

BACCALAUREUS TECHNOLOGIAE: ENGINEERING: ELECTRICAL

Qualification code: BTEE01 - NQF Level 7

Campuses where offered: Pretoria and eMalahleni campuses (day classes or block-mode and evening classes)
Last year of new intake: 2019
Teach-out (phase-out) date: 30 June 2023

Students registered for this qualification should complete their studies according to the teach-out date prescribed for the qualification, subject to the stipulations of Regulation 3.1.11 and 3.1.13 in the Students' Rules and Regulations.

Information on phased-out programmes can be obtained from the TUT website, www.tut.ac.za.

Key to asterisks:

* Information does not correspond to information in Report 151.
(Deviations approved by the Senate in August 2005.)

** MEQ40XT and MEQ40YT must be taken concurrently and will count as one subject.

CURRICULUM

Consult the 2019 Faculty Prospectus for the full contents of the qualification.

SUBJECTS PRINTED IN BOLD ARE NOT FOR REGISTRATION PURPOSES.

FIRST OR SECOND SEMESTER

The subjects below are offered in semesters, as determined by the Department.

| CODE | SUBJECT | CREDIT | PREREQUISITE SUBJECT(S) |
|--|---|----------|---|
| EGM411T | Engineering Management IV | (0,100) | |
| EMT451T | Engineering Mathematics IV | (0,100) | Mathematics III |
| IPR413T | Industrial Project IV | (0,300) | Design Project: Heavy Current III or Design Project: Light Current III |
| IPR413R | Industrial Project IV (re-registration) | (0,000) | Industrial Project IV |
| plus one of the following subjects: | | | |
| CSY401T | Control Systems IV | (0,100) | Control Systems III |
| SPR401T | Signal Processing IV | (0,100) | Mathematics III |
| plus four of the following subjects (consult the subject selection guide at the end of this qualification). Subjects are offered at the learning site determined by the Department: | | | |
| CNW401T | Computer Networks IV | (0,100) | |
| CSY401T | Control Systems IV (if not already passed) | (0,100) | Control Systems III |
| CTM401T | Clinical Engineering Technology Management IV | (0,100) | |
| DCS401T | Digital Control Systems IV | (0,100) | Control Systems IV Engineering Mathematics IV |
| DSP401T | Digital Signal Processing IV | (0,100) | Signal Processing IV |
| ELC411T | Electronics IV | (0,100) | Electronics III |
| EMA411T | Electrical Machines IV | (0,100) | Electrical Machines III |
| ENT401B | Entrepreneurship IV | (0,100)* | |
| EPC401T | Electrical Protection IV | (0,100) | Electrical Protection III |
| ETC401T | Electronic Communication IV | (0,100) | Electronic Communication III Signal Processing IV |



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|--------------------------------------|--|--------------|----------------------------------|
| HVE401T | High-Voltage Engineering IV | (0,100) | Electrical Engineering III |
| MCS401T | Micro-Controller Systems IV | (0,100) | |
| MEQ401T | Medical Equipment IV | | |
| MEQ40XT | Medical Equipment: Equipment IV** | (0,100) | Medical Equipment: Equipment III |
| MEQ40YT | Medical Equipment: Systems IV** | (0,100) | Medical Equipment: Systems III |
| MSD401T | Microsystems Design IV | (0,100) | |
| MWE401T | Microwave Engineering IV | (0,100) | Microwave Communication III |
| NMS401T | Numerical Methods and Statistics IV (offered in the second semester only) | (0,100) | Mathematics III |
| NSY401T | Network Systems IV | (0,100) | |
| OET401T | Opto-Electronics IV | (0,100) | Electronics III |
| PCM401T | Process Instrumentation IV | (0,100) | Process Instrumentation III |
| PWE411T | Power Electronics IV | (0,100) | Power Electronics III |
| PWS401T | Power Systems IV | (0,100) | Electrical Engineering III |
| RAE411T | Radio Engineering IV | (0,100) | Radio Engineering III |
| SCO401T | Satellite Communications IV | (0,100) | Electronic Communication III |
| SFE401T | Software Engineering IV | (0,100) | |
| SPR401T | Signal Processing IV (if not already passed) | (0,100) | Mathematics III |
| TVE401T | Television Engineering IV | (0,100) | Television III |
| TOTAL CREDITS FOR THE QUALIFICATION: | | 1,000 | |

SUBJECT SELECTION GUIDE

The following is a guide to the optional subjects to orient to a specific field in Electrical Engineering (timetable will give priority to subjects as set out in the subject selection guide):

- **CLINICAL ENGINEERING**
Clinical Engineering Technology Management IV, Electronics IV, Medical Equipment: Equipment IV, Medical Equipment: Systems IV and Signal Processing IV.
- **DIGITAL TECHNOLOGY**
Control Systems IV or Signal Processing IV.

plus four of the following subjects:
Computer Networks IV, Control Systems IV, Digital Control Systems IV, Digital Signal Processing IV, Micro-Controller Systems IV, Microsystems Design IV, Microwave Engineering IV, Numerical Methods and Statistics IV, Network Systems IV, Opto-Electronics IV, Signal Processing IV and Software Engineering IV.
- **ELECTRONIC ENGINEERING**
Electronics IV and Signal Processing IV.

plus three of the following subjects:
Control Systems IV, Digital Control Systems IV, Digital Signal Processing IV, Entrepreneurship IV, Numerical Methods and Statistics IV and Opto-Electronics IV.
- **POWER ENGINEERING**
Control Systems IV.

plus four of the following subjects:
Electrical Machines IV, Entrepreneurship IV, Electrical Protection IV, High-Voltage Engineering IV, Numerical Methods and Statistics IV, Power Electronics IV and Power Systems IV.
- **PROCESS INSTRUMENTATION**
Control Systems IV and Process Instrumentation IV.

plus three of the following subjects:
Digital Control Systems IV, Digital Signal Processing IV, Electronics IV, Entrepreneurship IV, Numerical Methods and Statistics IV, Network Systems IV, Opto-Electronics IV, Signal Processing IV and Software Engineering IV.



- **TELECOMMUNICATION TECHNOLOGY**
Electronic Communication IV and Signal Processing IV.

plus three of the following subjects:

Computer Networks IV, Control Systems IV, Digital Control Systems IV, Digital Signal Processing IV, Electronics IV, Entrepreneurship IV, Micro-Controller Systems IV, Microsystems Design IV, Microwave Engineering IV, Numerical Methods and Statistics IV, Network Systems IV, Opto-Electronics IV, Radio Engineering IV, Satellite Communications IV and Software Engineering IV.

- **OWN CHOICE**
Control Systems IV or Signal Processing IV plus four of the optional subjects from the optional subject list.

A student can compile his or her own stream leading to a desired field of specialisation by combining subjects from any of the optional subject choices given above. This will enable a student who has completed his or her studies to be skilled and competent in a stream leading to desired new specialisation field as required by their industry. Possible employers are those companies using cutting-edge technologies such as electronic system companies, power electronic and power application companies that operate in all electrical engineering fields.

SUBJECT INFORMATION (OVERVIEW OF SYLLABUS)

The syllabus content is subject to change to accommodate industry changes. Please note that a more detailed syllabus is available at the Department or in the study guide that is applicable to a particular module. On 1 October 2019, the syllabus content was defined as follows:

C

CLINICAL ENGINEERING TECHNOLOGY MANAGEMENT IV (CTM401T) **1 X 3-HOUR PAPER**
(Subject custodian: Department of Electrical Engineering)
Environment, research and development, the manufacturing process, acquisition, commissioning, support, replacement, communication skills, personnel structures and professional ethics. (Total tuition time: ± 70 hours)

COMPUTER NETWORKS IV (CNW401T) **1 X 3-HOUR PAPER**
(Subject custodian: Department of Electrical Engineering)
Introduction, electrical interfacing, local area networks (LAN), wide area networks (WAN) and Internet. (Total tuition time: ± 70 hours)

CONTROL SYSTEMS IV (CSY401T) **1 X 3-HOUR PAPER (OPEN BOOK)**
(Subject custodian: Department of Electrical Engineering)
State-space analysis of linear systems. Design of compensators using gain adjustment, Lead and Lag compensators. Designs of compensators for linear systems, using state space techniques. (Total tuition time: ± 70 hours)

D

DIGITAL CONTROL SYSTEMS IV (DCS401T) **1 X 3-HOUR PAPER (OPEN BOOK)**
(Subject custodian: Department of Electrical Engineering)
Discrete-time models and sampled data systems, difference equations, mathematical representation of the sampling process using the Z-transform, analysis of sampled data systems, stability considerations of sampled data systems, design of compensation for sampled data systems, using transform techniques. (Total tuition time: ± 70 hours)



DIGITAL SIGNAL PROCESSING IV (DSP401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Introduction to digital signal processing. Sampling analogue signals that are to be converted into their discrete counterparts. The characteristics of discrete-time signals and systems. The three different domains that discrete-time signals are represented in. Time-domain representation and analysis of discrete-time signals and systems (using convolution and difference equations), frequency-domain (Discrete Fourier series, Discrete Fourier Transform, Fast Fourier Transform) representation and analysis and the z-Transform. Applications of digital signal processing; for example, digital filter design. (Total tuition time: ± 70 hours)

E**ELECTRICAL MACHINES IV (EMA411T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

A deeper study of the design and maintenance of synchronous, induction and special machines, as well as the different control techniques and uses of those machines. (Total tuition time: ± 70 hours)

ELECTRICAL PROTECTION IV (EPC401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Symmetrical fault calculation in power systems, and determine their distribution taking into account transient and sub-transient components. Unsymmetrical fault calculation in power systems, and determine their distribution taking into account transformer connections. Select current transformers, circuit breakers, fuses, over-current relays and reclosers based on their characteristics, and evaluate their performance. Implement protective relaying schemes and techniques for unit and line protection. (Total tuition time: ± 70 hours)

ELECTRONIC COMMUNICATION IV (ETC401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

This subject is designed to equip students with the ability to design and solve problems related to the fundamental components and the real-world applications of digital communication systems that meet defined standards and specifications of overall performance while respecting system constraints related to power and energy; channel bandwidth; effect of noise; transmission and detection of signals. The subject provides students with the foundational knowledge needed for digital communication related courses, designs and problem solving in higher academic degrees. (Total tuition time: ± 70 hours)

ELECTRONICS IV (ELC411T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Design and analysis of electronic sub-systems by making use of basic building blocks of analogue integrated circuits. The emphasis is placed on transistor circuit design while giving enough information about operational amplifier that would enable the student to intelligent and innovative analogue electronic designs. PSpice is widely used in this module as a most valuable design tool (student version of circuit maker or Orcad lite) in a practical project that runs through the semester. (Total tuition time: ± 70 hours)

ENGINEERING MANAGEMENT IV (EGM411T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

The engineer and the manager, the engineering organisation. Total quality management: principles, applications, the human element in engineering management, engineering and construction contracts, professional ethics, the business plan, strategic and financial management. (Total tuition time: ± 70 hours)

ENGINEERING MATHEMATICS IV (EMT451T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Mathematics and Statistics)**

Advanced mathematical concepts are used in complex analysis and transforms. Complex variables. Complex differentiation. Complex integration. Z-transforms. Complex Fourier series. Fourier transforms. Solution of the wave equations. Matrix analysis (single-input–single-output systems). (Total tuition time: ± 70 hours)

ENTREPRENEURSHIP IV (ENT401B)**1 X 3-HOUR PAPER****(Subject custodian: Department of Management and Entrepreneurship)**

Introduction to strategic management. A strategic management model for a business. Situational analysis of a business. Strategy formulation, implementation and control. Continuous improvement approaches. Case studies and projects. Entrepreneurship: principles, innovation, creativity, opportunities, entrepreneurial options, sources of support. (Total tuition time: ± 70 hours)



H**HIGH-VOLTAGE ENGINEERING IV (HVE401T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Electrical insulation: breakdown mechanism in gases, liquids and solids. High voltage testing techniques: High voltage and current generation; alternating voltage, direct voltage, impulse voltage and impulse current. Measurement: high voltages and currents. High voltage testing: non-destructive insulation test techniques, power equipment insulation tests. Over-voltages and insulation coordination: internal and external over-voltages, methods and devices for protection against over-voltages, insulation coordination. (Total tuition time: ± 70 hours)

I**INDUSTRIAL PROJECT IV (IPR413T/R)****PROJECT ASSESSMENT****(Subject custodian: Department of Electrical Engineering)**

The industrial project is continued throughout the study period for at least 300 hours. The subject content is handled on a personal basis and is evaluated by a panel of experts. The work may be done in the University environment or in the industry itself. Assessment of the project is based on a written report and its oral presentation before a panel of experts. (Total tuition time: ± 12 months)

M**MEDICAL EQUIPMENT: EQUIPMENT IV (MEQ40XT)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Health delivery systems, overview of health policies and systems for treating patients, clinical engineering support systems and environmental hazards: health hazards, sterilisation, quarantine, EMC, gases. Advanced therapeutic equipment: anaesthesia, ventilators, energy transfer instruments and thrombo-elastography. Rehabilitation devices: cardiovascular prosthesis and assist devices, therapy equipment, therapy-supportive equipment, physiological prostheses. (Total tuition time: ± 70 hours)

MEDICAL EQUIPMENT: SYSTEMS IV (MEQ40YT)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Advanced transducers and sensors, advanced measurement and analysis techniques, modern imaging systems, neural assist devices, cardiac output measurements, ion and blood analysers, ultrasound, magnetic resonance imaging systems and computer applications in the medical field. (Total tuition time: ± 70 hours)

MICRO-CONTROLLER SYSTEMS IV (MCS401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Microcontrollers can be seen in action all around us. Although not noticeable, the microcontrollers function in environments not suitable for personal computers. Students learn the advantages and shortcomings of microcontrollers. The practical applications with which the students are confronted stress the importance of microcontroller use. (Total tuition time: ± 70 hours)

MICROSYSTEMS DESIGN IV (MSD401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

The world of the microprocessor and microcomputer is discovered in this subject, taking the i486 as an example. It is covered in fair detail, from register level to the general software design. The i386-EX with its integrated peripherals on the same chip is investigated as a complete microcomputer. (Total tuition time: ± 70 hours)

MICROWAVE ENGINEERING IV (MWE401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Introduction to electromagnetic field theory. Microstrip design and distributed matching techniques. Microwave filter and resonator applications. Power division and combining techniques. Analyses of microwave systems, including noise. (Total tuition time: ± 70 hours)



N**NETWORK SYSTEMS IV (NSY401T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Information Technology)**

This subject introduces the basic concepts and principles of wireless communication. The topics discussed include mobile radio propagation, coverage and capacity of mobile network, spread-spectrum, roaming, handover, wireless LAN and MAN, and emerging networks such as ad hoc and sensor networks. (Total tuition time: \pm 20 hours)

NUMERICAL METHODS AND STATISTICS IV (NMS401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Mathematics and Statistics)**

Mathematical basics, non-linear equations, ordinary differential equations, interpolation, numerical integration, sampling, descriptive statistics, regression analysis and probability. (Total tuition time: \pm 70 hours)

O**OPTO-ELECTRONICS IV (OET401T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Optical fibre wave guides: introduction, wave guide principles, transmission properties, fibre technology. Optical sources: emission, types, and transmission circuits. Optical detectors: principles, semiconductor transmitter type and semiconductor receiver circuits. Optical fibre systems: applications, measurements, noise and losses. Practicals include learning to polish a fiber and to send audio and data over the link. (Total tuition time: \pm 70 hours)

P**POWER ELECTRONICS IV (PWE411T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Revision of theory from PWE311T. Study of three-phase rectifiers. In-depth design of non-isolated DC choppers. Control of inverters. Basic control principles of switch mode DC power supplies. Design of high-frequency transformers and inductors and also of driver circuits. Basic design of high-frequency transformers and inductors and also basic design of driver circuits. Three-phase supplied DC drives. AC and DC drive control principles. (Total tuition time: \pm 70 hours)

POWER SYSTEMS IV (PWS401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Theory: transmission line parameters: transmission line design considerations, series impedances, shunt admittances, electric field and voltage, parallel circuit three-phase lines. Transmission lines steady state operation: medium and short line approximations, transmission lines differentials, lossless line, line loadability, reactive compensation techniques. Power systems representations and load flow analysis: node equations, bus admittance, network reduction, Gauss Seidal-solution, Newton-Raphson solution, DC power flow. Power system controls: generator-voltage control, turbine-governor control, load and frequency control, economic dispatch, optimal power flow. Transient operation of transmission line: travelling waves, Bewley Lattice diagram. Stability: the swing equation, power angle equation, simplified synchronous machine model and system equivalents, multi-machine stability. Energy management systems. Economic tariffs. (Total tuition time: \pm 70 hours)

PROCESS INSTRUMENTATION IV (PCM401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

The subject is a source of essential information for students involved or those in need of greater knowledge, in the design and use of process systems that relies on automated machinery. It emphasises on control systems and offers full coverage of other relevant topics, including machine building, manufacturing business systems and job functions in an industrial factory environment. (Total tuition time: \pm 70 hours)



R**RADIO ENGINEERING IV (RAE411T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Modern wireless communications, frequency reuse, channel assignment strategies, handoff strategies, interference and system capacity, trunking and GOS. Radio wave propagation and propagation models; outdoor propagation models, indoor propagation models, signal prediction in buildings. Doppler shift, impulse response for a multipath channel, small scale multipath measurements. (Total tuition time: ± 70 hours)

S**SATELLITE COMMUNICATIONS IV (SCO401T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

The objective is to apply fundamental principles of satellite communication theories in order analyse and design satellite communication systems by understanding the fundamental principles of satellite systems, understanding the implementation of satellite services, analysing Orbits, assessing transmission techniques, interference, multiple access and direct broadcasting, analysing satellite signal propagation losses, signal polarisation and satellite antennas types, analysing and designing satellite links, designing Spacecraft subsystems and Earth station. (Total tuition time: ± 70 hours)

SIGNAL PROCESSING IV (SPR401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Introduction to signal processing. Analogue signal processing. Signals and systems, and the characteristics of signals and systems. The different domains that continuous-time signals are represented in. Time-domain representation and analysis of continuous-time signals and systems (using convolution and ordinary differential equations), frequency-domain representation and analysis (Fourier series, Fourier Transform) and the Laplace Transform. Applications of signal processing; for example, the design of continuous-time filters. (Total tuition time: ± 70 hours)

SOFTWARE ENGINEERING IV (SFE401T)**1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

An introduction to software engineering. The principles involved in the design phases of the development cycle of a complete software project from conceptual development to product delivery. Concepts, such as definitions of the software product and process, project planning, risk analysis, tracking, analysis, design, object-orientated analysis and quality control. On completion, students have to submit a software product developed in a group context. (Total tuition time: ± 70 hours)

T**TELEVISION ENGINEERING IV (TVE401T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Electrical Engineering)**

Overview of Analogue Colour television Standards and Colour Television Systems: PAL, PAL+, D2-MAC, SECAM, NTSC. Digital Video Standards: DVB and ATSC. Digital formats: 4:2:2, 4:2:0; SIF, CIF and QCIF (bandwidth and bit rate problem). Video Compression Techniques: DCT, VLC, RLC, Huffmann entropy, JPEG, MPEG I and MPEG II. Audio Compression Techniques: MP3 and AC-3. Complete DVB transmitting and receiving chain – process and system multiplexers, scrambling, modulation transmission and receiving of DVB signal. (Total tuition time: ± 70 hours)

