



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en
Inligtingtegnologie / Lefapha la Boetšenere,
Tikologo ya Kago le Theknolotši ya Tshedimošo

Civil Engineering Postgraduate Brochure

2022



Version 1.2

9 February 2022

Message from the Head of Department

Welcome to the postgraduate programme of the Department of Civil Engineering in the School of Engineering at the University of Pretoria. We are proud to have a critical mass of teaching staff and associates in the profession to be able to offer doctoral, masters and honours programmes in more than ten focus areas, grouped into four disciplines, namely Geotechnical, Structural, Transportation and Water Resources Engineering. During the last 10 years, over 500 postgraduate students have graduated through this department and are held in high esteem in the industry, locally and abroad.

The postgraduate degree programmes in the School of Engineering meet the requirements of the South African Department of Higher Education and Training (DHET). All students who want to study towards a Master's degree must first complete the honours degree that is the course-work component for the Master's degree, and also serves as a separate degree exit. Following the completion of the honours degree, the Master's degree can be done as a research degree. The South African Qualifications Authority (SAQA) credits for the honours degree are calculated separately from that of the Master's degree. Credits cannot be transferred between the two degrees.

For the course-based honours degree (BEng(Hons)), the lectures are presented in four individual weeks of 5 lecture days each spread almost evenly over the year. Some lectures are outside of these block-weeks, but they are clearly indicated in this document. During the COVID-19 lockdowns, postgraduate studies continued with most of the honours teaching being done in an online mode, with research still conducted under strict safety protocols in the various laboratories and field. It is expected that some of the teaching may be moving back to in-person lectures during 2022, depending on the Institutional and national lockdown situation at the time. It should also be noted that the BSc(Hons)(Applied Science) programme has been phased out and no new students are accepted in this programme. Please study the different modules offered by the different disciplines before registering if accepted for study in the Department for the BEng(Hons) programme.

The masters research programme (MEng) enables students to conduct advanced research in a specific field of interest with the intention of developing skills that will enable advanced analysis and synthesis of industry questions. The research can be conducted in various modes, incorporating aspects of laboratory and / or fieldwork, combined with advanced analytical skills applications.

The doctoral programme (PhD) is the culmination of the theoretical and research knowledge that a student developed over many years of study, and focuses on the development of new knowledge in a field of interest. Students spend around 3 years conducting advanced research on a topic that requires new processes, knowledge, and applications to solve engineering problems. Typical research problems originate from either industry or fundamental engineering theory, and are assessed through a combination of laboratory, field and analytical research.

I look forward to welcoming you to the Department of Civil Engineering as a postgraduate student.

Prof Wynand Steyn **Head of Department**

1. General overview

1.1 The University and the Department of Civil Engineering

The University is located in Hillcrest Pretoria, 6 km from the CBD of Pretoria and 50 km from the Oliver Tambo International Airport (Johannesburg). Within walking distance is the Hatfield commercial complex with its many shops, restaurants, entertainment venues and of course bookshops, and the Hatfield Gautrain station. See [here](#) for maps of the different campuses.

The University was established in 1908 as the Transvaal University College (that is why it is commonly referred to as TUKKIES). In October 1930, the independent University of Pretoria came into being. Since then it has grown to have a resident student population over 50 000, the largest student population of any residential university in South Africa. This student population is made up of over 40 000 undergraduate students and more than 10 000 postgraduate students. For more information about the University of Pretoria, click [here](#).

The School of Engineering, which forms part of the Faculty of Engineering, Built Environment and Information Technology, has a student population of more than 11 000, of whom 3 152 are postgraduate students. **The School of Engineering has been ranked first in South Africa and Africa according to the 2020 US News and World Report Rankings of the Best Global Universities for Engineering.**

The Department of Civil Engineering has a teaching staff of 21, and in 2021 had a student population of 942 students, of which 150 were postgraduate students. During the last 10 years, the University of Pretoria has conferred over 1 000 undergraduate degrees and over 500 postgraduate degrees in the Department of Civil Engineering.

The department is housed in the Engineering 1 Building (often referred to as the Engineering Tower Building) on the main Hatfield Campus, as well as the Engineering 4.0 facility on the Innovation Africa @ UP / Hillcrest campus. It has access to a range of advanced laboratory- and field-related research equipment at the various facilities. It is supported by access to the wider suite of equipment available through other departments in the School of Engineering, as well as other faculties on campus.

1.2 BEng(Hons) versus MEng

The BEng(Hons) does not stand against the MEng, the two degrees complement each other. At most universities a student does a MEng over two years in Civil Engineering, which includes coursework. At UP a student does a BEng(Hons) first (which consists of the theoretical coursework) followed by a MEng (consisting of the research work). Each degree takes a minimum of 1 year (thus 2 years in total) for full-time students. The advantage of the UP approach is that a student still earns a degree (BEng(Hons)) based on completion of the coursework.

1.3 The Disciplines and Focus Areas

There are four main disciplines, namely Geotechnical Engineering, Structural Engineering, Transportation Engineering and Water Resources Engineering. These are the main disciplines in which the BEng(Hons) and MEng degrees are awarded while the PhD degree is awarded in the discipline of Civil Engineering without further specification. There are a number of focus areas within and across

these disciplines. E.g. if you choose to work in the focus area of Railway Engineering, your chosen discipline will be Transportation Engineering while if you choose Construction Materials as your focus area, your discipline will be either Structural Engineering or Transportation Engineering. For more information on the focus areas of each staff member at the Department of Civil Engineering, visit the website [here](#).

Note that the discipline of Water Utilisation Engineering falls under the department of Chemical Engineering, not Civil Engineering.

1.4 Contact Details

Applicants are invited to contact any of the staff of the Department of Civil Engineering with regards to possible research topics (MEng and PhD). More information about their research and their contact details can be found [here](#).

The following two persons can be contacted with regards to the postgraduate programmes:

Postgraduate Coordinator: Prof Billy Boshoff, billy.boshoff@up.ac.za

Head of Department: Prof Wynand Steyn, wynand.steyn@up.ac.za

For enquiries about the specific disciplines, especially (prospective) BEng(Hons) students, please contact the following:

Geotechnical Engineering: Prof Gerhard Heymann, gerhard.heyman@up.ac.za

Structural Engineering: Prof Chris Roth, chris.roth@up.ac.za

Transportation Engineering: Prof Christo Venter, christo.venter@up.ac.za

Water Engineering: Marco van Dijk, marco.vandijk@up.ac.za

The following websites are also useful:

Department of Civil Engineering: <https://www.up.ac.za/civil-engineering>

EBIT Faculty: <https://www.up.ac.za/faculty-of-engineering-built-environment-it>

University of Pretoria: <https://www.up.ac.za/>

2. Overview of Postgraduate Offering

There are three categories of postgraduate degrees available at the Civil Engineering Department of UP, namely BEng(Hons), MEng and PhD. They are explained, together with their admission requirements and admission process guidelines, in the following sections. Note that fees are not mentioned here as the fees breakdown can be found [here](#).

2.1 BEng(Hons) Programme

The BEng (Hons) programme can be done in one of four disciplines, namely:

- Geotechnical Engineering
- Structural Engineering
- Transportation Engineering
- Water Resource Engineering

The degree can be done as a full-time student (1 year) or part-time student (2 years). Note the total number of credits of the degree is 128, which means an average, study-fit, student will spend 1 280 hours completing this degree. For part-time students, these hours are split over two years with the maximum number of credits allowed to be taken in one year to be 72, i.e. 720 hours. Note when choosing modules that the Civil Research module has to be taken in the final year of study. Refer to Section 4 for more information on the choice of modules.

If a student fails or does not complete a module, for whatever reason, the student is entitled to retake the module the following year. A module can only be retaken once. For part-time students, the maximum number of 72 credits are not allowed to be exceeded, even if they failed modules.

Students are allowed to study for no more than 3 years and can apply for a study-break of 1 year with good motivation. This can be done in writing via email to the Head of the Department and the Postgraduate Coordinator.

The entrance requirements are as follows:

- A 4-year BEng Civil Engineering degree at the University of Pretoria or equivalent with a final year weighted average of at least 60% would generally be admitted. Acceptance of candidates with an academic record marginally not meeting the above, or a non-Washington Accord engineering degree is at the sole discretion of the departmental postgraduate committee and might be required to write an entrance exam, essay or project. Appropriate experience of 5 years or more and/or PrEng status will also be considered in the application process.

Application Process

Prospective applicants must apply online at www.up.ac.za/online-application. Note the form for the “find supervisor” phase as explained at www.ebitpostgraduatelifecycle.website is not applicable to BEng(Hons) applicants as the degree is based on coursework.

2.2 MEng Programme

The MEng programme can be done in one of four disciplines, namely:

- Geotechnical Engineering
- Structural Engineering
- Transportation Engineering
- Water Resource Engineering

This degree follows a BEng(Hons) at University of Pretoria as the two degrees together make out the coursework and research work required at a masters level. This programme is full-time (1 year), but with good motivation, part-time enrolment will be allowed (2 years).

The entrance requirements are as follows:

- A postgraduate BEng (Hons) degree from the University of Pretoria or equivalent with an average of at least 65%.

As a graduation requirement, a master's candidate has to submit one journal paper in a journal recognised by The Department of Higher Education and Training. A list of journals can be found [here](#).

Application Process

The application process is explained at www.ebitpostgraduatelifecycle.website and should be followed with the following exceptions:

- The "Preliminary Title and Supervisor" form does not need to be signed by the Head of the Department
- The "Preliminary Title and Supervisor" form should not be sent to the mentioned email, but should be uploaded with your application and also sent to billy.boshoff@up.ac.za.

Compulsory Presentation

Part of the MEng programme is a compulsory oral presentation, either in the beginning of the programme where the proposal is presented or closer to the end of the study where preliminary results are presented. The student has to liaise with his/her supervisor about an appropriate time for the presentation and liaise with the Postgraduate Coordinator to book a time-slot.

2.3 PhD Programme

The PhD programme does not use specific disciplines as all PhD degrees in the Civil Engineering Department use the Civil Engineering option as discipline. This degree follows an acceptable Master's degree and the PhD is a 3 year full-time degree. In special circumstances, with good motivation, part-time study will be allowed.

The entrance requirements are as follows:

- An appropriate Master's degree from the University of Pretoria or equivalent. The earlier academic record of the applicant will be evaluated, and the M-dissertation as well as published papers (if available) will be evaluated for admission.

It is required of a candidate to present proof by means of a thesis of **independent advanced original research** and/or **creative** work, which makes a **substantial contribution to the knowledge of engineering science** and/or **practice** before graduating.

As a graduation requirement, a PhD candidate has to submit two journal papers in international journals recognised by The Department of Higher Education and Training of which one must be accepted by the time of graduation. A list of journals can be found [here](#).

Application Process

The application process is explained at www.ebitpostgraduatelifecycle.website and this should be followed with the following exceptions:

- The “Preliminary Title and Supervisor” form does not need to be signed by the Head of the Department
- The “Preliminary Title and Supervisor” form should not be sent to the mentioned email, but should be uploaded with your application and also sent to billy.boshoff@up.ac.za .

3. Important Dates

These are the important dates for the 2022 postgraduate calendar. Note the official University of Pretoria website or other official publication will always take preference if a discrepancy arises.

The closings dates for applications for postgraduate studies in 2022:

| | |
|-------------|--|
| 31 Aug 2021 | Closing date for International BEng(Hons) applicants |
| 30 Nov 2021 | Closing date for South African BEng(Hons) applicants |
| Open Ended | Applications for MEng and PhD have no closing date |
| 10 Dec 2021 | Last day for non-University of Pretoria BEng(Hons) applicants to hand in their final year marks if their marks are still not available by 30 November 2021 due to ongoing exams. |

The following dates are important for the 2022 postgraduate calendar:

| | |
|---------------------------------|--|
| 5 Jan 2022 | Registration Opens for BEng(Hons), MEng and PhD |
| 14 to 18 Feb 2022 | BEng(Hons Module): Flood hydrology SHC792 |
| 7, 8 and 16 Feb 2022 | BEng(Hons) module: Theoretical Soil Mechanics SGS 788. |
| 14, 15 and 17 Feb 2022 | BEng(Hons) module: Analytical Soil Mechanics SGS 787 |
| 9 to 11 Feb 2022 | BEng(Hons) module: Specialised Geotechnical Testing SGS 789 |
| 7 to 11 March 2022 | BEng(Hons) module: Pipe flow SHC795 |
| 22 March 2022 | Last day for registration for 2022 for BEngHons students. However BEngHons students have to register at least 14 days before their first class if this is before 22 March 2022. |
| <u>28 March to 1 April 2022</u> | <u>BEng(Hons): First Block Week (See schedule here)</u> |
| 31 March 2022 | Last day of handing in MEng and PhD thesis/dissertation for examination for September Graduation |
| 16 to 20 May 2022 | BEng(Hons) module: Traffic Engineering SVC792 |
| 16, 17 May 2022 | BEng(Hons) module: Concrete Technology SGC794 |
| <u>23 to 27 May 2022</u> | <u>BEng(Hons): Second Block Week (See schedule here)</u> |
| 13,14 June 2022 | BEng(Hons) module: Concrete Technology SGC794 |
| 12 to 16 July 2022 | BEng(Hons) Examinations (See schedule here) |
| 1, 2 August 2022 | BEng(Hons) module: Concrete Technology SGC794 |

| | |
|-----------------------------|---|
| <u>29 Aug to 2 Sep 2022</u> | <u>BEng(Hons): Third Block Week (See schedule here)</u> |
| 31 Aug 2022 | Last day of handing in MEng and PhD thesis/dissertation for examination for April Graduation 2023 |
| 31 Aug 2022 | Close date for international students applying for 2023 |
| <u>17 to 21 Oct 2022</u> | <u>BEng(Hons): Fourth Block Week (See schedule here)</u> |
| 29 Nov to 10 Dec 2022 | BEng(Hons) Examinations (See schedule here) |

4. BEng(Hons) modules explained

A BEng(Hons) student has to complete 128 credits to be able to obtain their degree. This includes a research module (Civil Research) of 32 credits. As the typical modules are 24 credits, a student has to take four modules and Civil Research. Full-time students have to register for all the modules in one year while part-time students must register for three modules in the first year and two modules (of which one is Civil Research) in the second year.

Each discipline has a number of prescribed modules and elective modules for the rest of the credits. You will find overlap between the disciplines. The prescribed and elective modules are explained in the following sections for each discipline. **Note also that not all modules are presented each year, thus carefully consider the available modules for each year shown in Section 4.6.** Note that a student cannot register for two modules if their lecture time or examination slots clash. It is the responsibility of the student to ensure there is no clash.

All modules are presented in the four block-weeks (dates and schedules show in Section 3) except specific modules which are presented outside of the block weeks (dates shown in Section 3 and explained in the following sections).

4.1 Geotechnical Engineering

Geotechnical Engineering is a specialist field of research and application within the larger framework of Civil Engineering. All engineering aspects of soil and rock fall within this discipline. The courses presented cover the highly specialised theoretical Soil Mechanics and Geotechnical Engineering as well as the specialist fields of laboratory and in situ testing.

Three modules (SGS 787, SGS 788 and SGS 789) will be presented as short courses at the beginning of the year. Students enrolled for a degree will be required to attend the short course(s) as well as submit assignments and write examinations in June and November. The relevant courses for each module are shown in the table below.

| Module | Short course |
|--------------------------------------|---|
| Analytical Soil Mechanics 787 | Analytical Methods in Geotechnical Engineering (2 day course) Reliability Methods in Geotechnical Engineering (1 day course) |
| Theoretical Soil Mechanics 788 | Theoretical Soil Mechanics (3 day course) |
| Specialised Geotechnical Testing 789 | In-situ Geotechnical Testing (1 day course) Geotechnical Laboratory Testing (2 day course) |

The Geotechnical Engineering Discipline consists of the modules of which one of the two elective modules are to be chosen as indicated.

| Core Modules | Code | Credits |
|---|--------------------|----------|
| Civil Research 780 | SSC 780 | 32 |
| Analytical Soil Mechanics 787 | SGS 787 | 24 |
| Theoretical Soil Mechanics 788 | SGS 788 | 24 |
| Specialised Geotechnical Testing 789 | SGS 789 | 24 |
| Applied Statistical Methods and Optimisation 798 OR Numerical Methods and Finite Element Applications for Civil Engineers 790 | SHC 798 SIK 790 | 24 24 |

4.2 Structural Engineering

A wide spectrum of modules is presented, including more analytical subjects such as structural analysis and structural mechanics as well as design courses in reinforced concrete, steel and timber.

To obtain this degree, students will be required to obtain a minimum of 128 SAQA credits from the following modules. Note that not all modules are presented each year, refer to Section 4.6 for which modules available in the coming year.

| Core Modules | Code | Credits |
|---|---------|---------|
| Civil Research 780 | SSC 780 | 32 |
| Numerical Methods and Finite Element Applications for Civil Engineers 790 | SIK 790 | 24 |
| Electives (<i>remainder of the credits from the following</i>) | | |
| Prestressed Concrete Design 791* | SIN 791 | 24 |
| Reinforced Concrete Design 778 | SIN 778 | 24 |
| Steel Design 776* | SIN 776 | 24 |
| Structural Analysis 790* | SIN 790 | 24 |
| Structural Mechanics 777 | SIN 777 | 24 |
| Timber Design 779* | SIN 779 | 24 |
| Concrete Technology 794 | SGC 794 | 24 |
| Infrastructure Management 790 | SSI 790 | 24 |
| Approved module from the Department of Mathematics and Applied Mathematics | | |
| Approved module from Department of Mechanical Engineering | | |

* Not presented in 2022

4.3 Transportation Engineering

The Transportation Discipline consists of the following focus areas:

- Pavement Engineering
- Transportation Planning and Traffic Engineering
- Railway Engineering

Much of the postgraduate research in transportation engineering is undertaken in partnership with the Centre for Transport Development (CTD). See [here](#) for more information on current research and scholarship opportunities at the CTD.

A minimum of 128 SAQA Credits must be obtained from the following:

| Core Modules (Compulsory) | Code | Credits |
|---|---------|---------|
| Civil Research 780 | SSC 780 | 32 |
| Applied Statistical Methods and Optimisation 798 | SHC 798 | 24 |
| Electives | Code | Credits |
| Concrete Technology 794 | SGC 794 | 24 |
| Transportation Studies 790 | SVC 790 | 24 |
| Geometric Design and Safety 791 | SVV 791 | 24 |
| Infrastructure Management 790 | SSI 790 | 24 |
| Numerical Methods and Finite Element Applications for Civil Engineers 790 | SIK 790 | 24 |
| Multimodal Transport 788 | SVV 788 | 24 |
| Pavement Design 793 | SGC 793 | 24 |
| Road Rehabilitation Technology 797 | SGC 797 | 24 |
| Traffic Engineering 792 | SVC 792 | 24 |
| Transportation Special 791 | SVC 791 | 24 |

It is required that students identify one of the three focus areas within Transportation Engineering before commencing their studies. Within each focus area, the following course combinations are typical. Well-motivated requests for deviations from these combinations will be considered on an ad hoc basis.

| Focus Area: | Transport Planning & Traffic Engineering | Pavement Engineering | Railway Engineering |
|----------------------|---|---|---|
| Core modules | <ul style="list-style-type: none"> ▪ Civil Research 780 ▪ Applied Statistical Methods and Optimisation 798 | <ul style="list-style-type: none"> ▪ Civil Research 780 ▪ Applied Statistical Methods and Optimisation 798 | <ul style="list-style-type: none"> ▪ Civil Research 780 ▪ Applied Statistical Methods and Optimisation 798 |
| Electives: Any 3 of: | <ul style="list-style-type: none"> ▪ Geometric Design and Safety 791 ▪ Multimodal Transport 788 ▪ Traffic Engineering 792 ▪ Transportation Studies 790 ▪ Infrastructure Management 790 | <ul style="list-style-type: none"> ▪ Pavement Design 793 ▪ Road Rehabilitation Technology 797 ▪ Concrete Technology 794 ▪ Transportation Special 791 ▪ Infrastructure Management 790 | <ul style="list-style-type: none"> ▪ Transportation Special 791 ▪ Numerical Methods and Finite Element Applications for Civil Engineers 790 ▪ Infrastructure Management 790 ▪ Pavement Design 793 |

| | | | |
|--|--|--|---|
| | <ul style="list-style-type: none"> ▪ Transportation Special 791 | <ul style="list-style-type: none"> ▪ Numerical Methods and Finite Element Applications for Civil Engineers 790 ▪ Geometric Design and Safety 791 | <ul style="list-style-type: none"> ▪ Concrete Technology 794 |
|--|--|--|---|

SHORT COURSES IN RAILWAY ENGINEERING

General Information

The department is privileged to have the Transnet Freight Rail (TFR) Chair in Railway Engineering as well as the Railway Safety Regulator (RSR) Chair in Railway Safety. Various short courses are offered to industry and students can include these courses into their study programmes as credit bearing post-graduate modules. Modules in Railway Engineering are offered as full day blocks (contact lecturing for 3 – 5 days), online interactive (pre-determined 5 – 10 day schedule with live lectures) or purely online (pre-recorded lectures over 3 – 4 weeks) as detailed below. The necessary credits and assessment criteria will be identified per individual course.

Students who have chosen Railway Engineering as their focus area should select two courses from the list below and need to register these under the module SVC 791 (Transportation Special). The course “Introduction to Multi-Disciplinary Concepts in Railway Engineering” is a pre-requisite for doing any of the other Railway Engineering courses and should therefore be one of the two courses that are elected. Civil Engineering students are encouraged to do “Geotechnical Aspects of Railway Engineering” as their second course.

For enquiries and course dates, contact Prof Hannes Gräbe Tel: +27 (0)12 420 4723

e-mail: hannes.grabe@up.ac.za

website: www.up.ac.za/chair-in-railway-engineering

Short Courses

Introduction to Multi-Disciplinary Concepts in Railway Engineering (MCWR)

Brief description: The course provides an introduction to the multi-disciplinary aspects of railway engineering. **Outline of course:** It covers the principles applicable to each railway engineering field as well as a general background on how a railway transport system operates. **Learning outcomes:** An appreciation for the complexities of and multi-disciplinary inter relationships of the railway system.

▪ **Geotechnical Aspects for Railway Engineering (TGEO)**

Brief description: The course provides an introduction to railway track substructure fundamentals. **Outline of course:** It covers the principles and functions of the layered track foundation system, its drainage and failure modes and how it relates to track performance. Various case studies are included. **Learning outcomes:** An appreciation for the railway track substructure fundamentals and problems and solutions related to its interaction with the track.

▪ **Railway Infrastructure Maintenance Management (RIMM)**

Brief description: The course provides an introduction to the general principles of railway asset management. **Outline of course:** It covers the key facets of the management of a railway asset having a life cycle and the relationship between railway asset management as part of a system and of the business plan. **Learning outcomes:** An understanding of the appropriateness of the design of the railway system as related to the prevailing and future business needs and coupled to the

development of life cycle maintenance plans and the ability to adapt it to changing business circumstances.

- **Best Practice for Wheel and Rail Management (WRI)**
Brief description: The course provides an understanding of the interaction between wheel and rail. **Outline of course:** It is based on the manual published by the International Heavy Haul Association (IHHA) in 2001. It draws on information presented at 16 international IHHA conferences and technical sessions between 1978 and 2000. **Learning outcomes:** An understanding of the wheel/rail system and the root causes of wheel and rail damage. A systems approach to wheel and rail management is provided.

- **Locomotive Systems, Performance and Maintenance (LSPM)**
- **Management of Continuously Welded Rails (MCWR)**
- **Introduction to Railway Projects and Processes (IRPP)**
- **Railway Safety Investigation (RSI)**
- **Railway Asset Management (RAM)**
- **Transnet Freight Rail Operations (TFRO)**
- **Rolling Stock Technology (RST)**
- **Law, Risk, Economics and the Environment (LREE)**
- **Railway Safety Audits, Investigations and Reporting (RSAIR)**
- **Technical Writing and Presentation Skills (TWPS)**
- **Train Movement Control Systems (TMCS)**
- **Railway Technology for Executives (RTE)**

The courses listed above are presented throughout the year and specific dates can be obtained from Prof. Gräbe or on the departmental website under Railway Engineering (www.up.ac.za/chair-in-railway-engineering). As the courses start early in the year, and are open to industry, students should contact Nocwaka Sigenu (nocwaka.sigenu@up.ac.za) during November of the preceding year to ensure a place on the course. Part-time students in the department of Civil Engineering will receive a 50% discount when registering for the short courses while full-time students in Railway Engineering (with financial support from the Department of Civil Engineering) will register free of charge provided that they are on campus full-time and part of the Railway Engineering research group.

4.4 Water Resource Engineering

Water Resources Engineering encompasses various elements of the natural and man-made water cycle. Civil engineers' input in creating sustainable development that requires a safe water supply to all consumers and protect the natural resources is based on an understanding of the natural hydrological cycle, physical principles and the effect of human interference with these fields.

The modules that are presented are aimed at broadening the understanding of different aspects of hydrological and hydraulic phenomena and the application thereof in the design of pipelines, pump stations, open channels, hydraulic structures and the assessment of the yield from surface water resources. The lecture material is presented in such a format that it enhances the skills of the student to undertake real problems.

Two modules are presented outside of the block week, and they are SHC 792 and SHC 795. Refer to Section 3 for the dates. See Section 4.6 for which modules are presented each specific year.

The following shows the list of possible modules for a BEng(Hons) in water resource engineering

| Core Modules | Code | Credits |
|---|--------------------|----------|
| Civil Research 780 | SSC 780 | 32 |
| <i>at least 72 of the credits from the following:</i> | | |
| Flood Hydrology 792 | SHC 792 | 24 |
| Free Surface Flow 794* | SHC 794 | 24 |
| Pipe Flow 795 | SHC 795 | 24 |
| Pump Systems 785* | SHW 785 | 24 |
| Applied Statistical Methods and Optimisation 798 OR Numerical Methods and Finite Element Applications for Civil Engineers 790 | SHC 798 SIK 790 | 24 24 |
| Water Resource Analysis and Management 796# | SHC 796 | 24 |
| Hydraulic Design 793# | SHC 793 | 24 |
| <i>and the remainder, if needed, from the following:</i> | | |
| Infrastructure Management 790 | SSI 790 | 24 |
| Concrete Technology 794 | SGC 794 | 24 |
| Modules offered by the Department of Chemical Engineering (Section 4.5) | | |

Only presented when numbers warrant in collaboration with industry

* Not presented in 2022

4.5 Modules offered by other departments

Department of Chemical Engineering – Water Utilisation and Environmental Engineering

Mrs E. Otto

Tel: +27 (0)12 420 3824 e-mail: elmarie.otto@up.ac.za

South Campus: Building 2, Room1-26.

2021 - First Semester – for modules and dates enquire at the department (details will be available on the website of the Department of Chemical Engineering, www.up.ac.za/chemeng)

| Core Modules | Code | Credits |
|--------------------------|---------|-----------------|
| Chemical Water Treatment | WCW 780 | 32 SAQA credits |
| Water Quality Management | WQB 780 | 32 SAQA credits |

2021 - Second Semester – for dates enquire at the department

| Core Modules | Code | Credits |
|------------------------------|---------|-----------------|
| Biological Water Treatment | WBW 780 | 32 SAQA credits |
| Industrial Waste Engineering | WAI 780 | 32 SAQA credits |

Department of Mathematics and Applied Mathematics

Enquire at this Department.

Department of Mechanical and Aeronautical Engineering

Prof N J Theron Tel: +27 (0)12 420 3309 e-mail: nico.theron@up.ac.za

| Core Modules | Code | Credits |
|---------------------------------|---------|-----------------|
| Advanced Finite Element Methods | MEE 781 | 16 SAQA credits |
| Fatigue | MSV 780 | 16 SAQA credits |

4.6 Yearly Presentation schedule of Modules

Not all modules are presented every year. This table can be used to determine which modules are available.

| Module Code | Module Name | SAQA Credits | Geotechnical | Structure | Transport | Water | 2022 | 2023 | 2024 |
|-------------|---|--------------|--------------|-----------|-----------|-------|------|------|------|
| SGS 787 | Analytical Soil Mechanics | 24 | C | | | | X | X | |
| SHC 798 | Applied Statistical Methods and Optimisation | 24 | X | | C | X | X | X | |
| WBW 780 | Biological Water Treatment | 32 | | | | X | | S2C | |
| WCW 780 | Chemical Water Treatment | 32 | | | | X | | S1C | |
| SSC 780 | Civil Research | 32 | C | C | C | C | X | X | |
| SGC 794 | Concrete Technology | 24 | | X | X | X | D1 | | |
| SHC 792 | Flood Hydrology | 24 | | | | X | W1 | | W1 |
| SHC 794 | Free Surface Flow | 24 | | | | X | | W1 | |
| SVV 791 | Geometric Design and Safety | 24 | | | X | | | D1 | |
| SHC 793 | Hydraulic Design | 24 | | | | X | | | |
| SSI 790 | Infrastructure Management | 24 | | | X | X | X | X | |
| SVV 788 | Multimodal Transport | 24 | | | X | | | X | |
| SIK 790 | Numerical Methods and Finite Element Applications for Civil Engineers | 24 | X | X | X | X | X | X | |
| SGC 793 | Pavement Design | 24 | | | X | | X | X | |
| SHC 795 | Pipe Flow | 24 | | | | X | W2 | | W2 |
| SIN 791 | Prestressed Concrete Design | 24 | | X | | | | | |
| SHW 785 | Pump Systems | 24 | | | | X | | W2 | |
| SIN 778 | Reinforced Concrete Design | 24 | | X | | | X | X | |
| SGC 797 | Road Rehabilitation Technology | 24 | | | X | | X | X | |
| SGS 789 | Specialised Geotechnical Testing | 24 | C | | | | X | X | |
| SIN 776 | Steel Design | 24 | | X | | | | X | |
| SIN 790 | Structural Analysis | 24 | | X | | | | X | |
| SIN 777 | Structural Mechanics | 24 | | X | | | X | | |
| SGS 788 | Theoretical Soil Mechanics | 24 | C | | | | X | X | |
| SIN 779 | Timber Design | 24 | | X | | | | | |
| SVC 792 | Traffic Engineering | 24 | | | X | | D1 | | |
| SVC 791 | Transportation Special | 24 | | | X | | X | X | |
| SVC 790 | Transportation Studies | 24 | | | X | | X | | |
| WAI 780 | Industrial Waste Engineering | 32 | | | | X | | S2C | |
| WQB 780 | Water Quality Management | 32 | | | | X | | S1C | |
| SHC 796 | Water Resource Analysis and Management | 24 | | | | X | | | |

- X Recommended
- D1 and D2 First and second semester full day block
- C Compulsory
- S1C and S2C Chemical Engineers block week, first and second semester
- W Water Resources Engineering (outside normal block week).

Annexure A: Curricula for Postgraduate Modules

A1 PREREQUISITES:

For certain modules prerequisites are indicated. The system of coding is as follows:

AAAnnn: An ordinary module code means that the module should previously have been passed.

(AAAnnn): A module code in parentheses means that lecture attendance should have been satisfactory.

AAAnnn: Underlining means that at least simultaneous enrolment will be required. Satisfactory attendance as well as a pass will therefore also be acceptable.

A2 MODULES PRESENTED WITHIN THE DEPARTMENT OF CIVIL ENGINEERING

Analytical Soil Mechanics SGS 787 24 SAQA credits

Introduction to elasticity and plasticity theory in geomechanics. Solution of confined and unconfined seepage problems using the method of fragments, finite differences and finite elements. Numerical solutions of consolidation problems and secondary compression. Slope stability analysis methods. The point estimate method. Monte Carlo simulation.

Applied Statistical Methods and Optimisation SHC 798 24 SAQA credits

The course will apply some of the basic theories and methodologies in statistics and modelling to solve common civil engineering problems. The course seeks to demonstrate the theory, applicability and use of statistical and modelling in the civil engineering field. Emphasis will be on the applications of these methods in common civil engineering practice. Some of the applications will include; demand forecasting, optimum network design, statistical sample analysis, maximum flow problems, project scheduling, queuing theory, Markov chain, Probability theory, discrete and continuous probability distribution, reliability and decision analysis, Monte Carlo simulation, etc.

Civil Research SSC 780 32 SAQA credits

The course will require all honours students to conduct research in an appropriate field of civil engineering, linked to the main discipline in which the student specialises for their honours degree.

Concrete Technology SGC 794 24 SAQA credits

Properties of concrete and concrete mixes. Characteristics of Portland cement and supplementary cementitious materials. Aggregates, admixtures and practical design of mixes. Manufacture, curing and testing, including non-destructive methods. Statistical approach to quality control. Time-dependent behaviour and durability of concrete. The principles for appropriate selection of materials and techniques for repair, maintenance and strengthening of civil engineering structures. Investigation and diagnosis. Corrosion of reinforcement. Alkali-aggregate reaction, sulphate attack. Physical degradation. Repair materials. Protective systems. Systems for repair.

Flood Hydrology SHC 792 24 SAQA credits

This course entails the calculation of design flows for different return periods, using the statistical, deterministic - and empirical methods. Channel and level pool routing are discussed and the design of stormwater systems for flood events is also dealt with in this course.

Free Surface Flow SHC 794 24 SAQA credits

This course covers the theory of open channel flow as well as analytical and numerical procedures to analyse flow conditions. Dambreak analyses is included in this course and the procedures to determine flood lines and identify hydraulic controls are also covered.

Geometric Design and Traffic Safety SVV 791 24 SAQA credits

A selection of topics from the following: Rural/Peri-urban road networks: transportation policy, standards and safety, environmental quality, capacity, design, interchanges. Urban street networks: functional classes, town planning considerations, capacities, environment, safety, standards design, evaluation of road networks.

Traffic safety in global and national content, Road Safety Engineering and the assessment and interpretation of accident information, reactive and proactive identification of remedial measures, traffic safety strategies: 3E model and Haddon matrix.

Hydraulic Design SHC 793 24 SAQA credits

This course covers the hydraulic aspects associated with the design of hydraulic structures for dams, road drainage, and other conveyance systems. The hydraulic considerations for the selection and design of energy dissipation structures are assessed in this course.

Infrastructure Management SSI 790, 24 SAQA credits

This module will cover the following topics: Asset Management principles, Maintenance Management principles, Maintenance strategies and philosophies, Condition based Maintenance, Reliability Centred Maintenance (RCM), Resource Management, Maintenance Management Systems, Total Productive Maintenance (TPM) and Risk Management. Road network management and Intelligent Transport Systems as management strategies. Lifecycle economic evaluation. Maintenance management of the following disciplines will be studied in detail: Road infrastructure, Railway infrastructure, Airport infrastructure, Buildings and other structures, Water resources and water supply.

Multimodal Transport SVV 788 24 SAQA credits

This course reviews aspects of the policy, planning, and operations of multimodal transport systems in cities. Topics include land use-transport relationships; the economics and financing of transport systems; equity and environmental imperatives; the characteristics, impacts and role of different modes; theory and principles of public transport network design, scheduling and operations; contemporary issues and approaches to public transport restructuring and formalisation in South Africa, including Bus Rapid Transit (BRT) and non-motorised transport.

Numerical Methods and Finite Element Applications for Civil Engineers SIK 790 24 SAQA credits

In the first part of this course, numerical procedures and some underlying theory for solving systems of equations, eigenvalue problems, integration, approximation and boundary value problems will be discussed. The second part of the course covers general finite element theory, discretization aspects related to geometry, nodes and numbering, element type and shape, interpolation functions, formulation of element characteristic matrices and vectors for elasticity problems, assembly and solution of the finite element equations, modelling procedures and results processing. The student will use Finite Element software to apply the theory that was covered in the course for solving typical Civil Engineering problems.

Pavement Design SGC 793 24 SAQA credits.

Design philosophy in First and Third World environments; characterising and use of pavement materials; drainage; systems approach to layout, geometric and pavement design; stresses and strains

in pavements; mechanistic design methods and elasto-plastic behaviour; economic analysis; designing pavements for streets, gravel and paved roads, runways, and industrial areas.

Pipe Flow SHC 795 24 SAQA credits

The focus in this course will be on the practical aspects of pipeline design. The theoretical background to pipeline hydraulics will be covered and practical examples will be assessed. The following specific aspects such as pipeline hydraulics induced dynamic pressures, pipeline component selection and design, pipeline installation and the testing and operation of pipelines will be covered in this course

Pre-stressed Concrete Design SIN 791 24 SAQA credits

Material properties; prestressing systems; flexural design; losses; effects of continuity; shear; deflections; anchorage; cracking; prestressed concrete slabs and detailing

Pump Systems SHW 785 24 SAQA credits

The background theory and design practice of pumping station design will be highlighted. Various hydraulic problems associated to the inlets as well as the planning and design aspects of pump stations will be discussed. Pump selection, dimensioning of the layout to accommodate components required in a pump station (sump design, good design practice, superstructure, lighting ventilation and control, inlet design, switch gear, pump control, surge protection and optimal scheduling of pumping) are some of the aspects that will be evaluated during the course.

Reinforced Concrete Design SIN 778 24 SAQA credits

Material properties. Behaviour and analysis of reinforced concrete members for flexure, axial loads, flexure plus axial load and shear. Cracking and deflection (short- and long-term) of flexural members. Plasticity in flexural members. Braced and unbraced slender columns

Road Rehabilitation Technology SGC 797 24 SAQA credits

Development of road management systems and application to existing street and road networks. Evaluation of, and measurements on existing facilities. Maintenance management. Recycling of materials. Design methods for upgrading, re-construction and strengthening of the existing road infrastructure. Prerequisite: Pavement Design SGC 793.

Specialised Geotechnical Testing SGS 789 24 SAQA credits

Theory, application and interpretation of geotechnical laboratory and in-situ tests. Laboratory instrumentation and calibration, stress and strain conditions for laboratory tests. Triaxial stress space and stress paths. Triaxial tests, Direct shear tests, Oedometer test and Rowe cell test. Principles and applications of geotechnical centrifuge testing. Standard Penetration Test (SPT), Cone Penetration Test (CPT), Piezocone (CPTU), Continuous surface wave test, Borehole seismic tests and Seismic cone test.

Steel Design SIN 776_24 SAQA credits

Introduction to structural reliability, tension elements, buckling of plates in compression elements, compression elements, beams and plate girders, plastic analysis and design of structures and structural elements, connections, composite design and steel-framed structures.

Structural Analysis SIN 790 24 SAQA credits

Matrix methods: direct stiffness method for plane and three-dimensional structures. Stability: in-plane stability of beam-columns and frames; effective lengths and lateral torsional instability of beams.

Dynamics: free and forced, undamped and damped framed systems and mass matrices and natural frequencies, earthquake response spectra.

Structural Mechanics SIN 777 24 SAQA credits

Elasticity theory. Failure criteria. Beams on elastic foundations. Classical and numerical (finite difference, Rayleigh-Ritz and finite element) solutions for plane and plate structures. Theory of plates and shells.

Theoretical Soil Mechanics SGS 788 24 SAQA credits

Introduction to critical state soil mechanics. Stress and strain invariants. Stress paths. State boundary surfaces including Roscoe and Hvorslev surfaces. Cam clay model. Application of geotechnical constitutive models in finite element analysis. Introduction to unsaturated soil mechanics and Barcelona Basic Model.

Timber Design SIN 779 24 SAQA credits

Timber properties, grading, treatment, structural form, element design and bracing of structures. Analysis of I-beams, composite beams, frames and connections. Research project.

Traffic Engineering SVC 792 24 SAQA credits

Part 1: Traffic flow theory: Traffic and vehicle characteristics. Traffic flow studies. Traffic interactions. Traffic flow analysis and queuing theory. Traffic flow models. Traffic control theory. Part 2: Selected topics in Traffic studies and facility design: (e.g. Transportation and land use. Traffic impact studies. Site planning and design. Determination of demand. Traffic control investigations. Intersection design. Internal circulation. Parking areas).

Transportation Special SVC 791 24 SAQA credits

Module specially compiled to satisfy specific needs. Not available unless cleared with Head of Department.

Transportation Studies SVC 790 24 SAQA credits

Role of transport modelling in developmental context, land use, data collection and surveys. Four step transportation model, trip generation, trip distribution, modal split, trip assignment. Introduction to simulation of transport systems, and use of simulation software. Introduction to discrete choice models, econometrics, and stated preference analysis. New approaches to modelling.

Water Resources Analysis & Management SHC 796 24 SAQA credits

In this course students will be familiarized with the background and procedures used in the creation of flow records and the use of the WRSM2005 model. Surface water systems will be analysed and gross yields will be determined. In the second part of the course the theory and procedures required for the yield determination of surface water resources will be discussed.

A3 MODULES PRESENTED BY OTHER DEPARTMENTS WITHIN THE UNIVERSITY OF PRETORIA

A3.1 Department of Chemical Engineering

CHEMICAL WATER TREATMENT WCW780

32 SAQA credits

Water quality standards: drinking water quality standards (chemical), performance evaluation for drinking water treatment systems.

Basic water chemistry: Acid-base and solubility equilibrium chemistry; Chemistry of the carbonate system.

Conventional drinking water treatment: coagulation, flocculation; sedimentation, flotation; sand filtration; chlorination; chemical stabilisation.

Advanced drinking water treatment: activated carbon adsorption; ozone and ultra-violet disinfection; enhanced coagulation; membrane processes; softening; iron and manganese removal.

Industrial water treatment: chemical precipitation; neutralisation; oxidation-reduction; desalination processes; ion exchange.

BIOLOGICAL WATER TREATMENT WBW780

32 SAQA credits

Composition and characterisation of sewage; Basic design principles of: Simple sewage treatment systems – night soil, pit latrines, septic tanks; Small scale sewage works – oxidation dams, biological filters and reed beds; Anaerobic digestion; Suspended – and Attached growth processes; Sludge handling and treatment. The module includes training and practice for simulation software for wastewater treatment processes.

INDUSTRIAL WASTE ENGINEERING WAI 780/787

32 SAQA credits

Identify source materials, physical and chemical properties of waste; Release and transport mechanisms from source to air, groundwater, soil; Primary pathways of contaminants including sorption, volatilisation, biotic and abiotic transformations; Toxicology: absorption, distribution, biochemical transformation, and secretion of chemicals; Acute and chronic toxicity quantification and evaluation of risk; Hazard identification, exposure assessment, toxicity assessment, risk assessment and approaches to hazardous waste minimisation, treatment and disposal; The handling, classification and disposal of hazardous waste; Disposal of waste by landfill; Water monitoring at waste management facilities; Recycling and resource management; Waste prevention, minimisation and optimisation.

WATER QUALITY MANAGEMENT WQB 780

32 SAQA credits

Water quality parameters: physical, chemical, biological, microbiological. Units of expression. Evaluation of parameters. Methods of analysis and practical laboratory analyses; Water quality interpretation, evaluation and assessment, water quality guidelines and requirements for domestic, industrial, agricultural, ecological, recreational requirements; Limnology and water quality in rivers and lakes. Ground water quality and assessment; Regulatory aspects including all relevant legislation; Integrated environmental management, integrated pollution control; Procedures to assess effluent discharge impacts; Water quality management; policies and procedures, role of catchment management agencies, catchment management plans.