

# NATIONAL DIPLOMA: ENGINEERING: METALLURGY

## Qualification code: NDMY03 - NQF Level 6

Campus where offered: Pretoria Campus

### Important notification to new applicants:

Students who intend to enrol for this qualification for the first time in 2017 or thereafter, should note that it will not be possible to continue with any Baccalaureus Technologiae as from 2020, since it is being replaced by qualifications aligned with the newly-implemented Higher Education Qualification Sub-Framework. Potential students are advised to consult the University's website for any new qualifications which might not be published in this Prospectus.

## REMARKS

a. *Admission requirement(s) and selection criteria:*

### • **FOR APPLICANTS WHO OBTAINED A SENIOR CERTIFICATE BEFORE 2008:**

#### **Admission requirement(s):**

A Senior Certificate or an equivalent qualification, with a D symbol (50 – 59%) at Higher Grade or a C symbol (60 – 69%) at Standard Grade for English and C symbols (60 – 69%) at Higher Grade or B symbols (70 – 79%) at Standard Grade for Mathematics and Physical Science.

#### **Selection criteria:**

To be considered for this qualification, applicants must have an Admission Point Score (APS) of at least **28**.

#### **Assessment procedure:**

Applicants with a combined score of less than 10 for Mathematics and Physical Science and an APS of between 23 and 27 will write an Academic Placement Test before final acceptance. All applications will then be ranked according to APS achieved.

### • **FOR APPLICANTS WHO OBTAINED A NATIONAL SENIOR CERTIFICATE IN OR AFTER 2008:**

#### **Admission requirement(s):**

A National Senior Certificate with a bachelor's degree or a diploma endorsement, or an equivalent qualification, with an achievement level of at least 4 for English (home language or first additional language), 4 for Mathematics and 3 for Physical Sciences.

Applicants who do not meet the above criteria for Mathematics and/or Physical Sciences for admission to the National Diploma, may enrol for: Mathematics N3/N4 and/or Engineering Sciences N3/N4; or Mathematics, Physical Sciences and Process Chemistry, as presented as part of the National Certificate Vocational (NCV) at NQF Level 4, at any Technical and Vocational Education and Training (TVET) College. If these subjects are successfully passed at a performance level of at least 60%, they may re-apply for admission to the qualification at the University.

#### **Selection criteria:**

To be considered for this qualification, applicants must have an Admission Point Score (APS) of at least **23**.

#### **Assessment procedure:**

Applicants with a final combined score of 10 and more for Mathematics and Physical Sciences and an APS of 28 and more will be ranked according to APS achieved. Those with a combined score of less than 10 for Mathematics and Physical Sciences and an APS of between 23 and 27 will write an Academic Placement Test before final acceptance. All applications will be ranked according to APS achieved. After consideration of the Departmental Student Enrolment Plan (SEP), only the highest performing applicants will be selected. Applicants will be informed immediately of their acceptance into the programme.



- **FOR APPLICANTS WHO OBTAINED A QUALIFICATION FROM TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING (TVET) COLLEGES (PREVIOUSLY KNOWN AS FET COLLEGES):**

**Applicants with a National Certificate (Vocational) at NQF Level 4:**

**Admission requirement(s):**

A National Certificate (Vocational) at NQF Level 4 with a bachelor's degree or a diploma endorsement, issued by the Council for Quality Assurance in General and Further Education and Training (Umalusi), with at least 50% (APS of 4) for English and Mathematics, and at least 60% (APS of 5) for Physical Sciences/Applied Engineering Technology and any other two vocational subjects.

**Selection criteria:**

To be considered for this qualification, applicants must have an Admission Point Score (APS) of at least **23**.

**Applicants with a National N Certificate as published in Nated 191: N3 (NQF Level 4) and N4/N5/N6 (NQF Level 5):**

A National Senior Certificate or a National N Certificate as published in Nated 191: N3 (NQF Level 4) and N4/N5/N6 (NQF Level 5) issued by the Council for General and Further Education and Training (Umalusi), with at least 50% (APS of 4) for English and 60% (APS of 5) for Mathematics N3 and Engineering Sciences N3.

Applicants will be exempted from certain subjects on the grounds of N4/N5/N6 subjects passed (a minimum of 50% of the qualification's subjects). Exemption will be granted for equivalent engineering subjects (including Mathematics and Engineering Sciences), successfully passed with at least 60% (APS of 5).

- b. *Minimum duration:*  
Three years.
- c. *Presentation:*  
Day classes. Classes and assessments may take place on Friday afternoons and/or Saturdays. Certain subjects are offered at the location (Arcadia and Pretoria campuses) determined by the Head of the Department.
- d. *Intake for the qualification:*  
January only.
- e. *Exclusion and readmission:*  
See Chapter 2 of Students' Rules and Regulations.
- f. *Recognition of Prior Learning (RPL), equivalence and status:*  
See Chapter 30 of Students' Rules and Regulations.
- g. *Accreditation by professional body:*  
This qualification has been accredited by the Engineering Council of South Africa (ECSA).
- h. *Practicals:*  
It is compulsory for students to attend the practical classes. Students must pass the practical component of a subject to be admitted to the examination.
- i. *Personal protective equipment:*  
Students are required to wear laboratory coats and other applicable protective gear during practicals. Students must purchase their own safety equipment and clothing.
- j. *Textbooks:*  
Additional textbooks and other educational material will be required.



- k. *Work-Integrated Learning I and II:*  
Students may enrol for only one subject during any of the Work-Integrated Learning periods, provided that the Work-Integrated Learning provider agrees to such an arrangement in writing. If the subject is the last and only outstanding subject and the student has written the final exam within the past two years, the student may apply for an exit examination. See Chapter 5 of the Students' Rules and Regulations for more information.
- l. *Waiving of prerequisite subjects:*  
Prerequisites will only be waived in highly exceptional cases, based on a motivation by the Head of the Department and approved by the Executive Dean (prerequisite subjects published in Report 151 are excluded).
- m. *Subject credits:*  
Subject credits are shown in brackets after each subject.
- Key to asterisks:  
\* Information does not correspond to information in Report 151.  
(Deviations approved by the Senate in November 2008.)  
\*\* Students may choose to take Management Skills I or Entrepreneurial Skills I.

## CURRICULUM

**SUBJECTS ARE ONLY OFFERED IN THE SEMESTER AS INDICATED BELOW. SUBJECTS PRINTED IN BOLD ARE NOT FOR REGISTRATION PURPOSES.**

### FIRST YEAR

CODE	SUBJECT	CREDIT	PREREQUISITE SUBJECT(S)
<b>FIRST SEMESTER</b>			
CHE141B	Chemistry IA (offered in both semesters)	(0,083)	
CSK101B	Computer Skills I	(0,042)	
MAT171T	Mathematics I	(0,083)	
MEY101T	Metallurgy I	(0,084)	
<b>MNP201T</b>	<b>Mineral Processing II</b>		
MNP20XT	Mineral Processing: Chemical Principles II	(0,041)	
PHU161B	Physics IA	(0,083)	
TOTAL CREDITS FOR THE SEMESTER:		0,416	
<b>SECOND SEMESTER</b>			
COS101T	Communication Skills I	(0,042)	
MAT271B	Mathematics II	(0,083)	Mathematics I
MCI201T	Metallurgical Chemistry II	(0,083)	Chemistry IA
MDR101C	Mechanical Engineering Drawing I	(0,083)	
<b>MNP201T</b>	<b>Mineral Processing II</b>		
MNP20YT	Mineral Processing: Metallurgical Principles II	(0,042)	Chemistry IA Mathematics I Mineral Processing: Chemical Principles II
PML101T	Physical Metallurgy I	(0,085)	Metallurgy I
SMM201T	Strength of Materials II	(0,083)	Mathematics I Physics IA
TOTAL CREDITS FOR THE SEMESTER:		0,501	
TOTAL CREDITS FOR THE FIRST YEAR:		<b>0,917</b>	



**SECOND YEAR**

CODE	SUBJECT	CREDIT	PREREQUISITE SUBJECT(S)
<b>FIRST SEMESTER</b>			
ANP201T	Applied Mineral Processing II	(0,068)*	Metallurgical Chemistry II Metallurgy I
ENF201T	Extraction of Non-Ferrous Metals II	(0,067)*	Metallurgical Chemistry II
FAT201T	Ferro-Alloy Technology II	(0,067)*	Metallurgical Chemistry II Physical Metallurgy I
MGH201T	Metallurgical Thermodynamics II	(0,068)*	Metallurgical Chemistry II
MSK121T	Management Skills I**	(0,083)	
PMU201T	Practical Metallurgy II	(0,080)*	Metallurgy I Physical Metallurgy I
RFC201T	Refractories II	(0,067)*	
TOTAL CREDITS FOR THE SEMESTER:		0,500	
<b>SECOND SEMESTER</b>			
ANP301T	Applied Mineral Processing III	(0,100)*	Applied Mineral Processing II
CRS301T	Corrosion III	(0,100)*	Chemistry IA
ENF311T	Extraction of Non-Ferrous Metals III	(0,100)*	Extraction of Non-Ferrous Metals II
EPS101T	Entrepreneurial Skills**	(0,083)	
FAT311T	Ferro-Alloy Technology III	(0,100)*	Ferro-Alloy Technology II
QCL221T	Quality Control II	(0,083)	Mathematics I
RFC321T	Refractories III	(0,100)*	Refractories II
TOTAL CREDITS FOR THE SEMESTER:		0,583	
TOTAL CREDITS FOR THE SECOND YEAR:		<b>1,083</b>	

**THIRD YEAR**

CODE	SUBJECT	CREDIT	PREREQUISITE SUBJECT(S)
<b>FIRST OR SECOND SEMESTER</b>			
EXP1MET	Work-Integrated Learning I	(0,500)	
EXP2MET	Work-Integrated Learning II	(0,500)	Work-Integrated Learning I
TOTAL CREDITS FOR THE THIRD YEAR:		<b>1,000</b>	
TOTAL CREDITS FOR THE QUALIFICATION:		<b>3,000</b>	

**SUBJECT/MODULE 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 subject. On 13 October 2017, the syllabus content was defined as follows:

**A**

**APPLIED MINERAL PROCESSING II (ANP201T) 1 X 3-HOUR PAPER**  
**(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Introduction to ore preparation, mineralogy, economic characteristics of deposit, minerals processing accounting, particle size estimation and analysis, comminution. (Total tuition time: ± 60 hours)



**APPLIED MINERAL PROCESSING III (ANP301T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Concentration techniques, physical separation of ores, industrial flow sheets, equipment sizing, power consumption and environment impact. (Total tuition time: ± 60 hours)

**C****CHEMISTRY IA (CHE141B)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemistry)**

Matter and energy: atomic structure, chemical bonding, periodic table and nomenclature of inorganic compounds. Chemical equations and stoichiometry. Solutions. Acids, bases and salts. Chemical reactions. Chemical equilibrium. Electrochemistry and redox theory. Introduction to inorganic and organic chemistry. Practical: experiments based on the theory, with the emphasis on basic laboratory techniques. (Total tuition time: ± 60 hours)

**COMMUNICATION SKILLS I (COS101T)****CONTINUOUS ASSESSMENT****(Subject custodian: Department of Applied Languages)**

Communication theory, non-verbal communication (body language). Oral presentations, interviews, developing leadership and participation skills. Technical reports and correspondence. (Total tuition time: ± 64 hours)

**COMPUTER SKILLS I (CSK101B)****CONTINUOUS ASSESSMENT****(Subject custodian: End User Computing Unit)**

Students have to acquire theoretical knowledge (computing fundamentals) and practical skills as an end-user in operating systems and MS Office Suite applications (MS Word, MS Excel and MS PowerPoint) on an introductory level. Students will do online and computer-based tests. The modules are mapped with SAQA and IC3 Essential Skills for Digital Literacy (International certification). Open labs are available for additional practice time. (Total tuition time: ± 40 hours)

**CORROSION III (CRS301T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Corrosion processes and corrosion testing. Electrochemistry of corrosion. Passivity. Corrosion of iron and steel. Protection against corrosion. Alloying against corrosion. Non-ferrous alloys and polymers. (Total tuition time: ± 60 hours)

**E****ENTREPRENEURIAL SKILLS (EPS101T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Management and Entrepreneurship)**

Types of businesses. Management functions. Planning, organising, guidance, control. Budgeting. Accounting. Administration. Banking. Personnel management. Customer relations. (Total tuition time: ± 60 hours)

**EXTRACTION OF NON-FERROUS METALS II (ENF201T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Applied thermodynamics, reaction thermodynamics and kinetics calculations. Material sources for hydro-metallurgical processing, leaching of ores and concentrates. Separation, purification and enrichment processes for treatment of leach solutions. Precipitation processes for metal separation and recovery. Electrolytic processes for the recovery and purification of metals. (Total tuition time: ± 60 hours)

**EXTRACTION OF NON-FERROUS METALS III (ENF311T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Copper, gold, aluminium, lead, tin and zinc. Calculations. Laboratory practice. Casting of non-ferrous metals. (Total tuition time: ± 60 hours)

**F****FERRO-ALLOY TECHNOLOGY II (FAT201T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Iron and steel production, blast furnace iron-making. Steel production. Ferro-alloy technology. Söderberg paste and electrodes. Separation processes. Furnace design. (Total tuition time: ± 60 hours)



**FERRO-ALLOY TECHNOLOGY III (FAT311T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Iron and steel production. Production of alloy steels and stainless steel. Casting of steel. Off-gas systems and pollution. Steel slags. Ferro-alloy technology. Production of ferrosilicon, ferromanganese, ferrochrome and special ferro-alloys. Ferro-alloy furnace equipment. Pollution control and pollution control equipment. (Total tuition time: ± 60 hours)

**M****MANAGEMENT SKILLS I (MSK121T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Management and Entrepreneurship)**

Self-management, organisational environment, introduction to leadership and management principles. (Total tuition time: ± 60 hours)

**MATHEMATICS I (MAT171T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Mathematics and Statistics)**

Basic mathematics. Differentiation. Integration. Matrices and determinants. Vectors. Data handling. Complex numbers or mensuration. (Total tuition time: ± 60 hours)

**MATHEMATICS II (MAT271B)****1 X 3-HOUR PAPER****(Subject custodian: Department of Mathematics and Statistics)**

Revision of differentiation. Differentiation of functions with more than one variable. Further integration. Numerical methods. First-order ordinary differential equations. Matrices (Gauss elimination). (Total tuition time: ± 60 hours)

**MECHANICAL ENGINEERING DRAWING I (MDR101C)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Printing, freehand sketches, types of lines, construction of scales. Geometric construction of arcs and tangency, locus applications: i.e. ellipse, parabola, involute, archimedean spiral. Orthographic projections, isometric drawing, sectioning. Surface development, construction of fasteners, and detailed working and assembly drawing. (Total tuition time: ± 60 hours)

**METALLURGICAL CHEMISTRY II (MCI201T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemistry)**

Physical chemistry: introduction. Gases. Electrochemistry. Chemical equilibrium. Rates and mechanisms of chemical reactions. Colloidal properties of solutions. Colloids. Metallurgical analysis: sampling. Volumetric analysis. Gravimetric analysis. Instruments and analysis in the metal industry. (Total tuition time: ± 60 hours)

**METALLURGICAL THERMODYNAMICS II (MGH201T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Introduction. First and second law of thermodynamics. Heat capacity. Real gases. Thermodynamic relations. Properties of mixtures. Absorption. Enthalpy. Entropy (processes: spontaneous, reversible and irreversible). Free energy. Ellingham diagram for oxides and sulphides. Chemical equilibrium. Principles of phase equilibrium. Construction of phase diagrams: binary, free energy. (Total tuition time: ± 60 hours)

**METALLURGY I (MEY101T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Basic concepts of atomic bonds, crystal structures and material properties. Control over properties by heat treatment, microstructure and phase diagrams. Measuring material properties with mechanical tests like tensile tests, hardness tests, impact tests, etc. General forming processes, plastic strain, strain hardening, hot working, cold working, recrystallisation. Getting acquainted with the well-known non-ferrous alloys. The basic properties and behaviour of ceramics, polymers and compound materials. (Total tuition time: ± 60 hours)

**MINERAL PROCESSING: CHEMICAL PRINCIPLES II (MNP20XT)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Understanding the units and dimensions of the British, SI and American engineering systems. Converting one set of units to another. Defining a mole and converting from moles to mass and the reverse for any chemical compound, given the molecular weight. Writing and balancing chemical reaction equations. Calculating the stoichiometric quantities of reactants and products, given the chemical reaction. Understanding the mass conservation law. Calculating material balances for systems without chemical reactions. Calculating material balances for systems with chemical reactions. (Total tuition time: ± 60 hours)



**MINERAL PROCESSING: METALLURGICAL PRINCIPLES II (MNP20YT)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Ideal gas equation of state, PVT behaviour and cubic equations of state, energy balances and first law of thermodynamics, steam tables, phase changes and humidification processes, state properties and process changes, mixing and solution processes, effect of reactions on material and energy balances. (Total tuition time: ± 60 hours)

**P****PHYSICAL METALLURGY I (PML101T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Binary phase diagrams and their interpretation, phase reactions, equilibria and non-equilibrium solidification of Fe-Fe<sub>3</sub>C, Al-Si and Cu-Zn systems. Strengthening mechanisms, solidification phenomena. Heat treatment: the common processes like annealing, normalising, hardening, martempering, etc. Hardenability and the use of hardenability data. IT diagrams corrosion: an introduction to the eight basic corrosion types. (Total tuition time: ± 60 hours)

**PHYSICS IA (PHU161B)****1 X 3-HOUR PAPER****(Subject custodian: Department of Physics)**

Basic mathematics for physics, measurements, kinematics in one and two dimensions, Newton's laws of motion, dynamics of uniform circular motion, work, energy and power, impulse and momentum, rotational kinematics, rotational dynamics, fluids, temperature and heat, the ideal gas law and kinetic theory, thermodynamics, electric forces and electric fields, electric potential energy and the electric potential, electric circuits, geometric optics – reflection of light: mirrors, refraction of light: lenses and optical instruments. Practical work. (Total tuition time: ± 60 hours)

**PRACTICAL METALLURGY II (PMU201T)****PRACTICAL EXAMINATION****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Physical metallurgy: sampling and specimen mounting. Polishing and etching techniques. Macro- and micropreparation. Optical microscopy, qualitative and quantitative metallography. Photography. Introduction to scanning electron microscopy. Pyrometry. Evaluation of material properties. Extraction metallurgy: ore dressing. Hydro-metallurgy. Pyro-metallurgy. Analytical techniques. (Total tuition time: ± 60 hours)

**Q****QUALITY CONTROL II (QCL221T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Fundamentals of statistics. Statistical process control. Product acceptance (sampling). Quality engineering. Quality and economy. Computers and quality. (Total tuition time: ± 60 hours)

**R****REFRACTORIES II (RFC201T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Refractory principles: classification of refractories, the basic principles of refractories. The properties and testing of refractory materials. Refractory materials: the manufacturing of refractory shapes, acid refractory materials, basic refractory materials, non-oxide refractory materials and thermal insulation products. Design and installation: the refractory lining system. The design of a lining: selection of material, mechanical, thermal and physical design. The installation of a refractory lining: pre-fired shapes, castables and other monolithic materials. The commissioning of refractory linings. (Total tuition time: ± 60 hours)

**REFRACTORIES III (RFC321T)****1 X 3-HOUR PAPER****(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Raw materials for monolithic refractories. Manufacture and properties of monolithic refractories. Wear mechanisms of monolithic refractories. Design, applications and installations. (Total tuition time: ± 60 hours)



**STRENGTH OF MATERIALS II (SMM201T)**

**1 X 3-HOUR PAPER**

**(Subject custodian: Department of Mechanical Engineering, Mechatronics and Industrial Design)**

Static. Direct stresses. Thermal effects and material combinations. Deformation, Poisson's ration and Young's modules. Centroid and second moment of inertia. Sheer force diagram. Bending moment diagrams. Torsion. Combined stresses. (Total tuition time: ± 60 hours)

**W**

**WORK-INTEGRATED LEARNING I (EXP1MET)**

**WORK-INTEGRATED LEARNING**

**WORK-INTEGRATED LEARNING II (EXP2MET)**

**WORK-INTEGRATED LEARNING**

**(Subject custodian: Department of Chemical, Metallurgical and Materials Engineering)**

Practical experience in the industry. (Total tuition time: six months)

