Fakulteit Ingenieurswese, Bou-omgewing & IT

Faculty of Engineering, Built Environment & IT

School of Engineering

Department of Materials Science and Metallurgical Engineering

POSTGRADUATE PROGRAMMES: 2015

(Revision 07 of 25 January 2015)

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

TABLE OF CONTENTS

1. INTRODUCTION

The Department of Materials Science and Metallurgical Engineering at the University of Pretoria offers Honours, Masters and Doctoral programmes in four metallurgical engineering disciplines: Physical Metallurgy, Welding Engineering, Extractive Metallurgy (Minerals Processing and Hydrometallurgy) and Pyrometallurgy. This brochure provides prospective students with details on the admission requirements and programme contents.

2. STRUCTURE OF POSTGRADUATE PROGRAMMES

The postgraduate degree programmes presented by the Department of Materials Science and Metallurgical Engineering include the Honours qualification, which consists of coursework and follows after a Bachelor degree, the Masters qualification and the PhD qualification. The Masters degree, which is research-based, culminates in a dissertation, and requires the Honours degree as an entrance requirement. The PhD degree, which is also research-based, culminates in a thesis, and requires a Masters degree as entrance requirement.

The postgraduate degree programmes in the School of Engineering were redesigned during the course of 2003 to satisfy the requirements of the Departments of Education and Higher Education and Training. The South African Qualification Authority (SAQA) credits for the Honours degree are calculated separately from those of the Masters degree, and all students who want to continue towards a Masters degree must therefore first complete the Honours degree. Credits cannot be transferred between the two degree programmes.

All programmes can be followed on a full-time or part-time basis. The coursework (Honours programme) is presented on a block basis to facilitate attendance by part-time students and to encourage flexible learning. There are two streams in the postgraduate programme. Holders of Bachelors degrees in engineering from an ECSA accredited degree course within South Africa, or holders of engineering degrees obtained outside South Africa from Universities recognised by the Washington, Syndey or Dublin Accords, continue to BEng(Hons)(Metallurgical Engineering), MEng(Metallurgical Engineering) and PhD(Metallurgical Engineering). Holders of Bachelors degrees in engineering that do not fall into the above definitions, or degrees in natural sciences, or BTech degrees in relevant disciplines, continue to BSc(Hons)(Applied Science)(Metallurgy), MSc(Applied Science)(Metallurgy), and PhD(Metallurgy).

3. ADMISSION TO POSTGRADUATE STUDIES

A summary of the entrance requirements is given in Table 1 and shown schematically in Figure 1. A more complete overview of the access requirements is given in the yearbook*. An application form for first time postgraduate students at the University of Pretoria (supported by copies of degree certificates and identity document or passport) must be completed and submitted to Client Services at the University of Pretoria. Application forms are available from the Department or applications can be completed on-line by following the “Apply now” link on the University’s homepage at www.up.ac.za.

PLEASE NOTE THAT THE DEADLINE FOR NEW APPLICATIONS FOR ADMISSION TO THE BSc(HONS)(APPLIED SCIENCE) PROGRAMMES FOR 2015 IS 30 NOVEMBER 2014. NO LATE APPLICATIONS WILL BE CONSIDERED.

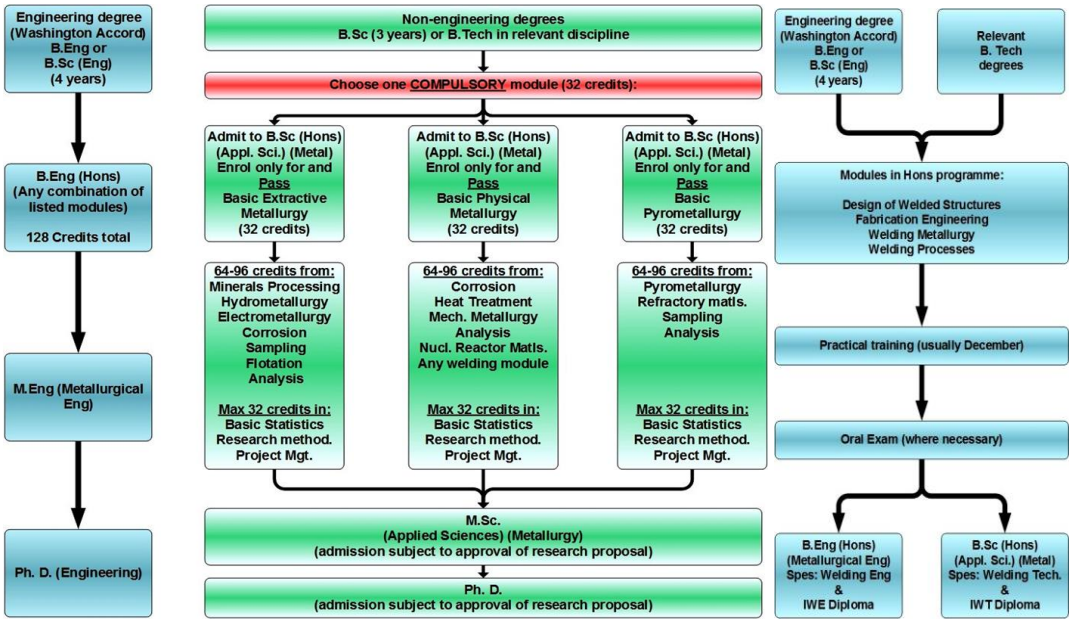

Figure 1

* Available on the University website (www.up.ac.za). Follow the links "UP Home » Prospective Students » Yearbooks"

Table 1. Admission requirements for 2015.

Degree programme	Entry requirements
BEng (Honours) (Metallurgical Engineering) or BEng (Honours) (Metallurgical Engineering) - Option: Welding Engineering	A Bachelors degree (BEng, BSc Eng or equivalent) in engineering from an ECSA accredited degree course in South Africa, or a 4 year (minimum) engineering degree from a University recognised within the Washington, Sydney or Dublin Accords.
BSc (Honours) (Applied Science) (Metallurgy) or BSc(Honours) (Applied Science) (Metallurgy) – Option: Welding Technology	A BSc or BTech degree in a relevant discipline, or an engineering degree in a relevant discipline from a University not recognised within the Washington, Sydney or Dublin Accords. The following access conditions for the BSc(Hons)(Applied Science) programmes will be strictly enforced: • An average of 65% or higher for all subjects in the applicant's last academic year (i.e. BTech year, or last academic year of a BSc or BSc Eng degree). Exceptions to this requirement may be considered for applicants with an average of 60% in the final year if work experience since obtaining the degree is considered adequate by the Program Leader or the Head of Department. • No subjects failed or repeated in the applicant's last academic year (i.e. BTech year, or last academic year of a BSc or BSc Eng degree). • **Note:** All **s**tudents in this category need to pass an introductory course first as set out in Section 4.1.3, Table 3 before being allowed to continue with any other post graduate module in Table 2. These introductory modules will bring the student up to level of the undergraduate students in the BEng program. Students who fail this introductory module will not be accepted for a second registration of this module in the following year.
MEng (Metallurgical Engineering)	A BEng(Hons) degree from the University of Pretoria, or its equivalent from a University recognised within the Washington, Sydney or Dublin Accords.
MSc (Applied Science) (Metallurgy)	A BSc(Hons) or BSc(Hons)(Applied Science) degree from the University of Pretoria, or its equivalent. An admission examination may be required.
PhD (Metallurgical Engineering)	A Masters degree in Engineering. The academic status of degrees obtained at other Universities needs to be clarified with the Student Administration Office of the Faculty of Engineering, the Built Environment and Information Technology.
PhD (Metallurgy)	A Masters degree (MSc) in a relevant discipline. An admission examination may be required. The academic status of degrees obtained at other Universities needs to be clarified with the Student Administration Office of the Faculty of Engineering, the Built Environment and Information Technology.

In exceptional cases, students who do not satisfy the admission requirements for the BSc(Hons) Applied Science programmes may be admitted provisionally at the discretion of the Head of Department. Note that Regulation G3 section 2 will be strictly enforced. This section states that "*in the case of part-time students, unless at least two equivalent semester modules are passed in a year, re-registration will not be permitted*".

4. PROGRAMME CONTENTS

4.1 Honours programmes

4.1.1 BEng(Honours)(Metallurgical Engineering)

The Honours degree in Metallurgical Engineering is based on course-work; the modules are presented in blocks (generally three blocks of two days each) during the semester. Typical duration of this programme is one year full-time or two years part-time. Modules amounting to at least 128 SAQA credits need to be completed. Table 2 presents a summary of the modules offered by the Department of Materials Science and Metallurgical Engineering. With the permission of the Head of Department, some modules can be taken from other departments (that is, in addition to those listed below in Table 2). Each of the modules presented in Metallurgical Engineering counts 32 credits – so four modules need to be completed to meet the degree requirements. Assignments are set which must be completed between blocks, one or more tests are written (normally after the second block), and the final examination typically follows in the month after the third block. Module block dates are as listed in Table 2, with short summaries of module contents. **Note that each module will only be presented if warranted by the number of students registered for the module.**

PLEASE NOTE THAT STUDENTS WILL NOT BE ALLOWED TO WRITE TESTS OR EXAMS AT THEIR PLACE OF EMPLOYMENT. STUDENTS ARE THEREFORE ADVISED TO ARRANGE FOR STUDY LEAVE, TRANSPORT AND ACCOMMODATION WELL IN ADVANCE OF THE FINAL TEST AND EXAM DATES.

Individual postgraduate coursework modules can also be followed as "short courses" by persons who are not registered as students, with the cost per module approximately double that for registered postgraduate students. More information is available from CE@UP.

Up to three modules may be run in parallel as a group. Students will not be allowed to register for modules with clashing lecture dates. Lecturing in each of the modules takes place on all of the contact dates listed; there is a total of five or six contact days in each module. Please confirm all dates at the start of each semester and about a month before the start of each module.

Table 2. BEng(Honours) module dates for 2015. Please note that all these modules are 32 credit courses except for NPA 700 which is only a 16 credit course.

Module	Course Coordinator	Dates	Test date	Exam date
Applied Theory of Sampling for Minerals Processing NMP701	Dr Naude	4-5 August 1-2 September 21-22 September	28 September	30 October
Corrosion NKR700	Prof RF Sandenbergh	6-7 August 10-11 September 27-28 October	TBA	20 November
Design of Welded Structures NWP701 [1]	Prof P Pistorius	7-11 September	-	16 October
Electrometallurgy NEL700	Prof RF Sandenbergh	3-4 September 14-15 October 19-20 November	TBA	4 December
Fabrication Engineering NFE700 [1]	Prof P Pistorius	2-9 November	-	4 December
Froth flotation NSF700	Mr K Schommarz	6-7 August 8-9 September 29 -30 September	22 September	20 October
Heat treatment of Steels NHB700	Dr CW Siyasiya	19-20 August 7-8 October 4-5 November	29 October	27 November
Hydrometallurgy NHM700	Prof RF Sandenbergh	1-2 April 9-10 June 14-15 July	TBA	7 August
Mathematical Modelling of Metallurgical Processes and Materials NWM 780	Dr JH Zietsman	4-5 March 9-10 April 7-8 May 18-19 May	5 June	24 July
Mechanical Metallurgy NMM700	Prof WE Stumpf	28-29 April 21-22 May 18-19 June	12 June	17 July
Metallurgical Analysis NPA 700 (16 credits)[2]	Ms Liezl Schoeman	14-18 September	25 Sept	16 Oct
Minerals Processing NMP700	Mr WP Roux	23-24 April 21-22 May 18-19 June	12 June	17 July
Physical Metallurgy NFM700	Prof WE Stumpf	20-21 August 8-9 October 12-13 November	28 October	4 December
Nuclear Reactor Materials NNR700 **(Runs together with MUA 785 and 786)** **(Only if more than 10 students wish to take this course)**	Prof WE Stumpf	22-23 April 21 May 1-2 Oct 30 October	10 June (NNR test) 12 November (NNR test)	10 June (MUA exam) 12 November (MUA exam) 20 November (NNR exam)
Pyrometallurgy NPM700	TBA	24-25 August 12-13 October 9-10 November	26 October	1 December
Refractory Materials NVM700	Prof AM Garbers-Craig	5-6 May 20-21 May 11-12 June	12 June (Lectures will commence after test)	29 July
Welding Metallurgy NSW700 [1]	Prof P Pistorius	27 July-31 July	-	26 August
Welding Processes NWP700 [1]	Prof P Pistorius	11-15 May	-	19 June

1 Although Honours students will be allowed to register for these modules individually, please note that any student wishing to obtain the South African Welding Institute's accreditation and the International Institute of Welding's International Welding Engineer (IWE) or International Welding Technologist (IWT) accreditation need to register for and pass all four modules (i.e. NWP701, NFE700, NSW700 and NWP700), while satisfying the additional requirements of IIW.

2. NPA 700 will only be offered if more than 6 students enroll for the course.

PLEASE NOTE THAT STUDENTS WHO REGISTER FOR AND PASS THE "SHORT COURSES" PRESENTED THROUGH CE@UP WILL NOT GET RECOGNITION FOR THE CORRESPONDING POSTGRADUATE MODULES. IT IS THEREFORE IMPERATIVE THAT STUDENTS WISHING TO OBTAIN CREDIT TOWARDS THE BEng(HONOURS) OR BSc(HONOURS)(APPLIED SCIENCE) DEGREES, REGISTER FOR THESE DEGREES FROM THE OUTSET.

A summary of the course content of all postgraduate modules is shown below.

- **Applied Theory for Sampling for Minerals Processing (NMP701):** This module covers both the theory and practice of sampling, primarily with respect to the minerals processing industry. As sampling is statistical in nature, basic statistics relevant to sampling theory will be considered. The module will then focus on the theory of sampling with specific reference to managing large and small scale variability. The effect of interpolation errors, periodic errors and increment weighting errors will be considered under large scale variability. Under small scale variability the determination and management of various errors that result in small scale variability will be covered, as well as the compilation of sampling protocols that can minimise these errors. The module will also examine the evaluation of dry and wet sampling equipment with respect to the different bias generators, as well as the implementation of sampling protocols in practice. Ore types covered during the course include coal, iron ore, gold and platinum.
- **Corrosion (NKR700):** The aim with this course is to facilitate the development of the students in corrosion engineering by considering the electrochemical fundamentals of corrosion processes as well as their experimental and practical implications for corrosion diagnosis and control. The practical manifestations of the broad types of corrosion are reviewed and the skills of the students to utilise corrosion control methodologies such as chemical and electrochemical control, protective coatings and material selection to control corrosion are developed.
- **Design of Welded Structures (NWP701):** This module examines welded joint design, the basics of weld design and the role of fracture mechanics in joint design. The behaviour of welded structures under different types of loading are considered, with special focus on the design of welded structures with predominantly static loading and the design of dynamically loaded welded structures. The design of welded pressure equipment, aluminium alloy structures and reinforcing-steel welded joints is considered.
- **Electrometallurgy (NEL700):** At the end of the module, students should be able to conceptualise and design new electrometallurgical processes and improve the operation of existing processes through an understanding of the basic principles of the thermodynamics and kinetics of electrochemistry, measurement techniques used in electrochemistry, and considering the principles of electrochemical reactor design, different electrode and cell configurations, role of additives to electrolytes, role of impurities in the electrowinning process, the steps involved in electrocrystallization processes and present practices used for the electrowinning of metals such as copper, nickel, cobalt, zinc, manganese and gold.
- **Fabrication Engineering (NFE700):** This module looks at quality assurance and control in welded fabrication and manufacture, and introduces various standards and codes of manufacture used in the welding industry. Measurement, control and recording in welding, the principle of fitness for purpose, as well as health and safety issues are addressed. Control of residual stresses and distortion during welding, non-destructive testing, repair welding, and the economics of welding are considered. This module also examines plant facilities, welding jigs and fixtures. Special emphasis is placed on the design and implementation of welding procedure specifications, procedure qualification records and quality control plans. A number of case studies are examined.
- **Froth Flotation (NSF700):** Fundamentals of sulphide and coal flotation are covered, including the chemistry of sulphide mineral flotation; natural and induced hydrophobicity; physical and chemical interactions in coal flotation; review of sulphydryl and oxydryl collectors and their absorption mechanisms; the role of activators/depressants and pH regulators as well as an investigation of frothers and froth stability, with reference to recent industrial developments. Aspects of flotation practice are addressed: Experimental methods for laboratory and plant trials; basic and complex flotation circuits with examples from recent developments; control in flotation plants: reagents/conditioning. Finally, relevant interfacial surface chemistry is covered: the role of water in flotation; mechanisms and thermodynamics of collector activity.
- **Heat Treatment (NHB700):** The emphasis is on the practice of the heat treatment of steels, covering the following topics: introduction and fundamental aspects of the Fe-C system; alloying elements; tempering of martensite; pearlite and bainite formation, hardenability; annealing, normalizing, hardening and tempering; stress relieving, use of CCT and TTT diagrams, HSLA steels, tool steels; stainless steels, heat treatment furnaces and their atmospheres, induction hardening, carburisation, nitriding, mechanical testing, non-destructive examination and heat treatment, hydrogen embrittlement, temper embrittlement, quantitative metallography for quality control, heat treatment for fracture toughness and heat treatment case studies. The course is partly available on CD-ROM with up-to-date references to the latest literature.
- **Hydrometallurgy (NHM700):** The aim with this course is to enable the students to understand the design and operation of hydrometallurgical processes for the beneficiation of minerals and metals. The theoretical basis of the solution chemistry underlying hydrometallurgical processes, the purification and concentration options available, and the metal recovery processes such as precipitation, hydrogen reduction, and electrowinning are reviewed. This is then followed by the consideration of the engineering aspects and the technical application of hydrometallurgical processes for a number of ores relevant to South Africa
- **Mathematical Modelling of Metallurgical Processes and Materials (NWM 780):** The aim of this course is to equip students to apply mathematical modelling to metallurgical processes and materials to solve problems in research and industrial practice. The course follows a very hands-on, practical approach to guide students to the point where they are competent and confident to use mathematical modelling and simulation. At the start of the course a brief revision of the basic concepts of the relevant physical, mathematical, numerical and programming concepts prepares students for the main volume of work in the course. Practices and principles are considered to equip students with a framework in which mathematical modelling can be practiced reliably and responsibly. Aspects such as process balancing, thermochemical calculations, kinetic modelling and steady state and dynamic process modelling are covered to enable students to create models and use them in investigations.

- **Mechanical Metallurgy (NMM700):** We cover the interaction between the internal structure of metals – on the atomic and microscopic scales – and their mechanical properties. Practically important topics such as elastic and plastic stress analysis, dislocations and deformation, room and high temperature deformation processes, mechanical property/microstructure relationships for low and medium Carbon steels and for micro-alloyed and HSLA steels, fatigue processes, stress corrosion cracking, creep deformation processes and fracture mechanics are covered in depth, and illustrated with case studies. The course is largely available on CD-ROM with references to the latest literature.

- **Metallurgical Analysis (NPA700) (16 credits only):** The aim is to solve metallurgical problems with the aid of hi-tech analytical techniques. These different analytical techniques are given in modular form and the respective metallurgical area of specialisation will dictate the combination of three techniques to suit the requirements of the research student. Specialisation areas like Physical Metallurgy, Welding Metallurgy, Hydro Metallurgy, Pyro Metallurgy and Minerals Processing are covered and any other combination can be requested by the study leaders after consultation with the course leader. The techniques included are TEM, SEM, Auger Spectroscopy (AES), , Glow Discharge Optical emission Spectroscopy (GDOES), X-ray Diffraction (XRD), X-ray fluorescence (XRF), Fourier transform infrared spectroscopy (FTIR), RAMAN spectroscopy, Thermogravimetric analysis (TGA), Gleeble hot working simulations and Dilatometry. Lectures cover the theory of these techniques in depth and the theory is illustrated with industrial case studies.

- **Minerals Processing (NMP700):** The advanced theory of the most commonly used mineral processing unit operations covering crushing, screening, classification, milling, gravity concentration, dense medium separation, magnetic separation and dewatering are covered. The theory is complemented with practical excel based tutorials that cover mass balances and modelling.

- **Nuclear Reactor Materials (NNR700) (Runs together with MUA 785 and 786):** In this module the mechanical behaviour of metals and alloys at room and high temperature is addressed but with special emphasis on nuclear materials used in commercial power reactors. In particular these materials' behaviour under deformation, creep, fracture, fatigue and also corrosion in irradiation conditions for in-core materials as well as their behaviour under the unique environmental conditions for out-of-core materials is covered.

- **Physical Metallurgy (NFM700):** The module deals with the basic understanding of phase transformations in alloys, and its relationship with microstructure and mechanical properties of alloys. Included are transformation processes such as solidification; nucleation, growth and coarsening of precipitates; the use of carbides and intermetallic compounds in steels; static and dynamic re-crystallisation; grain growth and the use of grain boundary engineering; the martensite, bainite and pearlite transformations; thermomechanical processing and some elements of quantitative metallography. The course is practice orientated; the current best fundamental understanding of these transformation processes covered, and its role in engineering application demonstrated. The course is fully documented on CD-ROM from the latest literature and is largely intended for that research student who is embarking on a physical metallurgical research project.

- **Pyrometallurgy (NPM700):** The aim of the modules is to provide practice in using fundamental principles to analyse pyrometallurgical processes – to be able to go from understanding to process improvement. To this end, the necessary fundamentals of reaction equilibria (including activity descriptions), reaction kinetics, and mass and energy balances are reviewed. Practical examples illustrate the use of these principles. In the final block, analysis of a number of practical processes in more detail – especially with respect to reaction kinetics. Throughout, the emphasis is on quantification, and at least half of the contact time is devoted to computer-based calculations.

- **Refractory Materials (NVM700):** The objective is to convey a fundamental understanding of the principles that are involved in the manufacture, selection and use of refractories. Relevant thermodynamic principles are reviewed, with emphasis on the thermodynamic properties of oxide materials, metals and slags, and how these affect refractory performance. Phase diagram use in refractory selection and prediction of slag-metal-refractory interactions is covered. A section on manufacture covers the types of raw materials, design and formulation, handling, manufacturing routes, and quality control (including practical mineralogy). Finally, design properties of refractories for the ferrous, cement, aluminium, copper, platinum and ferro-alloy industries are reviewed.

- **Welding Processes (NWP700):** This module examines arc physics, electrotechnics as applied to weld power sources, and power source design. The fundamental principles, applications, consumables and process variables of various arc welding processes, oxy-gas welding techniques, resistance welding processes, power beam processes and solid-state welding techniques are considered. Brazing and soldering, cutting, surfacing and metal spraying techniques are discussed. The module also looks at the welding of plastics, ceramics and composites, and at the mechanisation and use of robotics in the welding and joining industries. Practical training is included in this module.

- **Welding Metallurgy (NSW700):** This module examines the basic physical metallurgy and heat treatment of various metals and alloys, and the application of various mechanical testing techniques, microstructural analysis and corrosion testing to characterise metals and alloys. The structure and properties of welds in carbon steels, stainless steels, cast irons, copper and copper alloys, nickel and nickel alloys, aluminium and aluminium alloys and other materials (Ti, Mg, Ta and Zr) are discussed. Defects are discussed and various techniques to avoid the formation of these defects in welds are considered.

PLEASE NOTE THAT THE DATES SHOWN IN TABLE 2 ARE SUBJECT TO CHANGE. STUDENTS ARE ADVISED TO CONFIRM THE MODULE DATES BY CONTACTING THE DEPARTMENT AT (012) 420 3182 OR BY REFERRING TO THE WEBSITE OF THE DEPARTMENT OF MATERIALS SCIENCE AND METALLURGICAL ENGINEERING AT www.up.ac.za/metal ON A REGULAR BASIS.

4.1.2 BEng(Honours)(Metallurgical Engineering) – Option: Welding Engineering

Students wishing to obtain the internationally recognised International Welding Engineer (IWE) qualification have to register for the new BEng(Honours)(Metallurgical Engineering) – Option: Welding Engineering degree program. The IWE course presented at the University of Pretoria as the BEng(Honours)(Metallurgical Engineering) – Option: Welding Engineering program will only be accessible to students who are registered as Professional Engineers with the Engineering Council of South Africa (ECSA) at the time of qualification, or students who hold engineering qualifications accredited by ECSA as satisfying the educational requirements for registration as Professional Engineer. These qualifications include ECSA accredited Bachelors degrees in Engineering (BEng or BSc Eng) from a South African university, or an equivalent foreign qualification recognised under the Washington, Sydney or Dublin Accords.

The course will be presented in the form of four postgraduate modules. Each module corresponds to 32 SAQA credits, amounting to the full 128 credits required for the BEng(Honours) degree programme on successful completion of all four modules. The four modules are based on the four modules in the prescribed IWE syllabus and the module contents will follow the guidelines presented in the International Institute of Welding documents IAB-252-07 and IAB-195r1-07. IWE candidates have to successfully complete all four of the modules listed below with a minimum final mark of 60% in each module to qualify for the IWE diploma:

- Welding Processes (NWP700)
- Welding Metallurgy (NSW700)
- Design of Welded Structures (NWP701)
- Fabrication Engineering (NFE700)

This degree programme is presented on a part-time block basis to facilitate attendance by part-time students and to encourage flexible learning. Additional multi-media material, IWE Part 1 and IWE Part 3, will be supplied to students at an additional cost (to be confirmed) as compulsory self-study material. This material was developed in Germany and fully complies with the requirements of the International Institute of Welding IAB Distance learning guideline IAB 195-r2.

Part 1 (88 hours) covers the first part of the International Welding Engineer course according to IIW Guideline IAB-252-07. The material will be supplied in the form of a DVD or internet download and covers the basic principles of the following study themes:

- Module 1: Welding processes and equipment
- Module 2: Materials and their behaviour during welding
- Module 3: Construction and design

Part 3 (145 hours) covers more advanced computer-based self-study material for the IWE course and fully complies with IIW guidelines (the material is also supplied in DVD or internet download format). The following study-themes are covered:

- Module 2: Materials and their behaviour during welding
- Module 3: Construction and design
- Module 4: Fabrication, applications engineering

The total on-campus lecturing time will be 150 hours of contact time, with 88 hours (Part 1) and 145 hours (Part 3) allocated for Distance Learning. In addition to the web-based learning and formal contact time described above, students on the IWE program will have to complete 60 hours of practical welder training at approved local providers (such as SAIW or AWA).

On successful completion of the course and practical training, a student can apply to SAIW Certification for registration as an International Welding Engineer. Depending on their performance in the examinations, candidates may be invited for a Professional Interview and Oral Examination at SAIW Certification to assess their level of knowledge and understanding of the subject material before the IWE diploma can be issued. For more information, please refer to the “Guideline for IWE/IWT training” available on the department’s website at www.up.ac.za/metal

Note: Prospective students for the degree BEng Hons (Metallurgy) Welding option need to note the following conditions:

1. Students who may have taken any one or more of the above four welding modules as part of a normal or non-welding BEng Hons (Metallurgy) degree will not be able to get credit for these modules should they at a later stage apply for admission to the BEng Hons Welding equivalent.
2. This is partly due to a University regulation that one may not use a module taken for another degree to ”fill in” on a second degree.
3. Secondly, the accreditation of the welding degree for an IWE recognition by the SAIW and the IWI also requires the four modules to be taken under one accreditation round and will not recognize one of the four welding modules taken for another degree not included in this accreditation.

4.1.3 BSc(Hons)(Applied Science)(Metallurgy)

This programme provides focused knowledge and skills in metallurgy to holders of a first degree in natural sciences (physics, chemistry, applied chemistry or geology) or technology (in a relevant discipline). To build up appropriate background knowledge, the contents of modules from the higher years of the undergraduate programme in Metallurgical Engineering are first covered in one of three "basic" modules (in physical metallurgy, pyrometallurgy or extractive metallurgy), as shown in Table 3. All students on the BSc(Hons)(Applied Science)(Metallurgy) programme must successfully complete one of these "basic" modules before being allowed to register for any of the modules shown in Table 2. This compulsory "basic" (background) module (NHM 701, NFM 701 or NPM 701) counts 32 credits. Module summaries are given below.

- **Basic Extractive Metallurgy (NHM701):** This module covers the fundamental principles of hydrometallurgy and minerals processing. In the minerals processing part of the module, students are given perspective on the scope of and functions in mineral processing, different unit operations and processing options for different deposits. Themes are comminution, classification, concentration, and solid-liquid separation. In the hydrometallurgy portion the merits and limitations of hydrometallurgy when compared with other metallurgical processes (e.g. pyrometallurgy) are considered; and different feed materials for hydrometallurgical processes; different unit processes in hydrometallurgy; fundamental thermodynamic and kinetic concepts as used in leaching; different leach reactors and their applications; solution purification and metal recovery processes; selecting a suitable flowsheet for a given feed material to produce a final metal product are discussed.
- **Basic Physical Metallurgy (NFM701):** This module serves as a bridge into full post graduate studies in physical and mechanical metallurgy for students who do not have a formal first degree in these subjects. The following topics are covered in this module: phases in alloys, diffusion, solidification, the precipitation of second phases in alloys and the recrystallisation and grain growth of single phase alloys, aluminium and its alloys, copper and its alloys, nickel base alloys, the iron-carbon phase diagram, the heat treatment of steels, dislocations and the deformation of metals, engineering strength of metals and alloys, creep deformation, introduction to fracture mechanics and fatigue and failure analysis. This module will, therefore, enable the student to understand the fundamentals that govern alloy design, heat treatment, physical and mechanical properties and behaviour of materials during heat treatment and under stress and will enable the correct selection of alloys for a particular use, the prescription of heat treatments and further mechanical processing of these alloys to achieve the required metallurgical and mechanical properties.
- **Basic Pyrometallurgy (NPM701):** In this module the skills required to analyse the equilibria of pyrometallurgical processes will be developed. Solving such a problem requires skills in thermodynamic analysis, and knowledge of the typical processes (and the conditions within these processes) which are used to extract and refine metals like iron (steel), copper, titanium, chromium, manganese, and aluminium. The aim is to enable you to analyse a current or proposed process with regards to feasibility, and to propose processing conditions (e.g. temperature, slag composition) which will achieve the required equilibrium state. This also applies to refractory systems, where the primary aim will be to evaluate whether a given refractory material is suitable for a given application, or the impact of certain impurities on the refractory material.

Table 3. Compulsory basic (background) modules. All students on the BSc(Hons)(Applied Science)(Metallurgy) programme have to pass one of these modules before being allowed to register for any of the BEng(Hons) modules shown in Table 2.

Module	Course Coordinators	Credits	Contact dates	Test date	Exam date
Basic Extractive Metallurgy NHM 701[(1)]	Dr N Naudé and Dr D Groot	32	5-6 February 26-27 February 19-20 March	18 March	10 April
Basic Physical Metallurgy NFM701	Dr CW Siyasiya	32	5-6 February 26-27 February 19-20 March	18 March	10 April
Basic Pyrometallurgy NPM 701[(1)]	Prof AM Garbers-Craig TBA	32	5-6 February 26-27 February 19-20 March	18 March	10 April

1. PLEASE NOTE[(1)]: Each of these two modules NHM 701 and NPM 701 consists of two parts. A subminimum of 40% needs to be gained in each part of the module, both as a semester mark, and as an exam mark. Additionally, a combined mark (for the two parts) of 50% or higher is required to pass the module before proceeding further.

2. Please note: Students who fail the Basic module will be excluded from repeating this module the following year and, therefore, also from further studies in the chosen degree program BSc Hons (Applied Science) This exclusion is covered by Regulation G3 in the UP Annual Year Book.

3. After successfully completing the Basic 701 module, students need to obtain a further 96 credits for the total of 128 credits for the degree BSc Hons (Applied Science). (***Note*** *below that in the welding technology option for BSc Hons (Applied Science) Welding, a further 128 credits beyond the basic module NFM 701 are required*) Within the further 96 credits for all non-welding options, a maximum of 32 further credits may also be obtained from optional modules offered by other Departments (see Table 4 below) which provide general research skills. These optional modules can be selected to cover Basic Statistical Methods (24 credits, presented by Civil Engineering), Research Methodology (16 credits, presented by Engineering and Technology Management), or Project Management (16 credits, presented by Engineering and Technology Management). Basic Statistical Methods will be presented in the form of 2-hour lectures (from 07h30 to 09h30) on each of the days shown in Table 4, whereas Project Management and Research Methodology will be presented in full day blocks.

Table 4. Optional BSc(Hons)(Applied Science)(Metallurgy) modules providing general skills (a maximum of 32 credits).

Module	Code	Credits	Dates[1]	Exam date
Basic Statistical Methods 797	SHC 797	24	Covers both first and second semesters	TBA
Research Methodology 781	INI 781	16	Second semester	TBA
Project Management 780	IPK 780	16	Second semester	TBA

Note: (1) For module presentation and exam dates, please contact the relevant department's Administration.

The balance of credits (to achieve a total of at least 128) is obtained by completing elective modules from the Engineering Honours programme (see Table 2). Due to the specialised nature of these modules, students will only be allowed to register for BEng(Hons) modules in the same general focus area as the basic module passed. The selection of BEng(Hons) modules available to students who have passed one of the three basic modules is shown in Table 5. Typical programme duration is one year to eighteen months full-time or two years part-time.

Table 5. Selection of BEng(Hons) modules that students on the BSc(Hons)(Applied Science)(Metallurgy) programme will be allowed to register for after passing one of the basic modules shown in Table 3*.

Having passed Basic Physical Metallurgy (NFM701), students will be allowed to register for the following BEng(Hons) modules:	Having passed Basic Pyrometallurgy (NPM701), students will be allowed to register for the following BEng(Hons) modules:	Having passed Basic Extractive Metallurgy (NHM701), students will be allowed to register for the following BEng(Hons) modules:
Corrosion NKR700	Pyrometallurgy NPM700	Minerals Processing NMP700
Design of Welded Structures NWP701(3)	Refractory Materials NVM700	Hydrometallurgy NHM700
Fabrication Engineering NFE700(3)	Metallurgical Analysis NPA700(2) (16 credits only)	Froth flotation NSF700
Heat treatment NHB700	Applied Theory of Sampling for Minerals Processing NMP701	Applied Theory of Sampling for Minerals Processing NMP701
Mechanical Metallurgy NMM700	Mathematical Modelling of Metallurgical Processes and Materials NWM 780	Electrometallurgy NEL700
Metallurgical Analysis NPA700(2) (Note: This module is only 16 Credits)		Metallurgical Analysis NPA700(2) (16 credits only)
Nuclear Reactor Materials NNR700		Corrosion NKR700
Physical Metallurgy NFM700		
Welding Metallurgy NSW700(3)		
Welding Processes NWP700(3)		

Note:

1. Students will only be allowed to register for modules not listed in the relevant column of Table 5 at the discretion of the Head of Department and in consultation with the course lecturer. These exceptions will be considered on the basis of the student's background and experience.

2. The module NPA 700 worth 16 credits, will be offered in 2015 as a degree module for the last time and only if enough students wish to follow this module. From 2016 it will be a non-degree module offered through CE@UP only.

3. Students who may have taken any one or more of the above four welding modules as part of a normal or non-welding BSc Hons (Applied Science) Metallurgy or a BEng Hons degree, will not be able to get credit for these modules should they at a later stage apply for admission to the BSc Hons or BEng Hons welding equivalent.

PLEASE NOTE THAT:

- **NO BSc(HONS)(APPLIED SCIENCE)(METALLURGY) STUDENT WILL BE ALLOWED TO REGISTER FOR ANY ENGINEERING HONOURS MODULES (THOSE SHOWN IN TABLE 2) BEFORE SUCCESSFULLY COMPLETING A COMPULSORY "BASIC" MODULE (NHM 701, NFM 701 OR NPM 701).**
- **STUDENTS ON THE BSc(HONS)(APPLIED SCIENCE)(METALLURGY) PROGRAMME WILL NOT BE ALLOWED TO REGISTER FOR MORE THAN ONE OF THE BASIC MODULES SHOWN IN TABLE 3. SHOULD A STUDENT WISH TO COMPLETE MORE THAN ONE OF THE BASIC MODULES, ONLY ONE OF THESE MODULES WILL COUNT TOWARDS THE CREDIT TOTAL FOR THE DEGREE PROGRAMME.**
- **ANY STUDENT WHO FAILS THE BASIC 701 MODULE WILL BE EXCLUDED FROM ANY REPEAT AND, THEREFORE, FROM CONTINUING WITH THE DEGREE PROGAM, AS DICTATED BY REGULATION G3 IN THE UP ANNUAL YEAR BOOK.**
- **PLEASE NOTE THAT STUDENTS WILL NOT BE ALLOWED TO WRITE TESTS OR EXAMS AT THEIR PLACE OF EMPLOYMENT. STUDENTS ARE THEREFORE ADVISED TO ARRANGE FOR STUDY LEAVE, TRANSPORT AND ACCOMMODATION WELL IN ADVANCE OF THE FINAL TEST AND EXAM DATE.**
- **PLEASE NOTE THAT THE DATES SHOWN IN TABLES 3 AND 4 ARE SUBJECT TO CHANGE. STUDENTS ARE ADVISED TO CONFIRM THE MODULE DATES BY CONTACTING THE DEPARTMENT AT (012) 420 3182 OR BY REFERRING TO THE WEBSITE OF THE DEPARTMENT OF MATERIALS SCIENCE AND METALLURGICAL ENGINEERING AT www.up.ac.za/metal ON A REGULAR BASIS.**

4.1.4 BSc(Hons)(Applied Science)(Metallurgy) - Option: Welding Technology

Students wishing to obtain the internationally recognised International Welding Technologist (IWT) qualification have to register for the new **BSc(Honours)(Applied Science)(Metallurgy) - Option: Welding Technology** degree programme. The IWT course presented at the University of Pretoria as the **BSc(Honours)(Applied Science)(Metallurgy) - Option: Welding Technology** programme will only be accessible to students who satisfy the entry requirements for the BSc(Honours)(Applied Science) degree programmes as described below.

Note the following:

1. This means that students in this programme will have to gain entry by passing the Basic Physical Metallurgy NFM 701 module first before being allowed to embark on any of the four Welding modules listed below. It may be noted that the module NFM 701 is completed by a final examination early in April, allowing those who passed the entry requirement, to still complete all of the other welding modules within the same year.
2. Secondly, students need to recognise that failure of the basic module NFM 701 will automatically exclude those students from either repeating the entry module and, therefore, also from continuing with the entire degree program, as per regulation G3 in the UP Annual Year Book.

After satisfying the entry requirements, the welding degree programme for **BSc(Honours)(Applied Science)(Metallurgy) - Option: Welding Technology** will be presented in the form of four postgraduate modules. Each module corresponds to 32 SAQA credits, amounting to the full 128 credits required for the BSc(Honours)(Applied Science) degree programme on successful completion of all four modules. The four modules are based on the four modules in the prescribed IWT syllabus and the module contents will follow the guidelines presented in the International Institute of Welding documents IAB-252-07 and IAB-195r1-07. IWT candidates have to successfully complete all four of the modules listed below with a minimum final mark of 60% in each module to qualify for the IWT diploma:

- Welding Processes (NWP700)
- Welding Metallurgy (NSW700)
- Design of Welded Structures (NWP701)
- Fabrication Engineering (NFE700)

This degree programme is presented on a part-time block basis to facilitate attendance by part-time students and to encourage flexible learning. Additional multi-media material, IWE Part 1 and IWE Part 3, will be supplied to students at an additional cost (to be confirmed) as compulsory self-study material. This material was developed in Germany and fully complies with the requirements of the International Institute of Welding IAB Distance learning guideline IAB 195-r2.

Part 1 (88 hours) covers the first part of the International Welding Technologist course according to IIW Guideline IAB-252-07. The material will be supplied in the form of a DVD or internet download and covers the basic principles of the following study themes:

- Module 1: Welding processes and equipment
- Module 2: Materials and their behaviour during welding
- Module 3: Construction and design

Part 3 (145 hours) covers more advanced computer-based self-study material for the IWT course and fully complies with IIW guidelines (the material is also supplied in DVD or internet download format). The following study-themes are covered:

- Module 2: Materials and their behaviour during welding
- Module 3: Construction and design
- Module 4: Fabrication, applications engineering

The total on-campus lecturing time will be 150 hours of contact time, with 88 hours (Part 1) and 145 hours (Part 3) allocated for Distance Learning. In addition to the web-based learning and formal contact time described above, students on the IWT program will have to complete 60 hours of practical welder training at approved local providers (such as SAIW or AWA).

On successful completion of the course and practical training, a student can apply to SAIW Certification for registration as an International Welding Technologist. For more information, please refer to the “Guideline for IWE/IWT training” available on the department’s website at www.up.ac.za/metal

Note: Prospective students for the degree BSc Hons (Applied Science) Metallurgy in Welding need to note the following conditions:

1. Students who may have taken any one or more of the above four welding modules as part of a normal or non-welding BSc Hons (Applied Science) Metallurgy or a BEng Hons degree will not be able to get credit for these modules should they at a later stage apply for admission to the BSc Hons or BEng Hons welding equivalent.
2. This is partly due to a University regulation that one may not use a module taken for another degree to ”fill in” on a second degree.
3. Secondly, the accreditation of the welding degree for an IWT recognition by the SAIW and the IWI also requires the four welding modules to be taken under one accreditation round and will not recognize one of the four welding modules taken for another degree not included in this accreditation.

4.2 Masters degree programmes [MEng and MSc(Applied Science)]

The Masters degree follows the Honours degree, and is based on research. The research may be completed full-time or part-time, and culminates in a written dissertation and oral presentation. A member of the lecturing staff acts as supervisor of the project. The research project must be of sufficient scope to demonstrate that the student is capable of formulating a research hypothesis (based on a literature study and practical observations), designing experiments to test the hypothesis, and using the results to test the original hypothesis. At least one paper on the research work (co-written with the research supervisor) must be submitted to a recognised ISI accredited journal.

Students with Honours degrees from another university or with a non-engineering qualification from this university, and who wish to continue their higher postgraduate studies in this department, may be required to complement their knowledge as preparation for their Masters degree by attending and passing some of the Honours modules listed in Tables 2 and 3. These courses will be selected by the student's research supervisor to support the student's research topic. Attendance of these modules, writing the tests and examinations and submitting all assignments are compulsory in these cases. Successful completion of the required modules (for either degree or non-degree purposes) will be made a condition of re-registration the following year or alternatively, be addressed in the bursary contract between the university and the student.

4.3 Doctoral programmes [PhD(Metallurgical Engineering) and PhD(Metallurgy)]

The PhD degree is based on original, independent research and may be carried out on a part-time or full-time basis. This degree programme involves in-depth study of an aspect of the candidate's engineering or scientific work. The programme contents are as for the Masters degrees (see 4.2), but the project is of greater scope and depth.

Students with Masters degrees from another university or with a non-engineering qualification from this university, and who wish to continue their higher postgraduate studies in this department, may be required to complement their knowledge as preparation for their PhD degree ***by attending and passing*** some of the Honours modules listed in Tables 2 and 3. These courses will be selected by the student's research supervisor to support the student's research topic. Attendance of these modules, writing the tests and examinations and submitting all assignments are compulsory in these cases. Successful completion of the required modules (for either degree or non-degree purposes) will be made a condition of re-registration the following year or alternatively, be addressed in the bursary contract between the university and the student.

5. COMPULSORY FEEDBACK SESSIONS AND PROGRESS REPORTS

All students on the Masters and PhD programmes (part-time and full-time students) are required to submit one progress report during the course of the year, detailing research findings and project progress. These reports must be submitted to the study leader, and copies will be forwarded to the Head of Department, the industry partner funding the project or the student's employer (in the case of part-time students). The industry partner or the student's employer will be informed if the student fails to submit any of the scheduled progress reports, and such failure will be taken into account by the study leader when the final dissertation or thesis is submitted. The dates for the submission of progress reports for 2015 are shown in Table 6. Please diarise these dates as no late submissions will be accepted.

An oral feedback session is held at the beginning of the year, where students report on their research progress. The provisional date for the postgraduate feedback session is shown below in Table 6. Please note that attendance of this feedback session is compulsory and failure to attend will be communicated to the industry partner or the student's employer. The postgraduate committee of this department will gauge a student's progress during the last year based on the oral feedback session and this information will be used to determine whether a student will be allowed to reregister.

Table 6. Preliminary dates for the submission of progress reports and for the postgraduate oral presentation.

Compulsory feedback	Submission/presentation date
Progress report	14 July 2015
Feedback session	To be announced

6. FUNDING

The University of Pretoria provides bursaries for all levels of postgraduate study. The amounts awarded depend on the programme being followed, with the amounts generally being sufficient to cover tuition fees; refer to the "study finance" section of the University website (www.up.ac.za; follow the links "UP Home » Prospective Students » Finances Bursaries & Loans » Study Finance Information").

In addition, full-time postgraduate students (at Master's degree and Doctoral level) may qualify for a bursary which is funded from research funds of the Department of Materials Science and Metallurgical Engineering. These bursaries are awarded at the discretion of the Head of Department. See **Appendix A** for more information on these bursaries.

Running costs of full-time research projects are covered by the department, by means of grants from industry, the University, and the National Research Foundation.
Other forms of student support may be found on the webpage for the National Research Foundation (NRF) or from the UP Office for study funding:

Leanne.vanzyl@up.ac.za
mpai.mphunngoa@up.ac.za

or go to:

www.up.ac.za/feesfunding - go to **External Bursary** pages

Students need to identify and apply for such additional funds themselves although the Department's Administration Office will assist with such applications.

7. ACCOMMODATION

University accommodation is available to full-time postgraduate students, but application early in the second half of the preceding year is required.

8. CONTACT DETAILS

For further enquiries, contact Ms. Gabi Ngema, tel. 012 420 3188, fax 012 362 5304, e-mail: gabi.ngema@up.ac.za

APPENDIX A: Bursary scheme for full-time M and PhD postgraduate research students

A.1 UP Scholarships and Departmental Bursaries

Objective and premise

The objective of the Departmental bursary scheme is to support approved full-time students who are working towards master's degree or doctoral qualifications, by performing research as part of the Department's research programme. The bursaries are funded from the industrial sponsorship which the Department receives to conduct research, hence research outputs are important performance criteria for students on the programme. Note, however, that the award of these departmental bursaries is dependent on the availability of funds from industry sponsorships which are not necessarily guaranteed and post graduate research students need to search also for other forms of funding for their studies. These bursaries are in addition to those offered centrally by the University of Pretoria. For detail on the latter, follow the links "UP Home » Prospective Students » Finances Bursaries & Loans » Study Finance Information" on the University website (www.up.ac.za).

Level of support

1. **Departmental bursary**: M and PhD students may apply for a Departmental bursary to cover living expenses if sufficient financial support from an industry sponsor is available. Such a bursary and its level of support can, therefore, not be guaranteed but the Department undertakes to do what is possible to solicit such funds. The Departmental bursary amount is reviewed annually and is dependent on the level of funding from the industry sponsor and is paid into the student's account in monthly instalments. It is the student's own responsibility to plan to cover their expenses from the award (if available) but also from other sources should the Departmental bursary not be sufficient. In addition to the funding, the Department will provide each full-time student with shared office space, and reasonable access to computer facilities.
2. **UP Scholarships:** In addition to the Departmental bursary which is intended to cover living expenses, M and PhD students can also apply for an UP Scholarship to cover registration and annual tuition fees. The award of such Scholarships will be governed by the satisfactory progress of the student's research and the availability of central funds. Students who wish to apply for such a Scholarship can only apply after being registered for the degree program but also need to apply before May of that year as the Scholarship covers study fees from January to December of that year and will not be extended beyond the 2 years for an M degree and the 3 years for a PhD degree. Applications that are submitted after May of that year will, therefore, effectively only cover the study fees still for the remainder of the 2 or 3 years respectively.

Both the Departmental bursaries as well as the UP Scholarships are subject to a contractual agreement of the student and the University and will be awarded for a 3 year period for PhD students and 2 years for M-students and will not be extended beyond these deadlines unless exceptional circumstances exist. In selected cases where research students are allowed to register for an M degree without formally going through the Hons program**(1)** but in which they still do the full 128 credit Hons course work as part of the M degree, the award of a departmental bursary will be for a 2.5 year period and will not be extended beyond this deadline unless exceptional circumstances exist. Extension of any such bursary beyond the aforesaid deadlines will have to be approved by the Head of Department and will only be considered if the industry sponsor supports such an application.

Note (1): Please note that in the event of such a selected route of an M-degree without formally registering for the B Hons but doing the course work as part of the M degree, the student will eventually be awarded only the M degree and not the B Hons degree also. Also where such a student fails to complete his/her M degree the University will in no circumstances recognise the course work for the award of a Hons degree. This arises from a strictly applied regulation of the University that no student is allowed to be registered for two different degrees at the same time.

The running costs of the projects are funded separately by the Department, and are not taken from the bursary.

Eligibility

Full-time students working towards a research degree within the Department may be eligible for support if sufficient sponsorship funds are available. Bursaries are awarded at the discretion of the Head of Department. South African and foreign students may be funded. Students on the BEng(Honours) and BSc(Honours)(Applied Science) programmes can be supported, provided they continue to the Master's degree programme and sufficient funding is available.

Students are selected on the basis of a written entrance examination, which tests background knowledge and skills in the field of the proposed research project. Relevant study material and criteria of assessment are supplied before the examination, and at least two weeks of preparation is normally allowed before examination. During the preparation period prospective students may consult the supervisor of the proposed research project, to obtain further background information.

An alternative entrance route is successful completion of the Honours programme (BEng(Honours) Metallurgical Engineering or BSc(Honours) Applied Science: Metallurgy), without funding from the department. In this case, after successful completion of the Honours programme, the department can provide two years of funding to complete the Master's degree programme.

Performance requirements

The successful applicant will need to sign a contract with the University of Pretoria. The bursary is initially awarded for a period of twelve months but a review of progress after six months may lead to termination for the second six months if progress is unsatisfactory. Renewal after the first twelve months is also subject to satisfactory progress, which is defined as follows:

Students on Honours programmes: Successful completion of all coursework to date.

Students on Master's degree and Doctoral programmes: Research progress, regular contact with research supervisor, and presentations at departmental feedback sessions. Timely submission of progress reports and attendance of all feedback sessions are requirements for continued financial support.

Students are expected to spend at least 40 working hours per week on their projects. Students will be required to assist in departmental activities such as undergraduate practical sessions, tutorial classes, open days or engineering weeks.

After the initial 6-month period, the bursary is renewable for a second 6-month period, and thereafter for periods of a year (to a total of 2 years for the Master's degree programme, and 3 years for the Doctoral programme).

Note that if a research students does not complete his/her degree while having had the benefit of a departmental bursary, the University reserves the right to recover the full costs of the bursary from the student, including interest.

Termination

The Department may terminate funding if progress is unsatisfactory (as measured against the criteria stated above) or if the industry sponsor has ceased its financial support for any reason.

Should the student wish to leave before completing the project (for example, after completing the Honours coursework but before completion of the Master's degree project), the student will be required to reimburse the department for the amount of the bursary awarded to date. Reimbursement will also be required if the thesis or dissertation is not submitted within a reasonable period (normally one year) after completion of the experimental work.

A.2 Other sources of funding

As internal UP and Departmental funds for bursaries are mostly limited, research students are encouraged to also seek out other sources of funding external to UP. More information on these opportunities can be found on the UP webpage link: www.up.ac.za/feesfunding