Samples and sampling distributions: the standard parametric cases. Interval estimation and hypothesis testing: applying these principles in the standard cases of parametric inference. Data representation and description, calculating and interpreting sample measures.

Home department: Statistics and Actuarial Science

Method of Assessment: Flexible Assessment (EMS rules)

Required modules:
PP (Mathematics 114 and 144) or (Engineering Mathematics 115 and 145)
PP Probability Theory and Statistics 114 or 144

245 (8) Statistical Inference and Sampling Theory (2L, 1P)

Introduction to statistical inference. Principles of point estimation: efficiency, minimum variance unbiased estimators, consistency. Method-of-moments estimators. Maximum likelihood estimators. The Neyman-Pearson lemma: proof and applications. Likelihood ratio tests.

Sampling theory: sampling techniques in finite and infinite populations, surveys and sequential analysis.

Home department: Statistics and Actuarial Science

Method of assessment: Flexible Assessment (EMS rules)

Required modules:
PP Mathematical Statistics 214

246 (8) Linear Models in Statistics (2L, 1P)

Matrix algebra. Stochastic vectors and matrices. The multivariate normal distribution. Distributions of quadratic forms. The simple linear regression model. The method of least squares. Inference in the simple linear regression model. Introduction to R software.

Home department: Statistics and Actuarial Science

Method of assessment: Flexible Assessment (EMS rules).

Required modules:
PP Mathematical Statistics 214

312 (16) Statistical Inference and Probability theory (3L, 1P)

Advanced distribution theory, sequences of random variables, limit theory for sequences, generating functions, sampling distributions. Different approaches to inference. Parametric estimation theory and hypothesis testing, goodness-of-fit tests, non-parametric inference. Bayes inference. Decision theory.

Home department: Statistics and Actuarial Science

Method of assessment: Flexible Assessment (EMS rules)

Required modules:
PP Mathematical Statistics 244/245
P Mathematical Statistics 246
P (Mathematics 214, 244) or (Engineering Mathematics 214, 242)

316 16) Regression and Analysis of Variance (3L, 1P)

Fitting regression models by means of matrices. The multiple linear regression model. Inference in the multiple linear regression model. Residual analysis. Analysis of variance models. The use of R software to fit models in practice.

Home department: Statistics and Actuarial Science

Method of assessment: Flexible Assessment (EMS rules)

Required modules:
PP Mathematical Statistics 244 or 246
P Mathematical Statistics 245
P Mathematics 214, 214 or (Engineering Mathematics 214, 242 and Applied Mathematics B 242)

344 (16) Stochastic Processes (3L, 1P)

Introduction to stochastic processes. Markov chains, Markov processes and their applications. Markov jump processes. Elementary martingale theorem and applications. Brownian movements. Renewal theory.

Home department: Statistics and Actuarial Science

Method of assessment: Flexible Assessment (EMS rules)

Required modules:
P Mathematical Statistics 312 or 318
P Mathematical Statistics 316 or 318

59528 Operations Research (Eng)

345 (15) Operations Research (Deterministic Models) (3L; 3T)

The systems approach to problem-solving; problems leading to linear programming, network, integer and non-linear programming models; algorithms for solving such models; tasks, including exercises with computer packages.

Home department: Industrial Engineering

Method of Assessment: Flexible Assessment

Required modules:
P Engineering Mathematics 214

415 (15) Operations Research (Stochastic Models) (3L; 3T)

Analysis of problems leading to deterministic and stochastic dynamic programming models; Markov chains and waiting-line models; techniques for solving such models; decisions under uncertainty; Bayes' theorem; multi-criteria decision-making; local-search and population-based metaheuristics.

Home department: Industrial Engineering

Method of Assessment: Flexible Assessment

Required modules:
P Engineering Statistics 314

xxxxx[1] Optimisation (Eng)

414 (15) Nonlinear Optimisation (3L; 1,5P; 1,5T)

Classical methods: gradient-based approaches, the simplex method, BFGS, Nelder-Mead, trust-region, Quadratic Programming, Monte Carlo methods, and random walks. Metaheuristic methods: evolutionary algorithms, simulated annealing, swarm-based optimisation algorithms, and estimation of distribution algorithms. Theory of nonlinear problems, conditions for optimum, convergence rate, and sensitivity analysis.

Home department: Industrial Engineering

Method of Assessment: Flexible Assessment

Required modules:
P Operations Research 345

[1] Since these modules will only be offered from 2021 onwards, their 5-digit code will only be allocated in 2020.

65609 Philosophy and Ethics

414 (4) Philosophy and Ethics (2L)

Applied ethics; the code of conduct for professional persons of the Engineering Council of SA (ECSA); case studies of typical situations from engineering practice, including the social, workplace and physical environments.

Offered in the first term of the semester.

The quality assurance of Philosophy and Ethics is handled jointly by the Department of Philosophy and the Faculty of Engineering.

Home department: Philosophy

Method of Assessment: Flexible Assessment

56820 Probability Theory and Statistics

114 (16) Probability Theory and Statistics (3L, 3T)

Combinatorial analysis; the basic counting principles; permutations and combinations. Random phenomena; sample spaces and events; the probability axioms; the probability of an event; random selection; probability rules; conditional probability; the rule of Bayes; stochastic independence. Discrete and continuous stochastic variables; expected value and variance of a stochastic variable; important discrete distributions: binomial, Poisson, geometric, hyper-geometric, negative binomial; important continuous distributions, uniform, exponential, normal

Home department: Statistics and Actuarial Science

Method of Assessment: Flexible Assessment (EMS rules)

59447 Professional Communication

113 (8) Professional Communication (2L; 2T)

Effective communication with various target audiences with specific objectives in mind; particular focus on the planning and writing of a technical report; other document types in the professional environment such as proposals and correspondence; text skills, such as coherence, appropriate style and text structure; appropriate referencing methods; written communication in teams. Introduction to the engineering profession.

Home department: Engineering (Admin)

Method of Assessment: Project

46795 Project (E)

448 (45) Project (E) (20P)

Thesis project: Each student must do an independent project on an approved topic and submit a full report. An oral examination is required where the professional communication skills of each student is assessed.

Home department: Electrical and Electronic Engineering

Method of Assessment: Project

Required modules:
Final-year Enrolment

51993 Project Management

412 (12) Project Management (3L; 1T)

Project management framework: integration, scope, time, cost, human resources, communication, risk, safety and procurement. Project management processes: initiating, planning, execution, control and commissioning. Principles of business management and leadership. Multidisciplinary team work and project management.

Home department: Industrial Engineering

Method of Assessment: Flexible Assessment

46779 Systems and Signals

244 (15) Frequency Domain Techniques (3L; 1,5P; 1,5T)

The Laplace transform and its application to dynamic circuits; impulse and step response; convolution; transfer functions; Bode plots; basic passive filters; basic active filters; Fourier series and its application to circuits; Fourier transform and its applications to circuits; filters.

Home department: Electrical and Electronic Engineering

Method of Assessment: Flexible Assessment

Required modules:
C Electrotechnique 143
C Engineering Mathematics 214
C Engineering Mathematics 242