DURBAN UNIVERSITY OF TECHNOLOGY

FACULTY OF ENGINEERING & THE BUILT ENVIRONMENT

Self Assessment Report

MEng and MBE programmes

Co-funded by the Erasmus+ Programme of the European Union

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Contents

1 Introduction

This document is the self-assessment report (SAR) submitted for accreditation of eight Master's degree programmes in the Faculty of Engineering and the Built Environment (FEBE) at the Durban University of Technology (DUT) in South Africa.

DUT is a member of the International Association of Universities and is a multi-campus university of technology at the cutting edge of higher education, technological training and research with specialisation in the fields of engineering, natural, health and biological sciences, management and business sciences, arts and design, the built environment and education. DUT is a leading institute of higher learning within the Kwa-Zulu Natal (KZN) region that is committed to providing quality and current education, within the technology sector, to successful prospective learners. The university's vision is to be *a preferred university for developing leadership in technology and productive citizenship*.

In keeping with the above and with the promulgation and gazette of the Higher Education Qualifications Sub Framework (HEQSF)[1] in SA, the University had embarked on an intensive Curriculum Renewal Project to review all existing qualifications for: (1) alignment with the requirements of the HEQSF and (2) a critical and in-depth reflective analysis of what we have on offer and how relevant it is within the current context.

Notwithstanding the above, the institution mandated a revision of the qualifications on offer in order to achieve its long term strategic objectives, namely:

- A teaching and learning environment that values and supports the university community.
- Promoting excellence in learning and teaching, technology transfer and applied research.
- External engagement that promotes innovation and entrepreneurship through collaboration and partnership.

A concerted effort was made within FEBE to review all existing qualifications on offer. Culmination of this process are qualifications whose design and structures are such that it encourages graduates who are:

i. Socially relevant.
ii. Professionally career orientated.
iii. Exposed to a technologically relevant environment to ensure technological excellence
iv. Able to carry out the notion of "life-long learning".

FEBE is comprised of 10 academic departments, including Chemical Engineering, Civil Engineering and Geomatics, Construction Management and Quantity Surveying, Electrical Power Engineering, Electronic and Computer Engineering, Industrial Engineering, Town and Regional Planning, Architectural Technology and Mechanical Engineering, and has more than 6 000 students enrolled across the departments. The faculty is currently phasing in a new suite of qualifications in the various departments ranging from a two-year professional diploma, the three-year professional degree, one-year Honours degree, as well as Master's and doctoral qualifications. All the qualifications offered are aligned with both the HEQSF and the various South African statutory professional bodies.

The proposed coursework Master's qualifications submitted for accreditation are designed to fulfil the

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[1]www.che.ac.za/sites/default/files/publications/CHE%20-%20Higher%20Education%20Qualification%20Framework%20-%20EDITED%20171013.pdf

specifications of the following qualification frameworks/standards:

1. South African HEQSF requirements for a coursework Master’s degree at NQF level 9
2. Engineering Council of South Africa (ECSA) qualification standard for the Master of Engineering Degree

In addition, international comparability is ensured by complying with the EUR-ACE® Framework Standards and Guidelines for the Master’s degree programmes in engineering, and the ASIIN General Criteria for the Accreditation of Degree Programmes for the Master’s degree programmes.

This suite of coursework Master’s programmes will complement the suite of full research Master’s programmes currently on offer. The coursework Master’s programmes are designed to facilitate a high level of theoretical engagement and intellectual independence and to develop the ability to relate knowledge to a range of contexts for professional practice. The core of the programmes will be coursework modules relating to emerging technologies, as described by *Industrie 4.0,* and their application to the various listed disciplines of engineering and the built environment. In addition to the 120 SAQA[2] (60 ECTS) credits coursework modules, a 60 SAQA (30 ECTS) credit research project or mini-dissertation is prescribed.

[2] South African Qualifications Authority (www.saqa.org.za)

2 Formal Data

A. Name and contact details

Durban University of Technology
Steve Biko Road
Durban
4001

P O Box 1334
Durban
4000

B. Name of the degree programme (English)

Master of Engineering in Chemical Engineering
Master of Engineering in Mechanical Engineering
Master of Engineering in Industrial Engineering
Master of Engineering in Civil Engineering
Master of Engineering in Electronic Engineering – Intelligent Systems
Master of Engineering in Electronic Engineering – Renewable Energy
Master of Built Environment - Construction

C. Language of instruction

English

D. Contact person

Prof P Musonge

E. Web address

www.dut.ac.za

F. Classification

More practice oriented

G. Degrees to be awarded

Master of Engineering in Chemical Engineering
Master of Engineering in Mechanical Engineering
Master of Engineering in Industrial Engineering
Master of Engineering in Civil Engineering
Master of Engineering in Electronic Engineering – Intelligent Systems

Master of Engineering in Electronic Engineering – Renewable Energy
Master of Built Environment – Construction

I. Standard period of study

18 months

J. Commencement of degree programme:

January 2021

K. Fees / charges:

Can only be determined one year prior to implementation

3. Objectives and Demand – Reasons for Establishing the Programme

A. Educational Objectives and Competency Profile

The Master of Engineering (MEng) and Master of Built Environment (MBE) degrees are postgraduate qualifications at level 9 on the HEQSF. These Master's qualifications are designed specifically to articulate with the cognate Bachelor of Honours degree or a substantially equivalent degree. The qualification provides a pathway to NQF Level 10 doctoral programmes.

The qualification will aim to provide graduates who can apply in-depth and emerging principles of engineering sciences and complex systems thinking to solve problems in the appropriate areas of professional practice. Graduates will have the ability to be agile in applying technologies in decision making to provide innovative solutions to real world challenges of the fourth industrial revolution and beyond.

The qualification cultivates a critical awareness of developments at the forefront of the field and promotes interdisciplinary and intercultural competence. Research capacity is developed in the methodology and techniques of the specific engineering discipline. Graduates will meet the attributes/outcomes of a qualification that leads to professional registration and will be prepared for a specific niche in industry.

B. The Characteristic Profile of the DUT MEng Graduate:

Programmes leading to this qualification at DUT will enable students to:

- Work independently and responsibly, applying original thought and judgment to technical and risk-based decisions in *uncertain* and *complex* situations;
- Have a broad and fundamentals-based appreciation of the engineering sciences, with depth in specific engineering areas, together with knowledge of social, economic, health, safety, environmental and sustainability matters;
- Have professional expertise in a particular discipline and the ability to conduct *research* and perform in-depth engineering investigations to solve *complex* engineering problems.
- Have a broad appreciation of complex systems thinking; as well as emerging engineering, mathematical and natural sciences; and to engage and respond to the challenges of the fourth industrial revolution and beyond.

C. MEng Qualification Criteria

The proposed qualifications are designed to meet the following HEQSF and ECSA specifications:

1. The qualification shall contain a minimum of 180 SAQA credits (90 ECTS) including a research project of no less than 60 SAQA credits (30 ECTS) at NQF Level 9.
2. Not less than 120 SAQA Credits (60 ECTS) shall be at NQF level 9.
3. Credits shall be distributed in order to create a coherent progression of learning toward the exit level within the specified discipline.
4. The content of the qualifications when analysed by knowledge area shall not fall below the minimum credits in each knowledge area as specified by ECSA and listed in Table 1.

Table 1: Minimum credits in knowledge areas

	SAQA credits		ECTS credits
Total	**≥180**		**≥90**
Mathematical and natural Sciences	30		15
Engineering sciences	30		15
Engineering design & synthesis	30		15
Complementary studies	20		10
Engineering research project	60		30
Available for re-allocation in above areas	≥10		≥5

Whilst the proposed MBE programme is not required to meet the ECSA specification, it is required to meet the requirements of the HEQSF.

D. Description of the learning outcomes

The programme outcomes are formulated in a general way, to emphasise what should be common to engineering professional practice. The core curriculum proposed here with additional appropriate topics in natural sciences and mathematics, engineering sciences, and in non-technical areas will give a variety of concrete contents to the general outcomes. Graduates of these qualifications will have the following attributes:

Programme Outcome 1: Problem solving
Use a wide range of specialist skills to identify, conceptualize, design and implement methods of enquiry to solve complex and challenging problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialized context.

Students' problem solving skills will be developed and assessed in the context of advanced engineering problems across a range of core and discipline specific modules. Case studies and design problems undertaken in these modules will require creative solutions which will include: identification, formulation and analysis of the problem; collection of relevant information (physical and chemical properties, correlations and design procedures) from a variety of sources; and considerations of technical, social, environmental and economic factors

Programme Outcome 2: Application of scientific and engineering knowledge
Apply specialist knowledge of mathematics, natural science and engineering sciences to solve complex problems, conceptualize models and enable engagement with and critique of current and emerging research and practices.

The solutions formulated by the student for the various problems and case studies across the various modules must demonstrate a reasonable competence in correct application of scientific and engineering principles and solution methods appropriate to the knowledge being tested. In addition, students will use and extend their scientific and engineering knowledge to conduct, and report on an investigation of or research into an assigned topic. The application of scientific and engineering knowledge will be assessed in the context of the research and the dissertation produced by each student, and how it is used to inform the investigation, appropriate application in the analyses and the critical engagement with the knowledge in the discussion and conclusions drawn.

Programme Outcome 3: Engineering Design (not applicable to MBE programme*)*

Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes, demonstrate the ability to propose interventions at an appropriate level within a system based on an understanding of interdependent relations and address intended and unintended consequences of interventions.

The discipline specific modules will require the design of processes/systems which require the correct application of scientific and engineering principles, application of appropriate engineering codes of practice; and the application of appropriate engineering tools in the design and optimization of selected processes/systems, recognizing and dealing with technical, environmental and economic constraints

Programme Outcome 4: Research, investigations, experiments and data analysis

Demonstrate competence to conduct research, execute detailed technical investigations, implement strategies for the processing and management of information, including the review of current advances in the field, to produce new insights and solve complex problems.

In the Research Project (60 credits), students will undertake an intensive open-ended research project, using the knowledge gained in the various core and discipline specific modules. This GA is assessed on the evidence of the student's grasp of the knowledge that informs the investigation, the design of the investigation or research methodology and the manner in which the conclusions drawn from the investigation

Programme Outcome 5: Methods, skills and tools, including information technology

Demonstrate competence to develop, select and apply appropriate and creative techniques, resources, and modern engineering tools, including information technology, prediction and modelling, for the solution of complex problems, with an understanding of the limitations, restrictions, premises, assumptions and constraints.

Skills with respect to IT, information and data processing and analytics, organizational and process understanding, Simulation and Optimization methodologies and the ability to work and interact with modern interfaces of cyber-physical systems form the basis the for this suite of qualifications. Hence various core and discipline modules will require the students to use / develop computing algorithms as part of the solution methodology in case studies of the various modules

Programme Outcome 6: Professional and technical communication

Demonstrate an ability to use the resources of academic, professional and occupational discourses to communicate and defend substantial ideas that are products of research, investigation or development in an area of specialization; and a range of advanced and specialized skills and discourses appropriate to the field, discipline or practice, to communicate to a range of audiences with different levels of knowledge or expertise.

Students' ability to communicate well, both orally and in scientific writing, is emphasized throughout this qualification and will be assessed in several formats such as: case study reports, laboratory reports, design reports, project reports, Research Dissertation and several oral presentations.

Programme Outcome 7: Sustainability and the impact of engineering activity

Demonstrate critical awareness of the sustainability and impact of engineering/construction activity on the social, industrial and physical environment.

Critical awareness of the impact of engineering activity on the social, industrial and physical environment will be demonstrated through Targeted Case studies on Sustainability, Public Health and Safety, and Environment and Risk Management. The student must demonstrate correct application of scientific and engineering principles in recognizing and dealing with technical, economic constraints and a critical consideration of the environmental impact and consequences.

Programme Outcome 8: Individual, team and multidisciplinary working

Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

The individual, team or multidisciplinary effort will be explicitly assessed in group and individual reports, the student must demonstrate active participation and being an effective team player within the assigned group activity.

Programme Outcome 9: Independent learning ability

Demonstrate the ability to develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.

Throughout our curriculum we emphasize the limitations of what we are able to cover in our coursework and that students will need to be able to learn material for themselves throughout their careers. The scope of the research project is beyond what students have experienced in prior modules, and requires both independent initiative and well developed personal management skills. The student is required to demonstrate the ability to learn the key aspects of the project and state how the scientific method can be followed to address the specified problem. This is done assessed through a project proposal and presentation, literature review and submission of final report

Programme Outcome 10: Professionalism

Demonstrate critical awareness of the need to act professionally and ethically, to exercise judgment and take responsibility within own limits of competence and where appropriate to account for leading and initiating processes and implementing systems, ensuring good resource and governance practices.

A professional approach to their working, particularly in respect of meeting deadlines and honesty will be assessed. Students need to act professionally and ethically in order to complete their individual research project and need to demonstrate judgement within the limits of their own competence in what they present in their written report

Programme Outcome 11: Management

Demonstrate knowledge and understanding of management principles and economic decision making.

In summary, graduates of these qualifications must be able to deal with complex issues both systematically and creatively, design and critically appraise analytical writing, make sound judgements using data and information at their disposal and communicate their conclusions clearly to specialist and non-specialist audiences, demonstrate self-direction and originality in tackling and solving problems, act autonomously in planning and implementing tasks with a professional orientation, and continue to advance their knowledge, understanding and skills relevant to a particular profession.

E. Objectives of individual modules

i. Proposed Qualification Structure

Several discipline specific Master's programmes are developed. These include chemical engineering, mechanical engineering, electronic and computer engineering, industrial engineering, civil engineering and construction management. The core curriculum proposed here includes appropriate topics in natural sciences and mathematics, engineering sciences, and in non-technical areas will give a variety of concrete contents to the general outcomes. The proposed curriculum for the various disciplines are outlined in **Appendix A.** The proposed qualifications are constituted of three components: a set of generic modules that are common to all disciplines; a set of discipline specific modules; and a discipline specific research project. This combination will ensure that the purpose of these qualifications and the facilitation of interdisciplinary interactions will be realised.

The core of the programme will be coursework modules relating to emerging technologies, as described by *Industrie 4.0,* and their application to the various listed disciplines of engineering and the built environment. In addition to the coursework modules, a research project or mini-dissertation is prescribed. This 180 credit qualification at HEQSF level 9, consists of a minimum of 8 modules (minimum 120 SAQA credits / 60 ECTS credits) and a research dissertation (minimum 60 SAQA credits / 30 ECTS credits) which are assembled to form a coherent qualification. A summary of the programme structure is shown in the Figure 1 below.

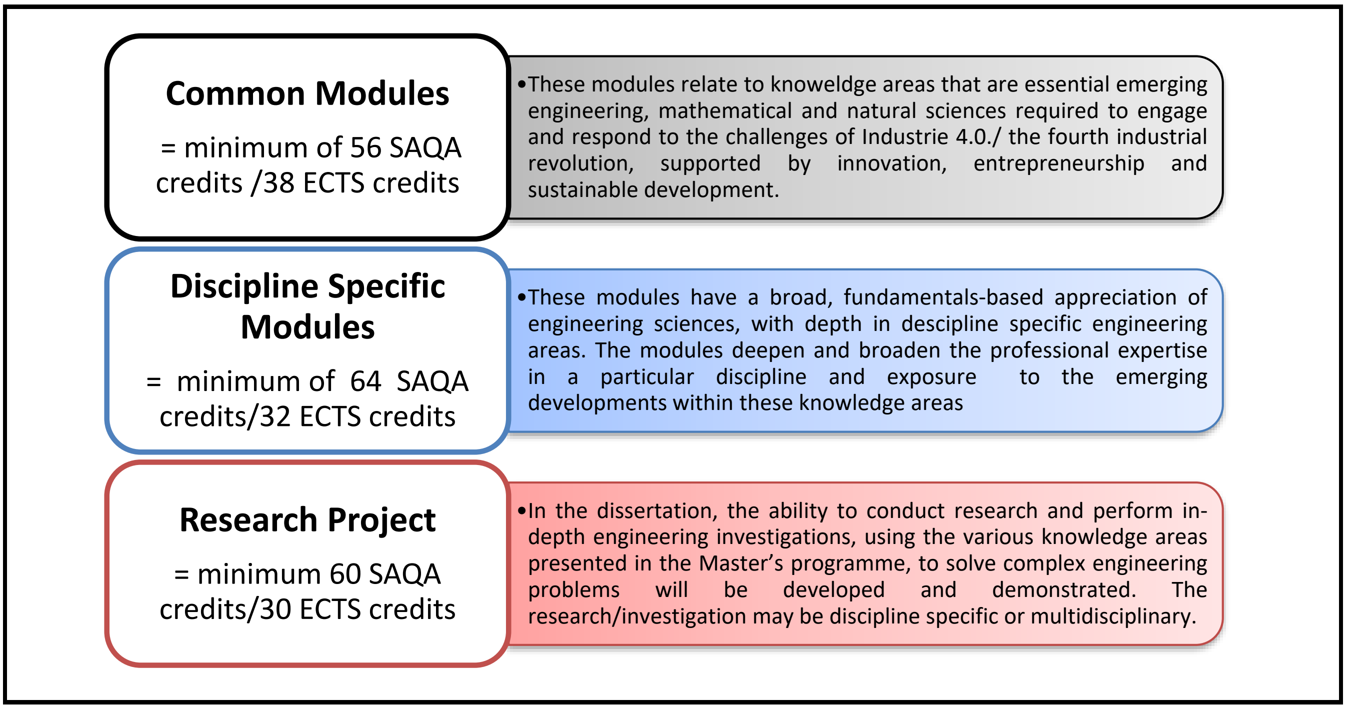


Figure 1. Summarised Structure of the proposed master programme

The content as well as the learning, teaching and assessment strategies of the various common core and discipline specific modules together with the research project will contribute to the required development of the various graduate attributes associated with these qualifications. The contribution of the various modules to the development and assessment of the various EURACE and ECSA graduate attributes are summarized and presented in **Appendix B** for the various discipline specific qualifications.

ii. International Comparability

The proposed DUT MEng qualifications are compliant with the ECSA MEng draft standard. This standard has been intentionally written so that the credit distribution across the various knowledge areas for the Bachelor of Engineering Technology, Bachelor of Engineering Technology (Honours) and Master of Engineering (Professional Practice) form a cohesive qualification, as shown in Table 2.

Table 2: Knowledge Area Credit Distribution (in SAQA credits) for the suite of qualifications

Knowledge area	BEngTech	BEngTech (Hons)	MEng	Combination of 3 qualifications
Total	≥420	≥140	≥180	≥740
Mathematics and natural sciences	70	21	30	121
Engineering sciences	140	42	30	212
Engineering design & synthesis	49	28	30	107
Complementary studies	49	14	20	83
Available for re-allocation in the above areas	≥112	≥5	≥10	≥127
Research		30	60	90

International comparability of the SA Higher Education engineering qualifications is ensured through the Washington, Sydney and Dublin Accords, which constitute the members of the International Engineering Alliance (IEA). The exit level outcomes and level descriptors defined in this suite of Master's qualifications fulfil and exceed the International Engineering Alliance's Graduate Attributes and Professional Competencies for professional engineers (Washington Accord)[3].

A comparative analysis of the EUR-ACE learning areas and ECSA exit level outcomes was conducted and is summarized in Table 3. The resulting populated matrix indicates that there is substantial equivalence or overlap between the EUR-ACE outcomes for the Second cycle qualification (Master's) as specified in the EUR-ACE Framework Standard used for the accreditation of Professional Engineering Programmes in European (Bologna Accord signatory) countries and the exit level outcomes of the ECSA MEng qualification standard. A detailed analysis is presented in **Appendix D**.

[3] www.ieagreements.org/

Table 3. Summary of the Comparative Matrix of the EUR-ACE Learning areas and ECSA exit level outcomes

EUR-ACE Learning Areas	ECSA Qualification Exit Level Outcomes										
	Problem Solving	Application of scientific and engineering knowledge	Engineering design	Research, investigations, experiments and data analysis	Engineering methods, skills and tools, including IT	Professional and technical communication	Sustainability and the impact of engineering activity	Individual, team and multidisciplinary working	Independent learning ability	Engineering professionalism	Engineering Management
Knowledge and Understanding		X	X	X				X			
Engineering Analysis	X	X	X	X	X		X				
Engineering Design		X	X	X			X				X
Investigations		X		X		X					
Engineering Practice			X		X			X		X	X
Making Judgements	X	X	X	X				X		X	X
Communication and Team-working						X		X			X
Lifelong Learning			X	X					X		

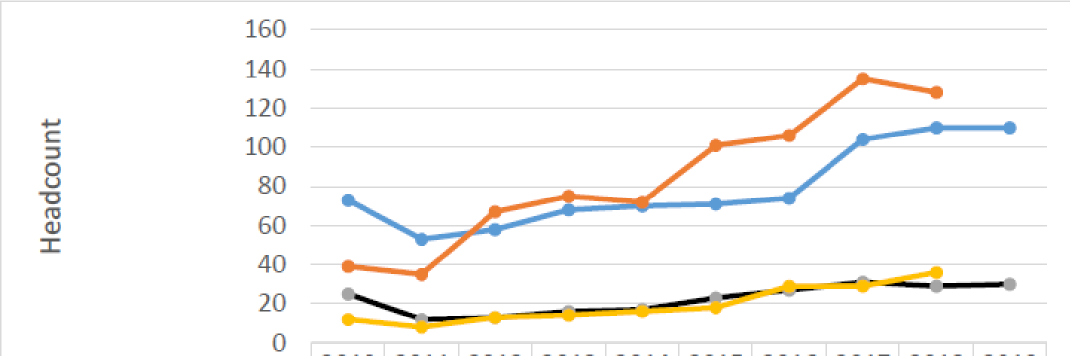
The proposed curriculum for the various core and discipline specific modules are presented **in Appendix C**.

The qualifications developed are based on qualification standards or recommendations by the various statutory bodies governing the engineering and built environment professions.

The primary purpose of the proposed coursework Master Degrees are to educate and train graduates who can contribute to the development of knowledge at an advanced level such that they are prepared for advanced and specialized professional employment. These qualifications are designed in consultation with the relevant professional bodies so as to fulfil all or part of the requirements for professional registration or recognition.

iii. Target enrolment / targeted staff-student ratio

The Figure 2 below shows the historic trajectory with respect to postgraduate enrolments in FEBE. The enrolments are currently for the research based postgraduate studies. In 2018, there were 128 Master's and 36 doctorate students enrolled across nine disciplines in the faculty. A significant increase is expected once the Honours programmes are approved, and with the introduction of the course-work Master's programs. The implementation date for the proposed programmes is 2021. The enrolment in these new qualifications is expected to be an average of 20 students per discipline. Hence the total student enrolment for the coursework Master's will be about 160 students in total. The enrolment into the course work programmes may reduce the number of students enrolling for the research Master's programme.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
masters planned	73	53	58	68	70	71	74	104	110	110
masters actual	39	35	67	75	72	101	106	135	128	
doctorate planned	25	12	13	16	17	23	27	31	29	30
doctorate actual	12	8	13	14	16	18	29	29	36	

Figure 2 Historical and projected enrolments for postgraduate qualifications

F. Demand

The Accelerated and Shared Growth Initiative for SA (AsgiSA), which was gazetted by the government in 2014, identified the shortage of *suitably skilled labour* as one of the key constraints in the economy and its capacity for growth. Resolving this constraint was identified as one of the priority interventions necessary to achieve the growth in South Africa. This gave rise to the Joint Initiative on Priority Skills Acquisition (JIPSA), which set to identify short to medium term solutions in addressing the skills shortage. The rationale for the introduction of this coursework Professional Master's Degree in Engineering programme arises from some three key recommendations of JIPSA. These are:

1. Accelerating the provision of priority skills to meet the objectives of AsgiSA.
2. Promoting greater relevance and responsiveness in the education and training system and strengthening the employability of graduates, and
3. Increasing the number of engineers, to support the rollout of public programmes and capacity within the industrial sectors as articulated in the National Development Plan, New Growth Path and the Industrial Policy Action Plan.

Moreover, this qualification is intended to meet the growing needs of the fourth Industrial Revolution, where decision-making is relying evermore on data science and the analysis of big data, which is being produced at a rate that is far greater than that of the computing power to process them. This means that there is a growing need for professionals who are able to master the models, the algorithms and the technologies to turn data into meaningful information for decision making.

Given these premises, these qualifications have been designed with the aim of educating the "next generation of engineers" endowed with deep computational, methodological and modelling skills that will allow them to design, implement and support the future data-intensive algorithms, tools and platforms, together with the mainstream tools for data and text mining, machine learning, artificial intelligence, and complex system modelling.

The various academic departments have liaised with industry via their industry advisory board, and other fora, and support for the programme has been overwhelmingly positive. Enrolments for these Master's programmes will primarily consist of graduates from the Bachelor of Technology Honours degrees to be introduced in 2020; the MEng and MBE programmes will be introduced directly thereafter, in 2021.
The composition of the various discipline specific industrial advisory boards is presented in **Appendix E**.

4 Educational Process

A. Entry and Admission Requirements

The minimum admission requirement is a relevant NQF Level 8 Bachelor of Technology Honours degree or a postgraduate diploma. A cognate Bachelor's degree at NQF Level 8 may also be recognised as meeting the minimum entry requirement to a cognate Master's degree programme.

Progression completion of a Master's degree meets the minimum entry requirement for admission to a cognate doctoral degree, usually in the area of specialisation in the Master's degree. A qualification may not be awarded for early exit from a Master's degree.

B. Course of Study

i. Curricular content

These qualifications are intended to meet the growing needs of the fourth Industrial Revolution, where decision-making is relying evermore on data science and the analysis of big data, which is being produced at a rate that is far greater than that of the computing power to process them. This means that there is a growing need for professionals who are able to master the models, the algorithms and the technologies to turn data into meaningful information for decision making.

Given these premises, these qualifications have been designed with the aim of educating the "next generation of engineers" endowed with deep computational, methodological and modelling skills that will allow them to design, implement and support the future data-intensive algorithms, tools and platforms, together with the mainstream tools for data and text mining, machine learning, artificial intelligence, and complex system modelling.

The detailed module descriptors for the all the modules are presented in **Appendix C**

ii. Orientation – national / international (classes held in foreign languages, semester abroad, bridging modules for international students)

Since these programmes are developed through the PEESA3 project, it is anticipated that there will be mutual recognition of modules with the various partners of the project as well as the possibility of these qualifications being offered as joint degrees or double degrees. These collaborative programmes may also involve the exchange of students and staff between the European and South African partners.

iii. Didactic concept / programme type

The various programmes will be offered both as full-time and part-time programmes. Since most of the candidates enrolling for these qualifications may be professionals working in industry, it is expected these qualifications will be offered on a part-time basis. The various modules may be offered in a block-week system during an academic semester whereby one or two modules are covered in their entirety over two or more weeks of full daily attendance. Whilst this qualification will be offered as a campus based qualification, it is expected that there will be some modules offered as online modules supported by multimedia / telematics.

These programmes are designed such that it facilitates the development and demonstration of the various "exit level outcomes" and the desired DUT graduate attributes. The learning programme features the following aspects:

1. Consists of a coherent assembly of knowledge areas. The knowledge areas associated with engineering practice (as specified in the engineering qualification standard) include: mathematical sciences, natural sciences, engineering sciences, engineering design, computing and IT, and relevant complementary studies.
2. The exit level learning outcomes guide the curriculum content as well as pedagogical and assessment decisions.
3. Is designed in such a way as to ensure a progressive and "scaffolded" combination of the key knowledge in specific subject areas, in such a way as to deepen and extend the preceding knowledge, whilst adding new elements.
4. Has a meaningful integration of the required skills and values.
5. Have adequate opportunities throughout the programme for the development and demonstration of the various competencies.
6. At each level (semester / year) there will be "integrative active learning activities" through case studies and mini projects. This teaching and assessment strategy is intended to develop a range of skills, both academic and professional, and an integration of different knowledge areas in the context of progressively more challenging problems and projects.

We recognised that different students may have different learning styles and that they may benefit from different instructional approaches. A concerted effort will be made in the design of this programme to better engage students in the learning process by using several methods of instructional delivery and assessments: lectures, tutorials, practicals, assignments, application software exposure, mini projects, oral presentations, and mini and capstone design and investigation projects. The several capstone activities included in the curriculum will have components that challenge the learners to realize their potential and contribute to the development of several of the desired DUT graduate attributes.

The other area of importance to our teaching programme is the integration of laboratory work into the curriculum. We believe that laboratories play a critical role in the teaching and learning of science and engineering principles and provide a hands-on learning experience that cannot be effectively duplicated by using other approaches. Laboratory sessions provide an interactive learning experience, as well as imparts technical and vocational knowledge to the student. The laboratory sessions will consist of using equipment designed for the understanding of the discipline specific engineering principles. These facilities will be fully integrated into the academic programmes.

iv. Structure

The structure for the coursework Master's programmes in various disciplines is presented in **Appendix A**.

There are four core essential modules relating to emerging technologies, as described by *Industrie 4.0.*	1. Applied Systems Thinking 2. Technology Development and Management 3. Green Engineering and Sustainability 4. Data Analytics	12 credits 12 credits 12 credits 12 credits
There are a minimum of 4 discipline specific modules. These modules have a broad, fundamentals-based appreciation of engineering sciences, with depth in discipline specific engineering areas. The modules deepen and broaden the professional expertise in a particular discipline and exposure to the emerging developments within these knowledge areas.	5. Minimum 4 discipline specific 16 credit modules	64 credits
In additional the programmes will have a minimum 60 credits research project. In the dissertation, the ability to conduct research and perform in-depth engineering investigations using the various knowledge areas presented in the Master's programme to solve complex engineering problems will be developed and demonstrated. The research/investigation may be discipline specific or multidisciplinary.	6. Minimum 60 credit Research Project	60 credits
	Minimum total	**180 Credits**

v. Workload

The coursework Master's programmes have been developed such that approximately 30% of the notional hours will consist of face-to-face teaching with the remaining national hours for independent study and assessments. A typical master programme module will consist of lectures, case studies and assignments/mini projects.

Hence, for a typical semester consisting of 20 weeks,

- a 12 credit module may typically consist of: 2 hours per week lectures (40 hours/semester), 40 hours of self-study and 40-hour assignment/ mini project.

- Similarly, a 16 credit module may typically consist of: 3 hours per week lectures (60 hours/semester), 60 hours of self-study and 40-hour assignment/ mini project.

Some modules may be developed and delivered as online modules supported by multimedia / telematics. The programme also includes a minimum 600-hour research project. The typical workload will be a minimum of 60 credits per semester over three semesters.

A review mechanism to establish the true workload and credit allocation will be concluded at the end of each semester. This will be verified through the review of the actual learning; teaching and assessment (LTA) activities that have been used to deliver the modules. indicative tools that may be used include pass rates per module, module evaluation surveys by students, external examiner/moderator feedback, etc.

vi. Examinations (oral, written, other)

The evaluation methods of all the modules will be public in the teaching guide and accessible through the FEBE web pages. In each module, sufficient number of assessment activities of varied types are planned that allow both the formative and summative evaluation of the students. All the assessment activities will be consistent with the specific goals and generic competences assigned to the module in the curriculum, as it is specified in detail in the teaching guides of the module.

The evaluation methods to be used include written and online tests, assignments, lab sessions, projects, and oral presentations. The evaluation methods will be tailored to the programme and module outcomes and competences. The academic SC is responsible for checking the procedures so that each module reliably and accurately evaluates the learning outcomes and competences.

The evaluation method for each module will be reviewed each semester by the subject committee (SC) associated with the module in Master’s programme and, if necessary, modified for a better adaptation to the target learning outcomes.

Since this programme will only be delivered in 2021, no statistics on student performance is available.

v. Assessment Methods for the qualification

A variety of appropriate assessment methods are employed throughout the learning programme. The typical assessments used will be tests, assignments, mini-projects and/o presentations. There will also be a major design project and a mini dissertation.

(a) Internal Processes
In each module an internal moderator is chosen by the module convenor. The internal moderator must moderate all assessments and the final examination in the module. The internal moderator is generally someone who is familiar with the subject matter of the module and/or teaching a related course in the curriculum. The system of internal moderation currently used is aligned to the institutional policy and is briefly described here:

- Following the marking of the examination scripts or project reports, each script or report is checked internally by the internal moderator to ensure that it has been completely marked, and that all marks have been entered and added correctly.

(b) External moderation

In addition to the internal moderation, an external moderator will be assigned for all modules. The system of external moderation currently used is aligned to the institutional policy and is briefly described here:

- The examination paper or project brief in each course is moderated by an external moderator appointed for each course to ensure that the paper or brief is at the correct level and (in the case of examinations) that the questions and solution memorandum are complete.
- The external moderator checks the scripts or reports for a particular course. While checking is carried over a range of scripts or reports, further emphasis is placed on students on the borderline between passing and failing.
- For the assessment of ELOs: Along with the examination scripts the external moderator for a module also receives any work that students have been assessed on that pertains to the achievement of an ELO. The external moderator will firstly, review a selection of these as per the institutional guidelines and secondly, draw on the evidence presented and thirdly, make a decision on whether they agree with the assessment of the internal examiner.

The dissertation will be subjected to external examination. For every dissertation the faculty research committee will appoint a minimum of two external examiners who are experts in the area of study.

5 Resources

A. Institution and Context

The Durban University of Technology (DUT) is comprised of six faculties: Accounting and Informatics, Applied Sciences, Art and Design, Engineering and the Built Environment, Health Sciences and Management Sciences. The total student population in 2017 was 29787. Programs are offered across seven campuses, five in Durban and two in Pietermaritzburg. The executive management structure consists of the positions of the vice-chancellor and three deputy vice-chancellors (Teaching and Learning; Research Innovation and Engagement; People and Operations). The executive deans, chief financial officer and the registrar are also members of the executive team. Each faculty is headed by an executive dean who reports to the deputy vice-chancellor: teaching and learning. DUT has a two-tier academic management structure; the head of an academic department and the executive dean who is supported by a deputy dean. These positions are renewal contract appointments. The current academic positions in a department are junior lecturer, lecturer, senior lecturer, associate professor and professor. In addition to the usual business functions' support, the academy is supported by various units that directly relates to the teaching, learning and research activities. These include: Centre for Quality Promotion and Assurance (CQPA), Centre for Excellence in Learning and Teaching (CELT), Research and Post Graduate directorate, International Education and Partnerships, Cooperative Education, and the library. Further information is available at www.dut.ac.za.

Vision of DUT

To be a preferred university for developing leadership in technology and productive citizenship.

Mission of DUT

To excel through: -

- A teaching and learning environment that values and supports the university community.
- Promoting excellence in learning and teaching, technology transfer and applied research.

- External engagement that promotes innovation and entrepreneurship through collaboration and partnership.

Core values of DUT

- Respect, Recognition, Opportunity and Access
- Loyalty, Dignity and Trust
- Transparency, Openness, Honesty and Shared Governance
- Responsibility, Accountability, Collegiality and Professionalism

The Faculty of Engineering and the Built Environment (FEBE) has more than 6 000 students enrolled across the departments of Chemical Engineering, Civil Engineering and Geomatics, Construction Management and Quantity Surveying, Electrical Power Engineering, Electronic and Computer Engineering, Industrial Engineering, Town and Regional Planning, Architectural Technology and Mechanical Engineering. FEBE offers a range of Bachelors, Bachelor Honours, Master's and Doctoral modules in various departments.

Focused research in areas including Membrane Technologies for Water Purification, Chemical Thermodynamics, Applied Computational Intelligence, Bio-composites/Nano-materials, Technology Station in Reinforced and Moulded Plastics, the Indlebe Radio Telescope, Real Time Power System Simulation, Renewable Energy, Transportation, Engineering Education, Sustainable Development and Human Settlement.

Vision of FEBE

To be known for excellence in producing relevant professionals, who use engineering, technology and design, for societal development in South Africa.

Mission of FEBE

- To continually ensure that our graduates are socially relevant.
- To ensure that the professional career orientation of our students is informed by the relevant stakeholders.
- To provide an appropriate infrastructure to our students that will ensure technological excellence.
- To ensure that learning and teaching in the faculty is in line with student's needs and latest innovative practices.
- To foster research and development that contributes to the national and international pool of knowledge, and that informs the undergraduate curriculum.

i. Committees responsible for teaching in the degree programmes

All Master's programmes will have the same coordination structure. The coordination will be implemented in three different levels: course level, area level (i.e. group of modules in the same area) and programme coordinator. The area coordinator is responsible for distributing the learning objectives and competences among the modules in the area. The programme coordination ensures the coordination among areas and semesters. Each Master's academic committee (AC) will be composed of several professors (according to the departments involved in the Master's programme), and the discipline head. The duties of the AC include the coordination of areas and the supervision of the education objectives/competences/contents of the modules. Each discipline has a Research committee which will validate all the research undertaken for the 60 credit research project. Any rule changes for any programme will need approval of faculty board and final approval at the university senate.

ii. Research facilities, main areas of research, R&D activities including an explanation of their relationship to the degree programme seeking accreditation

DUT has a deputy vice-chancellor portfolio for research that amongst other things, co-ordinates research and postgraduate studies at a systemic level; however, each faculty is responsible for its own research agenda. Over the last decade the leadership in FEBE made significant strategic interventions to develop and improve the scholarly production in the Faculty. These interventions included the initiation of research clusters, investment from the faculty operating budget in research clusters and conference attendance, departmental research colloquia, and faculty research clinics. The following is a list of research activity areas within the faculty:

- Bio-composites
- Urban Futures Centre
- Water Treatment Technologies
- Applied Computational Intelligence
- Re-enforced and moulded plastics
- Inlebe Radio Telescope (Radio Astronomy)
- Real-time Power System Simulation
- Renewable Energy
- Transportation
- Intelligent Systems
- Engineering Education

There are also other research productive staff and students who do not explicitly belong to a particular research area. Engineering education research is worthy of special mention. DUT FEBE continues to engage internationally and locally in this discipline, notably, local and international conferences.

Many of the activities mentioned above include national and international research collaborations, for example, Bio-Composites, Urban Futures Centre and the Inlebe Radio Telescope. Collaboration also takes place with industry and other enterprises such as the Department of Transport, Umgeni Water, eThekwini Municipality, the Department of Science and Technology and the Square Kilometre Array (SKA) radio telescope (SKA) South Africa. The Technology Station in re-enforced and moulded plastics is a technology development and transfer centre that works with various industries.

iii. Partnerships – Cooperation Related to the Degree Programme

National and international collaboration

FEBE has several MOUs with national and international partners. Some of the partners include Universidad de Huelva in Spain, Frankfurt School of Finance and Management GmbH in Germany, University of Dortmund Hochschule Bremen City University of Applied Sciences in Germany, Ulm University of Applied Sciences (HSU) in Germany and Fachhochschule Erfurt University of Applied Sciences in Germany., Dassault

Systèmes and the French Ministry of Education, Higher Education and Research, ESTP Paris and UPS University Toulouse III. The faculty has also hosted several international students from France, Germany, Poland, Sweden and Thailand. Several faculty students also spent time abroad in several countries including Spain, Germany and Poland.

Below is the current list of European Higher Education Institutions which have mutual recognition of modules in various engineering programmes at DUT. This has resulted in several students completing at least a semester of studies at DUT and receiving credits at their home institution:

ENSAIT	France
ESTP Paris	France
University of Applied Sciences - Koblenz	Germany
DHBW Ravensburg	Germany
DHBW Loerrach	Germany
INP-ENSIACET	France
Hochschule Bremen - City University of Applied Sciences	Germany
IITBTP - CNAM Champagne Ardenne	France
Uppsala University	Sweden
Technical University Vienna	Austria
Gdansk University of Technology	Poland
Ulm University of Applied Sciences - Hochschule Ulm	Germany
University of Rome "La Sapienza"	Italy
Munich University of Applied Sciences MUAS	Germany
Universidad de Huelva	Spain

The Departments of Chemical, Mechanical, Electronic and Computer, Civil and Industrial Engineering and Construction Management and Quantity Surveying are currently involved in the EU Erasmus+ funded PEESA 3 project. This three-year project will lead to the design and delivery of a course work Master qualifications between UoTs in South Africa, Germany, Poland and Romania that is intended to fulfil the requirements of the ECSA MEng standard. In addition, a requirement of this project is that the proposed qualification will also be subjected to the EURACE and the ASIIN (Germany) accreditation processes. This project also involves international curriculum development and participation in conferences and seminars in partner countries.

The Departments of Electronic and Computer Engineering is currently involved in the EU Erasmus+ funded DCT-REES project. This three-year project involves the promotion and support of direct current (DC) technologies in renewable energy education as well as skills development in the energy sector of South Africa. This is a collaboration between UoTs in South Africa, Germany, Belgium and Netherlands. This project also involves international curriculum development and participation in conferences and seminars in partner countries.

The faculty also has an Urban Futures Centre (UFC). All research and engagement projects that the UFC partake in operate in a networked approach; this means that strong partnership arrangements have been forged with a range of civic organizations including Refugee Social Services, Senzokuhle Home Based Care, and the Homeless 30 Peoples Forum. Non-government organizations are key partners on all their projects. This include TB HIV Care Association, the Dennis Hurley Centre, ASONET, Democracy Development Programme, and others. The UFC have collaborative arrangements with a number of government departments at the city, provincial and national level. Of particular interest here are the Department of Health, the Department of Human Settlements, Safer Cities and the police. They have also collaborated in 2017 through the Anti-Racism Network in South Africa with national civil society organizations such as the Ahmed Kathrada Foundation and the Nelson Mandela Foundation. The UFC international collaborations remain strong with other urban centres across the globe. The Migration and Inclusion project which is funded by the Cities Alliance in Brussels, and the Dreaming Workshop project, which is funded under the Effects of Race project is jointly headed by Prof Nina Jablonski from Penn State University in the USA. In 2017 the UFC also hosted seminars by colleagues from Poland (Gdansk University of Technology), University of British Columbia in Canada (David Morton), and Yale University in the USA (Jacob Dlamini).

iv. Participating Staff

Staff teaching in professional programs are suitably qualified and experienced. The norm within the faculty is that a lecturer teaching and assessing a module at a particular level should have a qualification higher than the qualification for that module or be professionally registered in the appropriate category. There are a few legacy exceptions where the staff will have an equivalent qualification. The total teaching staff positions in FEBE is 122. In addition, the human resource needs of the faculty are supported by an adequate part-time staffing budget that is allocated annually to the faculty.

Many Staff in FEBE hold key positions in learned societies and professional councils and are actively engaged in accreditation activities for these councils.

The table below shows the qualification profile of all staff in FEBE. Vacant posts are not shown although they are currently filled with part-time appointments. Over 77, 1 % of the full time teaching staff hold a Master's qualification and above. By end 2019 staff with doctoral degrees are expected make up 30%, and the Master's and doctoral composition of staff is expected to be about 78%.

Staff category	Total number	Number/highest qualification			
		Doctorate	Masters	4-Year	Other
Academic/ teaching	122	35	59	28	0
Technical support	40	0	9	18	13
Administration support	18	0	1	11	6

v. Financial and Physical Resources

The Faculty of Engineering and the Built environment currently offers a full suite of qualifications from undergraduate to doctorate qualifications in the various engineering disciplines. These programmes are currently fully accredited by the Council for Higher Education (CHE) and the professional programmes are fully accredited by the various relevant professional bodies including the Engineering Council of South Africa (ECSA). Hence the faculty is deemed to be adequately resourced to offer the proposed course work Master's programmes.

Computer facilities

The faculty has several general multi-purpose and discipline specific computer laboratories with up to date hardware. In addition to the generic software like the Microsoft Suite, several discipline specific software is also available. These include statistical, simulation and mathematical software like MATLAB and Simulink, SPSS and Mathematica; process simulation software like ChemCad and Aspen; and design software like Autocad; etc.

Library / Literature / Media facilities

The University has a comprehensive selection of books and e-books covering the whole field of engineering. The library also makes use of electronic inter-library loan services that are available through Sabinet. The library provides access to several online journal databases including, among numerous others, Scopus, Web of Science, IEEE Explore. Compendex, ProQuest, EbscoHost, Science Direct, Springerlink, Water Resources Worldwide, and Emerald

Laboratory facilities / equipment

The university has a comprehensive set of laboratories for the various disciplines in the faculty. These comprehensive facilities are used extensively in the delivery of the various undergraduate qualifications. The laboratory facilities and its integration into the academic programmes is an essential requirement for professional body accreditation. In addition, there are several research oriented laboratories that are extensively used for the various postgraduate Master's and doctorate qualifications offered in the various disciplines. Some of existing laboratory facilities in the faculty is presented in the table below.

Discipline	**Existing Laboratory Facilities**
Civil Engineering	Structures Laboratory; Concrete Laboratory; Soils Laboratory; Bitumen and Asphalt Laboratory; Geotechnical Laboratory; Water Laboratory
Electronic Engineering	2 x Electronics Laboratories; 3 x Digital Systems Laboratories; 2 x Computer Systems Laboratories; Computing and IT Laboratory; 2 x Projects Laboratories; Projects CAD Laboratory; Process Instrumentation Laboratory ; Instrumentation Computer Laboratory; Process Control Laboratory; Communications Laboratory; Radio Engineering Laboratory; Microwave Communications Laboratory
Mechanical Engineering	Mechanical Manufacturing Laboratory; Mechanics Laboratory; Mechanics (Theory of Machines) Laboratory; Computer Integrated Manufacturing (CIM) Laboratory; Thermodynamics Laboratory; Strength of Materials; Hydraulics Laboratory; Thermal Analysis Laboratory; Scanning Electron Microscopy (SEM) Laboratory
Industrial Engineering	Manufacturing Laboratory ; Mechanics Laboratory ; Electro technology Laboratory; Industrial Engineering Laboratory
Chemical Engineering	Unit Operations Laboratory; Transport Phenomena Laboratory; Water and Wastewater Laboratory; Projects Laboratory
Construction management and Quantity Surveying	Structures and Materials Laboratory and a QS Software Lab

7. Attainment of Objectives

Assessment of outcomes and assessment system

In this section we provide a brief explanation of how competences developed in the programme are aligned with the appropriate NQF level. In the development of this qualification, which conforms to the ECSA Engineering qualification standard, the following criteria are fulfilled:

1. The exit level outcomes (ELOs), knowledge area credit distribution and the DUT graduate attributes developed in this programme are aligned to the requirements of the ECSA Engineering qualification standard.
2. The cognitive complexity of the qualification defined by its range statements, and associated assessment criteria are aligned to Level 9 SAQA Level Descriptors.
3. The qualification structure and purpose is aligned to the HEQSF requirements for a professional Master's degree.

For each ELO, modules have been identified in which the learning, which contributes to the achievement of exit level assessment, will take place. A summary of how the outcomes will be attained was outlined in Section 3D.

Validation of assessment of exit level outcomes.
An extensive system of internal and external moderation is in place across all modules in this postgraduate programme. This is of special significance in the validation of assessment of ELO's. For each ELO assessment there will be a system for both the internal examiner(s) and the external moderator to attest that each student has met that particular ELO. Any course that has an ELO associated with it would have had the assessment of the particular course-level outcome related to this ELO developed by an academic team and not only the course convenor. This ensures that an overall plan for the programme can be assured.

Students will be made aware (through the module learner guide) of the individual requirements for demonstrating an acceptable level of achievement in each assessment relating to an ELO. Should a student not have achieved an outcome satisfactorily, in most instances it will be possible to resubmit an assessment task to demonstrate to the internal examiner that they are in fact at a level that is satisfactory for this outcome.

In modules where particular outcomes are being assessed, these outcomes are made "duly performed" (DP) requirements i.e. in addition to any other assessments a student has to successfully meet the ELO(s) to obtain a DP to write the final examination associated with the module. If a student does not meet the ELO, the student is refused a DP and that student may not be permitted to write the examination. Hence, a student passing a module will be deemed as achieving the ELO associated with the module.

Along with the examination scripts, which an internal and/or external examiner and/or moderator receives to examine/moderate, will be any work that students have been assessed on that pertains to the achievement of an ELO. The external moderator will be required to review a selection of these, as per the institutional guidelines, draw on the evidence presented, and subsequently make a decision on whether they agree with the assessment of the internal examiner.

8. Quality Assurance Measures

All engineering / professional qualifications are subjected to several layers of external and internal auditing / quality assurance measures. The suite of qualifications presented here will be subjected to the accreditation process of two professional statutory bodies: The MEng programmes will be audited by the Engineering Council of South Africa (ECSA)[4], and the MBE by the South African Council for Project and

[4] https://www.ecsa.co.za/EcsaDocuments/sitepages/ecsa%20documents.aspx

Construction Management Professionals (SACPCMP)[5]. The accreditation process provides benchmarking of academic programmes against high, internationally recognised standards. During the accreditation/auditing process, the assessment panel undertakes an in-depth review of programmes against the published criteria. The accreditation decision results from an evidence-based assessment of the learning outcomes delivered by the degree programme and the levels at which these are achieved. The accreditation process therefore takes into account all factors that influence delivery of learning outcomes and hence are triangulated from an in-depth analysis and assessment of documentary material relating to the programmes, evaluation of resources (physical, human, financial) and discussions with staff and students. The accreditation process is a high value, discipline-specific review by a panel of experienced professional chemical engineers drawn from industry and external academe. These external accreditation processes generally take place in a five-year cycle.

In addition to external accreditation processes, the university has an established and comprehensive framework for the quality assurance and the principles and concepts that underpin the framework; whereby

- ownership of quality and standards rests with the university and ultimate responsibility is formally vested in the Senate;
- day-to-day responsibility for the quality of academic provision, service provision and the student learning experience rests with faculties, programme teams and support departments;
- processes for monitoring and evaluation of the quality and standard of academic provision are grounded in evidence-based reflection;
- the university promotes the effective involvement of students in monitoring and evaluation.

At the university, monitoring and evaluation of academic programmes is grounded in the annual quality monitoring process which contributes to the six-yearly programme review and evaluation process.

Each faculty is responsible for the establishment of a faculty quality committee (FQC) as a sub-committee reporting to the faculty boards. This committee has a key role in:

- planning and development of new learning programmes
- monitoring and enhancement of existing programmes
- monitoring of the support required by the lecturers to promote quality learning and teaching
- annual quality monitoring processes of the departments and faculty
- monitoring that good practices are sustained and disseminated within the faculty
- monitoring the implementation of improvement plans developed in response to the outcomes of the programme review process
- submitting to faculty board and the Centre for Quality Promotion and Assurance (CQPA), the composite annual report and improvement plans for the faculty arising from:
    - Annual Quality Monitoring (AQM)
    - programme review and evaluation
    - national reviews and accreditation processes

[5] http://sacpcmp.org.za/our-services/programme-accreditation/

Academic departments are responsible for the establishment of reliable and robust systems and processes to manage quality and safeguard academic standards at the level of the academic programme/s provided by the department. The compulsory elements of a framework for programme management are that:

a) all staff in the department are familiar with, and implement, the quality assurance (QA) framework and processes, and all relevant DUT policies

b) a Staff-Student Committee is established and is functional for each programme offered by an academic department

c) an Advisory Board is fully constituted and meets regularly. The departmental Advisory Board (which is comprised mostly of senior industrial representatives and alumni), meets bi-annually and takes a strong interest in the undergraduate programme. The Advisory Board not only provides useful input on the programme but also valuable feedback from employers of our graduates.

d) systematic feedback is elicited from the students through questionnaires on modules and academic staff. All course evaluations are scrutinized by the head of department (HOD) and any issues that arise are discussed with individual staff members and/or at the subject review committee meetings

e) feedback obtained through the graduate survey, the student experience survey, and from a comprehensive and balanced range of sources as identified by the department is triangulated and informs improvement plans

f) a cohort analysis of the first year students is completed by the HOD

g) the department analyses relevant management information (MI) data, and acts accordingly to effect improvement

h) all departments implement processes for annual quality monitoring

i) all academic programmes are peer-evaluated at least once in a six-year cycle

APPENDIX A: Proposed Structure of Coursework M Eng Programmes at DUT

Proposed Structure of Coursework M Eng/MBE Programmes at DUT – PEESA3 Project							Credits
Common Modules	1. Applied Systems Thinking (12 credits) 2. Technology Development and Management (12 credits) 3. Green Engineering and Sustainability (16 credits) **4.** Data Analytics (16 credits)						**56**
Discipline	**Chemical Engineering**	**Mechanical Engineering**	**Industrial Engineering**	**Electrical Engineering**	**Civil Engineering**	**Construction**	
Discipline specific Modules (16 credits)	1. Process Synthesis and Process Integration 2. Process Optimisation 3. Chemical Process Design **Electives: (choose one elective)** 1. Applied Reaction Engineering 2. Advanced Separation Systems 3. Advanced Fluid Mechanics (CFD) 4. Bioprocess Engineering 5. Biofuels and Bio-refining 6. Pharmaceutical Engineering	1. Advanced Strength of Materials 2. Mechatronic Control Systems 3. Design Optimisation for Additive Manufacturing **Electives: (choose one elective)** 1. Autonomous and Robotic Systems 2. Quality and Reliability engineering 3. Renewable Energy Engineering 4. Smart City and Factory Technologies 5. Process Optimisation 6. Advanced Fluid Mechanics (CFD)	1. Global Supply Chain Design 2. Enterprise engineering 3. Man/machine interface Engineering **Electives: (choose one elective)** 1. Design and Analysis of Experiments 2. Quality and Reliability engineering 3. IT design and application	1. Cyber-Physical Systems 2. Autonomous Systems **Electives: (choose two electives)** 1. Advanced Digital Image Processing 2. Radio Astronomy 3. Advanced Control Systems 4. High Voltage DC Transmission 5. Energy Storage Systems	1. Engineering Management 2. Materials Technology **Electives: (choose two electives)** 1. Transportation Design 2. Urban Design 3. Water & Wastewater Treatment Technology 4. Hydraulics & Hydrology 5. Rehabilitation of Structures 6. Advanced Structures	1. Artificial Intelligence in Construction 2. Building Information Modelling in Design, Construction and Operations 3. Value Engineering in Construction 4. Decision Science	64
Research Project (Discipline specific)							60
Total Credits							180

APPENDIX B

Summary of Module contribution to EUR-ACE Learning areas and ECSA exit level outcomes

MEng (Chemical Engineering)

	Learning Area/Outcomes \ Modules	Applied Systems Thinking	Technology Development and Management	Green Engineering and Sustainability	Data Analytics	Process Optimisation	Chemical Process Design	Process Synthesis and Process Integration	Elective	Project
EUR-ACE Learning Areas	Knowledge and Understanding	O	O	O	O	O	O	O	O	O
	Engineering Analysis	O		O	O	O	O	O	O	O
	Engineering Design					O	O	O		
	Investigations									O
	Engineering Practice		O	O		O	O	O	O	O
	Making Judgements		O	O		O	O	O		O
	Communication and Team-working		O	O		O	O	O		O
	Lifelong Learning	O	O	O	O	O	O	O	O	O
ECSA Qualification Exit Level Outcomes	Problem Solving	X	X	X	X	X	X	X	X	X
	Application of scientific and engineering knowledge	X		X	X	X	X	X	X	X
	Engineering design					X	X	X		
	Research, investigations, experiments and data analysis									X
	Engineering methods, skills and tools, including information technology		X		X	X	X	X		X
	Professional and technical communication		X	X		X	X	X		X
	Sustainability and the impact of engineering activity		X	X		X	X	X		
	Individual, team and multidisciplinary working		X	X		X	X	X		X
	Independent learning ability	X	X	X	X	X	X	X	X	X
	Engineering professionalism			X		X	X	X		X
	Engineering Management		X			X	X	X		X

MEng (Industrial Engineering)

Learning Area/Outcomes	Modules	Applied Systems Thinking	Technology Development and Management	Green Engineering and Sustainability	Data Analytics and Machine Learning	Enterprise Engineering	IT Design and Applications	Man Machine Interface Engineering	Electives: Global Supply Chain Design	Electives: Design and Analysis Applications	Electives: Quality and Reliability Engineering	Project
EUR-ACE Learning Areas	Knowledge and Understanding	O	O	O	O	O						O
	Engineering Analysis	O		O	O						O	
	Engineering Design					O	O			O	O	
	Investigations					O	O	O			O	
	Engineering Practice		O	O					O	O		
	Making Judgements		O	O			O					O
	Communication and Team-working		O	O				O				O
	Lifelong Learning	O	O	O	O	O						O
ECSA Qualification Exit Level Outcomes	Problem Solving	X	X	X	X		X	X	X			
	Application of scientific and engineering knowledge	X		X	X	X				X	X	
	Engineering design					X	X					
	Research, investigations, experiments and data analysis							X		X		
	Engineering methods, skills and tools, including information technology		X		X				X		X	
	Professional and technical communication		X	X								
	Sustainability and the impact of engineering activity		X	X		X	X	X				
	Individual, team and multidisciplinary working		X	X		X	X					
	Independent learning ability	X	X	X	X							X
	Engineering professionalism			X								X
	Engineering Management		X									X

MEng (Civil Engineering)

Learning Area/Outcomes	Modules →	Applied Systems Thinking	Technology Development and Management	Green Engineering and Sustainability	Data Analytics and Machine Learning	Engineering Management	Materials Technology	Transportation Design (Electives)	Water & Wastewater Treatment (Electives)	Hydraulics & Hydrology (Electives)	Rehabilitation of Structures (Electives)	Advanced Structures (Electives)	Urban Design (Electives)	Research Project
EUR-ACE Learning Areas	Knowledge and Understanding	O	O	O	O	O	O	O	O	O	O	O	O	O
	Engineering Analysis	O		O	O	O	O	O	O	O	O	O	O	O
	Engineering Design						O	O					O	
	Investigations						O	O	O	O	O	O	O	O
	Engineering Practice		O	O				O	O	O	O	O	O	O
	Making Judgements		O	O				O				O	O	O
	Communication and Team-working		O	O				O				O		O
	Lifelong Learning	O	O	O	O	O	O	O	O	O	O	O	O	O
ECSA Qualification Exit Level Outcomes	Problem Solving	X	X	X	X	X	X	X	X	X	X	X	X	X
	Application of scientific and engineering knowledge	X		X	X	X	X	X	X	X	X	X	X	X
	Engineering design						X	X					X	
	Research, investigations, experiments and data analysis						X	X	X	X	X	X	X	X
	Engineering methods, skills and tools, including information technology		X		X	X	X	X	X	X		X	X	X
	Professional and technical communication		X	X				X				X		X
	Sustainability and the impact of engineering activity		X	X				X						
	Individual, team and multidisciplinary working		X	X			X	X	X	X	X	X	X	X
	Independent learning ability	X	X	X	X	X	X	X	X	X	X	X	X	X
	Engineering professionalism			X				X				X	X	X
	Engineering Management		X			X		X				X		X

MEng (Mechanical Engineering)

	Learning Area/Outcomes \ Modules	Applied Systems Thinking	Technology Development and Management	Green Engineering and Sustainability	Data Analytics and Machine Learning	Advanced Strength of Materials	Dynamics and Stability	Design Optimisation	Process Optimisation	Advanced Fluid Mechanics (CFD)	Autonomous Systems	Research Project
EUR-ACE Learning Areas	Knowledge and Understanding	O	O	O	O	O	O	O	O	O	O	O
	Engineering Analysis	O		O	O	O	O	O	O	O	O	O
	Engineering Design							O	O		O	
	Investigations											O
	Engineering Practice		O	O				O	O	O	O	O
	Making Judgements		O	O				O			O	O
	Communication and Team-working		O	O				O				O
	Lifelong Learning	O	O	O	O	O	O	O	O	O	O	O
ECSA Qualification Exit Level Outcomes	Problem Solving	X	X	X	X	X	X	X	X	X	X	X
	Application of scientific and engineering knowledge	X		X	X	X	X	X	X	X	X	X
	Engineering design							X	X		X	
	Research, investigations, experiments and data analysis											X
	Engineering methods, skills and tools, including information technology		X		X	X	X	X	X	X	X	X
	Professional and technical communication		X	X				X			X	X
	Sustainability and the impact of engineering activity		X	X				X				
	Individual, team and multidisciplinary working		X	X				X				X
	Independent learning ability	X	X	X	X			X	X	X	X	X
	Engineering professionalism			X				X				X
	Engineering Management		X					X				X

MEng (Electronic Engineering – Intelligent Systems)

Learning Area/Outcomes	Modules →	Applied Systems Thinking	Technology Development and Management	Green Engineering and Sustainability	Data Analytics and Machine Learning	Data Structures and Algorithms	Advanced Control and Automation	Electives: Embedded Communication Systems and Security	Electives: Image Processing and Computer Vision	Electives: Autonomous and Robotic Systems	Electives: Pattern Recognition and Deep Learning	Project
EUR-ACE Learning Areas	Knowledge and Understanding	O	O	O	O	O	O	O	O	O	O	O
	Engineering Analysis	O		O	O	O	O	O	O	O	O	O
	Engineering Design					O	O	O		O		
	Investigations						O	O		O		O
	Engineering Practice		O	O			O	O		O	O	O
	Making Judgements		O	O								O
	Communication and Team-working		O	O								O
	Lifelong Learning	O	O	O	O	O	O	O	O	O	O	O
ECSA Qualification Exit Level Outcomes	Problem Solving	X	X	X	X	X	X	X	X	X	X	X
	Application of scientific and engineering knowledge	X		X	X	X	X	X	X	X	X	X
	Engineering design					X	X	X		X		
	Research, investigations, experiments and data analysis					X			X	X	X	X
	Engineering methods, skills and tools, including information technology		X		X	X	X	X	X	X	X	X
	Professional and technical communication		X	X								X
	Sustainability and the impact of engineering activity		X	X						X		
	Individual, team and multidisciplinary working		X	X						X		X
	Independent learning ability	X	X	X	X	X	X	X	X	X	X	X
	Engineering professionalism			X								X
	Engineering Management		X					X				X

MEng (Electronic Engineering – Renewable Energy)

Learning Area/Outcomes	Modules	Applied Systems Thinking	Technology Development and Management	Green Engineering and Sustainability	Data Analytics and Machine Learning	Data Structures and Algorithms	Advanced Control and Automation	Electives: Embedded Communication Systems and Security	Electives: Power Generation and Renewable Energy Systems	Electives: Advanced Machines, Drives and Power Systems	Electives: DC Energy Systems	Project
EUR-ACE Learning Areas	Knowledge and Understanding	O	O	O	O	O	O	O	O	O	O	O
	Engineering Analysis	O		O	O	O	O	O	O			O
	Engineering Design					O	O	O				
	Investigations						O	O				O
	Engineering Practice		O	O			O	O	O	O	O	O
	Making Judgements		O	O								O
	Communication and Team-working		O	O								O
	Lifelong Learning	O	O	O	O	O	O	O	O	O	O	O
ECSA Qualification Exit Level Outcomes	Problem Solving	X	X	X	X	X	X	X	X	X	X	X
	Application of scientific and engineering knowledge	X		X	X	X	X	X	X	X	X	X
	Engineering design					X	X	X				
	Research, investigations, experiments and data analysis					X						X
	Engineering methods, skills and tools, including information technology		X		X	X	X	X	X			X
	Professional and technical communication		X	X								X
	Sustainability and the impact of engineering activity		X	X					X		X	
	Individual, team and multidisciplinary working		X	X								X
	Independent learning ability	X	X	X	X	X	X	X	X	X	X	X
	Engineering professionalism			X					X			X
	Engineering Management		X					X				X

APPENDIX C: Module Descriptors

MEng Module descriptor: Common Core Modules

<table>
<tr><td colspan="2">Faculty</td><td>Engineering and the Built Environment</td><td colspan="2">Department</td><td>Electronic Engineering</td></tr>
<tr><td>1</td><td>Module title</td><td>Applied Systems Thinking</td><td>2
6</td><td>Module code</td><td>TBC</td></tr>
<tr><td>5</td><td>HEQSF level</td><td>9</td><td>6</td><td>HEQSF Credits</td><td></td></tr>
<tr><td>7</td><td>Annual/semester</td><td>Semester</td><td>8</td><td>Compulsory or elective</td><td>Compulsory</td></tr>
<tr><td>9</td><td>Total notional hours</td><td>120</td><td>10</td><td>Contact hours</td><td>36</td></tr>
<tr><td>11</td><td>Purpose of this module in relation to the programme/s</td><td colspan="4">Systems thinking provides theory and practical tools for seeking solutions to complex social, engineering and organisational problems at local, regional and global levels. Systems thinking is a way of looking at the world and its complexity that emphasises holistic understanding rather than a reductionist approach. The course covers the fundamental concepts related to thinking, different thinking styles (analytical, creative, critical and systems), as well as thinking processes in collaboration and decision making. Using real-world examples, the course provides methods and tools for your own examples, enabling you to apply systems and complexity thinking in your personal and professional life. In addition, this module explores complex adaptive systems, such as organisations and large-scale engineered solutions, and provides concepts, methods and ways of thinking that can deal with such complexity.</td></tr>
<tr><td>12</td><td>Learning outcomes</td><td colspan="4">Specific Outcomes of Instruction
Differentiate systems concepts
Assess the underlying principles of systems methods
Demonstrate the ability to think systemically and conceptually
Apply a set of systems methods and techniques
Apply systems thinking to a wide variety of social and technical systems
Apply the method of drawing systems diagrams to represent systems and their dynamics
Apply the formal systems model to practical situations
Apply knowledge of feedback loops and their likely impact on system behaviours
Apply the concepts of complex systems system to understand why systems are unpredictable
Collaborate with others analysing and improving systems</td></tr>
<tr><td>13</td><td>Graduate attributes developed and/or assessed in this module</td><td colspan="4">Student Outcomes Addressed by the Course
Ability to use a wide range of specialist skills to identify, conceptualise, design and implement methods of enquiry to solve complex and challenging engineering problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialised context.
Ability to apply specialist knowledge of mathematics, natural science</td></tr>
</table>

		and engineering sciences to solve complex engineering problems, conceptualize models and enable engagement with and critique of current and emerging research and practices. • Develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.
14	**Module content**	• Philosophy and overview of systems thinking • Problem solving techniques • Argumentation, rationality, and logic • Analytical thinking, including problem definition, hypothesis formulation, data gathering, analysis and solution development • Creative and whole brain thinking • Critical thinking • Decision making, collaboration and decision justification • Systems thinking and problem structuring • unravelling complexity and systems challenges. • Systems methods and techniques • Application of systems methods
15	Teaching and learning	The module uses a combination lectures (face-to-face and distance), blended learning tools, case discussions, selected readings and hands-on projects. In the individual and group projects, students will analyse a real-world socio-engineering problem, interpret and propose solutions based on analytical and systems thinking approaches.
16	**Assessment and moderation**	The assessment for this module may be a combination of test, tutorials, assignments and/or mini-projects / case studies.

MEng Module descriptor

Faculty	Engineering and the Built Environment		**Department**	Electronic Engineering	
1	**Module title**	**Green Technologies and Energy Sustainability**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	The first part of the course will provide an overview of the most significant renewable energy resources, concepts, technologies and challenges to overcome climate change and other sustainable development goals and an insight into the possible solutions to sustainable energy usage; students will be able to recognise, understand and evaluate the different renewable energy resources available today and in the future. The second part of the course will provide an overview of the most significant global environmental, social and economic challenges that face humankind, and an insight into the solutions suggested by the universal commitment to sustainable development; students will be able to recognise, understand and apply the divergent interpretations of sustainable development that currently exist. This course will also explore ways in which we can provide clean, safe, sustainable energy supplies for South Africa, and the world, despite increasing population levels and affluence. This module aims to provide a world view to engineers, whereby they will take a perspective on their impacts that is wider than technical or economic. It guides them to act as change agents for sustainability.			
12	**Learning outcomes**	Specific Outcomes of Instruction • Understand and describe the principal sources of primary energy in use today, their development over the past century, and the general patterns of world, regional and national energy consumption. • Understand and describe the pollutants produced through the combustion of fossil fuels, their environmental impacts and the amelioration of these. • Understand and describe the forms of energy and the various definitions of 'sustainable' energy, and the relevance of sustainability to the design and implementation of energy systems • Understand and describe the basic principles underlying the design and use of energy supply systems, and the basic principles underlying the efficient use of energy • Evaluate different energy technologies, in terms of their economics and environmental impacts. • Compare different techniques available for minimizing the level of pollutants generated by various energy sources and systems • Compare the relative resource depletion impacts of different energy technologies. • Understand the full social and economic impacts of fossil fuels and alternative energy sources and their sustainability. • Providing a fundamental understanding of energy resources, its impact			

		on society and its sustainability for the future generations. • Understanding several multi-scalar impacts of energy and sustainability, ranging from global climate change to socio-cultural disruption at the local and national scale.
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to use a wide range of specialist skills to identify, conceptualise, design and implement methods of enquiry to solve complex and challenging engineering problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialised context. • Ability to apply specialist knowledge of mathematics, natural science and engineering sciences to solve complex engineering problems, conceptualize models and enable engagement with and critique of current and emerging research and practices. • Ability to use the resources of academic, professional and occupational dismodules to communicate and defend substantial ideas that are products of research, investigation or development in an area of specialization; and a range of advanced and specialized skills and dismodules appropriate to the field, discipline or practice, to communicate to a range of audiences with different levels of knowledge or expertise. • Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment. • Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments. • Develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning. • Demonstrate critical awareness of the need to act professionally and ethically, to exercise judgment and take responsibility within own limits of competence and where appropriate to account for leading and initiating processes and implementing systems, ensuring good resource and governance practices.
14	**Module content**	• Forms of energy: investigate some basic ideas around the various types of energy and conversion of energy • Fossil fuels and nuclear power • Primary energy: an overview of the world's primary energy situation, its recent history and its problems. • Energy consumption and cost: the different ways of using energy and how these have changed over the centuries. • Energy storage. • Renewable energy: hydro, geothermal, tidal, wave and ocean, wind, solar thermal and photovoltaic systems • Energy in buildings: an introduction to this topic focusing on improving insulation standards and heating efficiency in the housing stock. • Impacts of energy use: from local air pollution to climate change. • Remedies for sustainable energy systems: a critical look at how to make fossil fuel use more sustainable. • Environmental problems: climate change, waste and pollution, biodiversity destruction, and the general contradiction between

		resource use and carrying capacity; • Social challenges: demographic change and expansion, pandemics, poverty, endemic violence, migration and urbanisation • Global economic trends that currently determine and shape the dynamics of national and local economics • introduction to the history of, and different approaches to, the notion of sustainable development
15	Teaching and learning	The module uses a combination lectures (face-to-face and distance), blended learning tools, case discussions, selected readings and hands-on projects. The student will learn to use the appropriate scientific techniques applied to energy related issues. In the individual and group research projects, students will use real-world data to analyse and critically comment and report on social, economic, environmental and political problems relating to energy supply and sustainability.
16	**Assessment and moderation**	The assessment for this module may be a combination of assignments and mini-projects / case studies.

MEng Module descriptor

Faculty	Engineering and the Built Environment		Department	Electronic Engineering	
1	**Module title**	**Data Analytics**	2	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	Data analytics is the science of examining raw data with the purpose of drawing conclusions about that information. It is used in many industries to allow companies and organizations to make better business decisions and in the sciences to verify or disprove existing models or theories. Data analytics is also used in engineering decision making as well as for the understanding of phenomena to assist in better engineering design for socio-technical systems. This module will include the development of mathematical and processing techniques for data analysis.			
12	**Learning outcomes**	Specific Outcomes of Instruction • Apply fundamental techniques relevant to the field of data analytics such as exploratory data analysis and pre-processing techniques • Conduct research in a specific topic in machine learning such as decision trees, neural networks and support vector machines. • Investigate and apply a machine learning algorithm to a problem from a specific application domain and interpret the results. • Implement a big data analytics solution in order to analyse and interpret a very large data set.			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to use a wide range of specialist skills to identify, conceptualise, design and implement methods of enquiry to solve complex and challenging engineering problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialised context. • Ability to apply specialist knowledge of mathematics, natural science and engineering sciences to solve complex engineering problems, conceptualize models and enable engagement with and critique of current and emerging research and practices. • Develop, select and apply appropriate and creative techniques, resources, and modern engineering tools, including information technology, prediction and modelling, for the solution of complex engineering problems, with an understanding of the limitations, restrictions, premises, assumptions and constraints. • Develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.			
14	**Module content**	• Data Analytics: Overview of data analytics including example applications in areas such as finance, web, marketing etc. Introduction			

		to exploratory data analysis, including data summarization, exploratory statistics and visualizations such as boxplots, histograms and scatter plots. Common pre-processing techniques such as data cleaning and feature selection. • Machine Learning: Introduction to different categories of machine learning such as supervised and non-supervised learning algorithms. Application of classification, clustering and regression models such as k-means, decision trees, Bayesian classification, linear regression, support vectors machines and ensemble methods. • Big Data Frameworks: Principles and challenges of big data. Overview of big data frameworks for parallelized processing of data. • Large Scale Analytics: Introduction to algorithms for the analysis of high velocity data. Machine learning for parallel analysis of large data sets using a distributed framework. Distributed stream processing for data analysis real-time using a distributed framework. • Case Study: Application of distributed data analytics to a real-world use case such as sentiment analysis, fraud detection, customer analysis, recommender systems.
15	Teaching and learning	The module uses a combination lectures (face-to-face and distance), blended learning tools, case discussions, selected readings and hands-on projects. In the individual and group projects, students will analyse a socio-engineering problem using existing real-world data, interpret and propose solutions.
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, tutorials, assignments and/or mini-projects / case studies.

MEng Module descriptor

Faculty	Engineering and the Built Environment		Department	Chemical Engineering	
1	Module title	**Product Development and Management**	2 6	Module code	TBC
5	HEQSF level	9	6	HEQSF Credits	12
7	Annual/semester	Semester	8	Compulsory or elective	Compulsory
9	Total notional hours	120	10	Contact hours	36
11	Purpose of this module in relation to the programme/s	This module analyses the innovation management function, including research and development, with special emphasis on product development. The module will provide a theoretical foundation and practical tools for describing, analyzing, comparing and designing innovation processes at the company level and apply them to product development processes in technology companies. The course provides a link between the strategic management of technology and the management of individual innovation projects.			
12	Learning outcomes	Outcomes of Instruction • assess and interpret the innovation process • develop and formulate managerial strategies to shape innovative performance • utilise tools of innovation management to map and measure innovative activities • diagnose different innovation challenges and make effective recommendations for resolving them • employ different ethically and socially sound mechanisms to profit from innovative efforts • Compare and evaluate the impact of the key functional areas (strategy, marketing and finance) on the commercial performance of an organisation, relevant to the manufacture of a product or provision of a technical service.			
13	Graduate attributes developed and/or assessed in this module	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	Module content	1. **The Business Environment**: Understanding the business environment; identifying key trends and their implications for the organisation. 2. **Innovative work in technology companies:** Theory and practice on technological innovation processes 3. **Process analysis and design:** Introduction to and basic training in applying tools for mapping, analysis and designing processes 4. **Product development processes:** Theory and practice on product development processes in technology companies. Commercialising technology. Market drivers. Time to market. Focusing technology. Concerns. 5. **Business planning:** Working in teams (companies), students will set up a technology company and make decisions on investment, R&D funding, operations, marketing and sales strategy.			
15	Teaching and learning	The module uses a combination of lectures, case discussions, selected paper readings, and an accompanying textbook. Some parts of the teaching may be through online lectures.In the team project, a technical and financial report will be presented for the manufacture of a product or provision of a technical service.			
16	Assessment and moderation	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

MEng (Chemical Engineering) Module descriptors

Faculty	Engineering and the Built Environment		**Department**	Chemical Engineering	
1	**Module title**	**Process Optimization**	**2** **6**	**Module code**	TBC
5	**HEQSF level**	9	**6**	**HEQSF Credits**	16
7	**Annual/semester**	Semester	**8**	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	**10**	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This module covers the principles and application of optimization in the chemical industry. It will develop a students' ability to analyze a real-world problem and develop a mathematical formulation that is amenable to a solution using appropriate mathematical techniques and algorithms. The module contents include unconstrained optimization, linear programming, nonlinear programming with constraints, and mixed-integer optimization.			
12	**Learning outcomes**	Outcomes of Instruction • Apply chemical engineering principles to formulate optimization problems in the chemical/process industry. • Analyse, Select and apply the appropriate solution method/algorithm such as LP, MINLP and NLP. • Understand advanced optimization techniques like Genetic algorithms			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Assess the impact of engineering solutions in a global, economic, environmental and societal context. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• Basic concepts of optimization; • Optimization of unconstrained functions, Newton and Quasi-Newton Methods; • Unconstrained multivariable optimization, Simplex search, Grid search, Random search • Linear programming, Simplex and Barrier methods • Nonlinear Programming, Quadratic and Lagrangian methods • Mixed-Integer Programming, Branch-and Bounds method			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

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Faculty	Engineering and the Built Environment		Department	Chemical Engineering	
1	Module title	Process Synthesis and Process Integration	2 6	Module code	TBC
5	HEQSF level	9	6	HEQSF Credits	16
7	Annual/semester	Semester	8	Compulsory or elective	Compulsory
9	Total notional hours	160	10	Contact hours	48
11	Purpose of this module in relation to the programme/s	This module aims to introduce a wide range of principles and methods of sustainable development applicable for new and retrofit process design. It will introduce methods of systematic process synthesis and process integration tools for the synthesis, development, and screening of potential processing flowsheets. The module will reinforce the hierarchy of process synthesis and design strategy for: reactor network design; separation system selection and design, and the design of heat exchanger networks. With emphasis on environmentally-benign and inherently-safe designs.			
12	Learning outcomes	Outcomes of Instruction • Apply heuristics and systematic methods for process synthesis of: Reaction, mixing and recycle, separation, temperature – pressure - phase change systems. • Apply algorithmic methods for process synthesis of: reactor network synthesis, synthesis of separation trains and sequencing of mass exchange processes. • Apply graphical and mathematical techniques for synthesis of mass and heat integration networks that match specified process constraints and objectives and choose the best solution from the generated alternatives.			
13	Graduate attributes developed and/or assessed in this module	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	Module content	• Introduction to Process Design approaches:1. Process synthesis 2. Process analysis and simulation 3. Detailed equipment design 4. Process integration 5. Process optimization. • Philosophy and overview of process synthesis • Reactor network synthesis: mathematical and graphical techniques to determine optimal reactor types, sizes, and arrangements which will optimise a specific objective function. • Mass Integration: Detailed design and costing of stagewise and continuous mass exchange equipment 2. Thermodynamic, design, and economic-optimization aspects of mass exchange operations 3. Screening of candidate separation processes using mass pinch analysis 4. Tradeoffs between fixed and operating costs 5. Targeting of process performance 6. Allocation, segregation, mixing, and direct reuse/recycle 7. Stream interception 8. Visualization tools 9. Algebraic techniques 10. Pollution prevention IV. • Energy Integration: 1. Detailed design and costing of heat exchangers and energy conversion equipment 2. Global flow of energy in a process 3. Thermal pinch analysis 4. Optimization of heating and cooling utilities as well as combined heat and power.			
15	Teaching and learning	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution.			
16	Assessment and moderation	The assessment for this module will be a combination of mini-projects / case studies.			

<table>
<tr><td colspan="2">Faculty</td><td>Engineering and the Built Environment</td><td colspan="2">Department</td><td>Chemical Engineering</td></tr>
<tr><td>1</td><td>Module title</td><td>Chemical Process Design</td><td>26</td><td>Module code</td><td>TBC</td></tr>
<tr><td>5</td><td>HEQSF level</td><td>9</td><td>6</td><td>HEQSF Credits</td><td>16</td></tr>
<tr><td>7</td><td>Annual/semester</td><td>Semester</td><td>8</td><td>Compulsory or elective</td><td>Compulsory</td></tr>
<tr><td>9</td><td>Total notional hours</td><td>160</td><td>10</td><td>Contact hours</td><td>48</td></tr>
<tr><td>11</td><td>Purpose of this module in relation to the programme/s</td><td colspan="4">This module focuses on the systematic methods of “conceptual design and “process systems design” for the analysis and the design of complex chemical processes. This module comprises a sequence of learning opportunities designed to integrate and consolidate most of the fundamental science and engineering knowledge acquired in earlier modules and during the previous levels of the degree programmes.The module develops and tests the students' ability to complete the design of a process plant with particular emphasis on sustainability, economic and operational feasibility, engineering practicality and inherently-safe process plant design.</td></tr>
<tr><td>12</td><td>Learning outcomes</td><td colspan="4">Outcomes of Instruction
1. Analyse the factors involved in completing the mass and energy balances of a complex chemical production process with multiple internal recycles, the principles of plant start-up/shutdown, layout and the health and sustainability considerations inherent to the design process.
2. Analyse the interactions between process requirements and practical equipment design and convert the design brief into a feasible process design.
3. Collect/generate the physical property data necessary to for design making appropriate judgements to reconcile conflicts.
4. Identify and analyse the fundamental chemical and physical phenomena associated with the complex pieces of equipment being designed and propose a logical procedure for the design of equipment,
5. Effectively use the procedure to design with appropriate iterations/optimisation and to generate the necessary equipment data sheets including the selection of the materials of construction and the methods of fabrication and testing.
6. Use contemporary tools for advanced model-based process design
7. Estimate the capital cost, and assesses the sustainability of the process designed.
8. Communicate the design process in written and oral formats</td></tr>
<tr><td>13</td><td>Graduate attributes developed and/or assessed in this module</td><td colspan="4">Student Outcomes Addressed by the Course
• Ability to apply knowledge of mathematics, science, and engineering science.
• Ability to identify, formulate and solve engineering problems.
• Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td></tr>
<tr><td>14</td><td>Module content</td><td colspan="4">The previous knowledge of heat, mass and reaction processes taught in the undergraduate curriculum will be recapped, integrated and expanded. Many aspects of doing an industrial project design will be practiced. Such as:
• Systematic process design starting from "process overall" to conceptual design, Index Flowsheet and Process Flow Diagram (PFD) level;
• Phasing and project organization, how to handle alternatives selection and evaluation of processes and technologies;
• Functional analysis of existing processes and how to create concepts for improved designs;
• Basics of heat exchanger selection and heat integration (pinch technology);
• Equipment selection and design (down to basic dimensions needed for costing);
• Fundamentals and application of process safety and process control
• Process economics for economic evaluation;
• Generation and evaluation of process alternatives on environmental; technical and economic feasibility;
• Simulation of the investigated process using Process simulation tools, for instance software like Chemcad;</td></tr>
<tr><td>15</td><td>Teaching and learning</td><td colspan="4">The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, and industrial applications. Students will analyze a real industrial problem and formulate a complete design of a process plant with</td></tr>
</table>

		particular emphasis on sustainability, economic and operational feasibility, engineering practicality and inherently-safe process plant design.
16	**Assessment and moderation**	The assessment for this module may be a combination of the final report, presentations and finally the participation in the lectures and workshops.

Faculty	Engineering and the Built Environment		Department	Chemical Engineering	
1	**Module title**	**Applied Reaction Engineering**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This module focuses on the processes of heat and mass transfer with chemical reaction in *multiphase* reaction systems (gas-liquid, gas-solid, gas-liquid-solid etc.), including the effects of non-ideal residence time distributions. The objective is to be able to derive the reactor models and determine the performance of multiphase chemical reactors. These can be implemented in a reactor model to be able to calculate reactant conversion, selectivity and product yield, accounting for the effects of residence time distribution, mass transfer in combination with homogeneous or heterogeneous reaction kinetics, equilibria and heat effects.			
12	**Learning outcomes**	Outcomes of Instruction • Using fundamental mass and energy balances, mass and heat transfer in combination with (homogeneous and heterogeneous) reactions to derive reaction kinetic models. • Calculate reactor performance where reaction rate is significantly influenced by internal mass transfer and temperature distribution in heterogeneous catalytic systems • Analyse, Select and apply the appropriate solution method/algorithm to solve Non-ideal flow in reactors; RTD, Estimation of dispersion/back-mixing, dispersed plug flow and tanks in series model, design aspects of reactors with non-ideal flow, micro and macro mixing in reactors • Design multiphase reactors			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• **Kinetics Of Heterogeneous Reactions:** Catalytic Reactions, Rate controlling steps**,** Langmuir - Hinshelwood model, Rideal - Eiley Mechanism, Steady State approximation, Noncatalytic fluid - solid reactions, Shrinking and unreacted core model. • **Population Balance Models:** Mixing concepts, Residence Time Distribution, Response measurements, Segregated flow model, Dispersion model, Series of stirred tanks model, Recycle reactor model, Analysis of non-ideal reactors. • **External and Internal Transport Diffusional Processes In Heterogeneous Reactions:** Intra pellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction. Mass and heat Transfer coefficients in packed beds, Quantitative treatment of external transport effects, Modeling diffusion with and without reaction. • **Design Of Heterogeneous Catalytic Reactors:** Isothermal and adiabatic fixed bed reactors, Non-isothermal and non-adiabatic fixed bed reactors. Introduction to multiphase reactor design, Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model. • **Introduction to multiphase reactor design:** Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model. Photocatalytic reactors.			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution.			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

Faculty	Engineering and the Built Environment		**Department**	Chemical Engineering	
1	**Module title**	**Advanced Separation Systems**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This module focuses on the selection of separation technology for given molecular and thermodynamic properties, and the subsequent molecular design of more advanced separation technologies including: membrane systems; pervaporation, crystallization, adsorption, etc.			
12	**Learning outcomes**	Outcomes of Instruction • Describe the working principles, molecular basis of relevant industrial (advanced) separations and their role within industrial processes. • Make a motivated decision for a separation technology based on the molecular properties of the molecules to be separated. • Analyze a separation technology related case, asses the technical feasibility of different separation technologies, and develop a separation process. • Calculate the relevant thermodynamic and mass transfer properties for separation processes. • Be able to design a functional process for a given molecular separation.			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• **Introduction:** Reveiw of conventional processes, Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid - liquid separations involving a second liquid. • **Membrane Separation:** Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fiber membrane reactors and their relative merits, Commercial, pilot plant and laboratory membranes permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and dialysis, Economics of membrane operations, Ceramic membranes. • **Separation By Adsorption Techniques:** Mechanism, Types and choice of adsorbents, Normal adsorption techniques, Affinity chromatography and immune chromatography. Types of equipment and commercial processes, Recent advances and process economics. • **Ionic Separations:** Controlling factors, Applications, Types of equipment employed for electrophoresis, Di-electrophoresis, Ion exchange chromatography and electro dialysis, Commercial Processes. • **Other Techniques:** Separations involving Prevaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Adductive crystallization, Supercritical fluid extraction.			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution.			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

Faculty	Engineering and the Built Environment		**Department**	Chemical Engineering	
1	**Module title**	**Biofuels and Bio-refining Processes**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	The aim of the module is to provide students with advanced knowledge of the sources of biomass available for liquid biofuels production and the range of technologies used for conversion of the biomass into biofuels. The module focuses on liquid biofuels as a current opportunity to decrease greenhouse gasses emissions when used to replace fossil fuels, and as a route to fulfil the sustainable goals on the use of renewable energy. The module covers characteristics of biomass and biofuels, conversion processes and existing technologies, and applications of biofuels including their use in alternative engines. In addition, an introduction to the Bio-refining concept will be provided.			
12	**Learning outcomes**	Outcomes of Instruction • Critically evaluate a range of biomass resources and technologies available for liquid biofuels production from biomass and analyse the potential for future reduction in costs through technological development; • Explain the main theoretical concepts and practical implementation associated to biofuels engineering systems; • Identify the high-value products that can be obtained from biomass feedstock, and construct simple bio-refining schemes and critically evaluate the potential of bio-refining processes**.**			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	1. **Raw materials for liquid biofuels production, characterization and assessment:** Biofuel feedstocks and characteristics: starch- and sugar-derived biomass, oleaginous-based biomass, lignocellulosic biomass, and algae. Sugar, Fatty acid, and Syngas platforms technologies 2. **First generation of biofuels:** **Bioethanol and ETBE production:** Enzymes for fermentation. Microbial modelling of bioethanol: microbial growth models, kinetic rare expression, temperature effects. Bioreactor operation and design for bioethanol production **Biodiesel production**: Biodiesel production technologies: biochemical, and catalytic and non-catalytic chemical processes. Biodiesel production: biochemical aspects. Biodiesel production: chemistry and thermodynamic aspects. 3. **Second generation of biofuels:** Thermochemical routes: Biomass-to-Liquids. Biochemical routes: Hydrolysis processes. Hydrothermal Liquefaction and gasification 4. **Bio-refining** and **High-value products from biomass feedstock:** Classification of Bio-refineries. Main products and Current and prospective markets			
15	Teaching and learning	The module uses a combination of lectures, case discussions and selected paper readings, to present up to date technologies for biomass processing combined with problem solving sessions giving opportunity for group work and discussion. The topics will be addressed on process level by calculating the key parameters for specific biomass conversion technologies and identifying associated bio-refinery processes to enable maximal utilisation of biomass potential			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

Faculty	Engineering and the Built Environment		**Department**	Chemical Engineering	
1	**Module title**	**Computational Fluid Dynamics**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This module focuses on the capabilities and limitations of CFD in the context of chemical engineering, develop a modelling approach for fluid flow, mass transport and heat transfer, and apply it successfully as a tool to solve problems in process design and development.			
12	**Learning outcomes**	Outcomes of Instruction • Describe and explain methodology and formulation of finite volume method and apply it to fluid flow, mass and heat transport and heat transfer applications. • Define the scope and objectives of a CFD project, and develop a modelling approach to achieve the objectives, balancing accuracy and cost of analysis • Demonstrate an ability to build, solve, refine and develop CFD models to simulate chemical engineering processes using modern CFD software, enhancing model fidelity, identify and address sources of error • Critically evaluate, interpret, and present modelling results, extracting relevant data from the results to inform process design and development.			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• **Introduction to Fluid Dynamics:** Concepts of Fluid Flow, Pressure distribution in fluids, Reynolds transport theorem, Integral form of conservation equations, Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations, Properties of supersonic and subsonic flows, Flow characteristics over various bodies. • **Introduction to CFD**: Philosophy of CFD, Governing equations of fluid dynamics and there physical meaning, Mathematical behaviour of governing equations and the impact on CFD simulations, Simple CFD techniques and CFL condition. • **Geometric Modeling and CAD Repairing:** Geometric transformations, Parametric representation of curves and surfaces, Concept of topology, Surface modeling, Faceted models, Solid modeling. Creation of water tight geometry, Faceted Boolean operations, Dependent and independent CAD errors. • **Structured and Unstructured Grid Generation**: Basic theory of structured grid generation, Surface grid generation and Volume grid generation. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination • **Numerical Methods in CFD:** Finite Difference, Finite Volume, and Finite Element, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Study and transient solutions. • **Introduction to Turbulence Modeling**: Introduction and background, Algebraic models, One equation models, Two equation models, Near wall treatment, Reynolds stress models, Eddy viscosity models (EVM), Nonlinear eddy viscosity models, LES, RANS, and, hybrids, Direct numerical simulation (DNS) • **Introduction to Multiphase Modeling**: Fundamentals of multiphase flows, Eulerian-Lagrangian (ELAG) approach, Eulerian-Eulerian (E2P) approach, Volume Of Fraction (VOF) approach. • **Chemical Fluid Mixing Simulation**: Stirred tank modeling using the actual impeller geometry, Rotating frame model, The MRF Model Sliding mesh model, Snapshot model, Evaluating Mixing from Flow Field Results, Industrial Examples • **Post-Processing of CFD results**: Contour plots, vector plots, and scatter plots, Shaded and transparent surfaces, Particle trajectories and path line trajectories, Animations and movies, Exploration and analysis of data.			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using commercial software, and interpret the solution.			
16	**Assessment and**	The assessment for this module may be a combination of test, assignments and mini-			

	moderation	projects / case studies.

MEng (Mechanical Engineering) Module descriptors

Faculty	Engineering and the Built Environment		**Department**	Chemical Engineering	
1	**Module title**	**Advanced Strength of Materials**	**2 6**	**Module code**	TBC
5	**HEQSF level**	9	**6**	**HEQSF Credits**	16
7	**Annual/semester**	Semester	**8**	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	**10**	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This module covers the main topics of advanced strength of materials, theory of elasticity and the pertinent numerical methods. It will develop a students' ability to analyse real-world engineering problems using both analytical and numerical techniques. The model contents include analysis of stress and strain, analysis of various structural elements and simple structures, understanding of fatigue and creep as well as finite-element analysis.			
12	**Learning outcomes**	Outcomes of Instruction • To introduce students to new advanced topics of mechanics of materials and develop a deeper understanding of already learned topics. • To demonstrate why is vital for modern engineers to have understanding and profound knowledge of these topics, methods and techniques. • Ability to apply both analytical and numerical analysis to real-world problems in various fields of mechanical engineering and related fields. • Ability to work in a team (enhanced team and interpersonal skills). • Improved communications skills through report writing and oral presentations.			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• Theory of stress and strain. • Inelastic behaviour. • Application of energy methods. • Beams on elastic foundation. • Elastic and inelastic stability of columns. • Plates and simple shells. • Contact stresses. • Elastic vibrations. • Fracture mechanics and fatigue. • Time dependant deformations (creep). • Advanced finite element analysis.			
15	Teaching and learning	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, and FEA analysis of industrial type problems.			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

Faculty	Engineering and the Built Environment		Department	Mechanical Engineering	
1	Module title	Design Optimisation for Additive manufacturing	2 6	Module code	TBC
5	HEQSF level	9	6	HEQSF Credits	16
7	Annual/semester	Semester	8	Compulsory or elective	Compulsory
9	Total notional hours	160	10	Contact hours	48
11	Purpose of this module in relation to the programme/s	This module will provide an overview of additive manufacturing and the role of additive manufacturing in product development. It will develop a students' ability to analyse a real-world problems and develop appropriate design solutions using the optimisation tools and techniques provided.			
12	Learning outcomes	• Demonstrate knowledge and understanding of the scientific principles of additive manufacturing • Analyse a component and select and apply the appropriate optimisation method to generate multiple proposed solutions • Evaluate the strengths and weaknesses of the proposed design and justify the final selection • Present the design solution to both technical and non-technical audiences			
13	Graduate attributes developed and/or assessed in this module	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. • Ability to perform creative, procedural and non-procedural design and synthesis of components. • Demonstrate an ability to use the resources, professional and occupational dismodules to communicate and defend substantial ideas that are products component development in advanced manufacturing. • Communicate to a range of audiences with different levels of knowledge or expertise.			
14	Module content	Design optimisation for additive manufacturing (AM) • Overview of AM Technologies including polymer and metal printing processes and the associated manufacturing constraints • Finite Element Analysis as applied to AM • Optimisation including topology optimisation concepts, objectives and constraints • Multi-scale methods for modelling the effects of AM • Lattice structure design • Buckling optimisation • Stiffness versus strength considerations • Commercial optimisation software including utilisation of a commercial software package • Component design project			
15	Teaching and learning	The module uses a combination of lectures, computer labs, selected paper readings, case studies and AM modelling project. In the project, students will analyse a real industrial problem, and using optimisation techniques justify their design solution			
16	Assessment and moderation	The assessment for this module may be a combination of test, assignments, case studies and projects. The design project will require two distinct reports/presentations, one for technical audiences and one for non-technical audiences			

Faculty	Engineering and the Built Environment	**Department**	Mechanical Engineering
1 Module title	**Advanced Fluid Dynamics**	**2 6 Module code**	TBC
5 HEQSF level	9	**6 HEQSF Credits**	16
7 Annual/semester	Semester	**8 Compulsory or elective**	Compulsory
9 Total notional hours	160	**10 Contact hours**	48
11 Purpose of this module in relation to the programme/s	This module covers the principles and application of computation fluid dynamics. It will develop a students' ability to analyse a real-world problem and develop a computational formulation that is amenable to a solution using appropriate algebraic equations and systems of equations.		
12 Learning outcomes	• Demonstrate a critical awareness of the governing equations of fluid mechanics in various formulations • Apply the principles of numerical analysis and concepts of stability, approximation and convergence • Analyse, select and apply the appropriate solution principle /method such as finite difference/volume/element and functional decomposition. • Evaluate, and contrast, both experimental data and that obtained from CFD simulations.		
13 Graduate attributes developed and/or assessed in this module	Student Outcomes Addressed by the Course • Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.		
14 Module content	• Governing equations of fluid flow • Discretization of governing equations • Numerical methods for incompressible and compressible flow • Grid generation • Boundary conditions and constraints • Simulation/analysis of a turbulent flow problem using a CFD package		
15 Teaching and learning	The module uses a combination of lectures, computer labs, selected paper readings, an accompanying textbook, and a CFD modelling project. In the project, students will analyse a real industrial problem, formulate a model, collect data, solve the problem using a commercial CFD package		
16 Assessment and moderation	The assessment for this module may be a combination of test, assignments and projects.		

MEng (Industrial engineering) Module descriptors

Faculty	Engineering and the Built Environment			Department	Industrial Engineering
1	**Module title**	**Global supply chain design**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This module is designed to develop the skills for practical problem-solving approach to complex areas of supply chain. It guides through and helps explore and learn various themes of global supply chains along with practical implementation. This course will enable participants to obtain good hands on experience with exposure to different learning tools used in the SC domain. The course objective is to enhance problem-solving ability of SC practitioners in complex, uncertain dynamic global marketplace.			
12	**Learning outcomes**	To achieve success in this module the students need to demonstrate the following: 1. Apply technical and communication skills to design, evaluate, implement, analyse, theorise about developments that contribute to high levels of supply chain performance outcomes; 2. Plan and execute a substantial research-based project, capstone experience and/or piece of scholarship (in the domain of supply chain analysis and management); 3. Demonstrate and use cognitive, technical and creative skills to generate and evaluate complex supply chains at an abstract and at a practical level; 4. Effectively investigate SCM problems and opportunities, using communication and technical research skills to justify and interpret theoretical propositions, methodologies, conclusions and professional decisions to specialist and non-specialist audiences; 5. Effectively apply knowledge of research principles and methods of supply chain analysis and business decision analysis; 6. Use cognitive, technical and creative skills to investigate, analyse and synthesise complex information, problems, concepts and theories and to apply theories of SCM to different contextual problems in supply chains and their business applications;			
13	**Graduate attributes developed and/or assessed in this module**	Graduate attributes as per ECSA elo's 1. Application of scientific and engineering knowledge 2. Engineering design 3. Sustainability and the impact of engineering activity 4. Individual, team and multidisciplinary working			
14	**Module content**	Introduction – issues to consider Conceptual frameworks for Global supply chains Modelling and decision support for global supply chain design Importance and implications of Global factors on Network design Classification scheme			
15	**Teaching and learning**	The module uses a combination of lectures, computer labs, selected paper readings, an accompanying textbook,			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and projects.			

Faculty	Engineering and the Built Environment		**Department**	Industrial Engineering	
1	**Module title**	**Enterprise engineering**	**2 6**	**Module code**	TBC
5	**HEQSF level**	9	**6**	**HEQSF Credits**	16
7	**Annual/semester**	Semester	**8**	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	**10**	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	Enterprise engineering is a discipline that views the enterprise as a complex system that can be purposefully designed or re-designed. It applies systems theory and engineering techniques to the specification, analysis, design, re-design or improvement, and implementation of an enterprise for its life cycle. It is a multi-disciplinary approach that "takes a broad perspective in synthesizing technical and non-technical aspects of enterprise capability". Innovation also an important driver for enterprise design /re-design, and therefore the management or enablement of innovation is therefore a key focus.			
12	**Learning outcomes**	To achieve success in this module the students need to demonstrate the following: • Recognise and analyse the significant similarities and differences between Systems Engineering, System-of-Systems Engineering, and Enterprise Engineering. • Develop critical thinking skills in the area of Enterprise Engineering by critiquing research and recommending approaches to improve or correct the research. • Adapt existing Systems Engineering techniques applying critical thinking skills to develop new System-of-System approaches to solve Enterprise Engineering problems. • Construct an Enterprise Systems Engineering model applying critical thinking skills to support the evolution of a complex enterprise system. • Use Enterprise Systems Engineering appropriate critical thinking skills to judge an Enterprise Systems Engineering model's ability to address challenges unique to complex enterprise systems.			
13	**Graduate attributes developed and/or assessed in this module**	aduate attributes as per the ECSA elo'S: 1. Problem Solving 2. Engineering methods, skills and tools, including information technology			
14	**Module content**	1. The module covers: 2. Background on systems thinking 3. Systems design and systems engineering 4. Prominent approaches for creating an enterprise engineering capability (e.g. Zachman, The Open Group, Dietz/Hoogervorst). 5. Mechanisms and practices associated with different phases of enterprise design (e.g. enterprise modelling, languages, road maps, maturity assessment etc.) 6. Research methods and techniques to validate and extend the EE knowledge base 7. Case studies 8. Change management discipline.			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyse a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

Faculty	Engineering and the Built Environment		Department	Industrial Engineering	
1	Module title	Human-machine interface engineering	2 6	Module code	TBC
5	HEQSF level	9	6	HEQSF Credits	16
7	Annual/semester	Semester	8	Compulsory or elective	Compulsory
9	Total notional hours	160	10	Contact hours	48
11	Purpose of this module in relation to the programme/s	The human-machine interface (HMI) is the hardware and software that allows a human to interact with a machine or any other automated device. The effective design of this interface can significantly influence the ergonomics, and as such, the efficiency of the human operator and the system as a whole. Automation and computer integration of production processes results in a work environment where the human workers constantly interact with hardware and software. The task of the industrial engineering professional is to ensure the optimal design of the human-machine interfaces of the hardware and software chosen and/or developed for the relevant processes. To ensure that the specification, selection and development of any human-machine interface is optimal, the industrial engineering professional need to be proficient in the underlying philosophies, principles and methodologies of optimal human-machine interface design. The purpose of this subject is to equip the student with the necessary knowledge and skill to ensure optimal human-machine interface design. Firstly, through educating the student in the underlying philosophies, principles and methodologies of optimal human-machine interface design, and secondly, through the application of this knowledge to real world design problems.			
12	Learning outcomes	To achieve success in this module the students need to demonstrate the following: 1. Concept Understanding: students will be able to determine the relationships between specific instances and broader generalizations. 2. Directed Application: students will be able to use concepts and principles to explain, analyse and solve specific situations, often with the applicable concepts implicit in the setting. 3. Realistic Problem Solving: students will be able to apply course content in coping with real life situations. These differ from directed applications by having less structured questions and issues, no direction as to which concepts will be applicable and a range of potentially acceptable answers. For example, students can design an interface for real tasks and evaluate/defend their choices.			
13	Graduate attributes developed and/or assessed in this module	Graduate attributes as per the ECSA elo'S: 1. Application of scientific and engineering knowledge 2. Engineering methods, skills and tools, including information technology			
14	Module content	Indicative content for this module: 1. Introduction to HMI. Natural communication, multimodality, types of human-machine interfaces. 2. Human perception and recognition. Psychology of users, attention, thinking, perception of visual, sound and haptic incitements. 3. Concept of combined reality and virtual reality technologies. 4. Sensing and tracking. Sensors for sensing of fingers, hands and touching. Interactive digital surfaces, manipulation of digital objects, displays with rear projection. 5. Multimodal speech interface. Basics of multimodal dialog systems. Speech synthesis. 6. Speech recognition. 7. Interface based on gestures. Sensing of movement, controlling by movement. 8. Sound interaction and acoustics. 9. Psychoacoustics. Analysis and synthesis of sound. 10. Haptic interfaces. Haptic perception and recognition.			

		11. Interfaces for visual and hearing-impaired people. Brain-computer interface. Medical applications, special sensors. 12. Questions and problems in combining different modalities. Simultaneous and alternative use of modalities, influence of environment, task type and user.
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, and accompanying textbooks, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyse a real industrial HMI problem, formulate a model, collect data, solve the problem using the appropriate techniques, prepare a technical specification, develop a design and then test the effectiveness of their design.
16	**Assessment and moderation**	The assessment for this module is a combination of tests, assignments and a design project.

Faculty		Engineering and the Built Environment	**Department**		Industrial Engineering
1	**Module title**	**Design and analysis applications**	**2 6**	**Module code**	TBC
5	**HEQSF level**	9	**6**	**HEQSF Credits**	16
7	**Annual/semester**	Semester	**8**	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	**10**	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This course deals with the concepts and techniques used in the design and analysis of experiments. The concepts and different models of an experimental design will be studied, leading to their statistical analysis based on linear models and appropriate graphical methods.			
12	**Learning outcomes**	To achieve success in this module the student need to demonstrate the following: 1. Critically review basic concepts and models of experimental design. 2. Analyse the results of a designed experiment in order to conduct the appropriate statistical analysis of the data. 3. Interpret statistical results from an experiment and report them in non-technical language.			
13	**Graduate attributes developed and/or assessed in this module**	Graduate attributes as per ECSA elo'a 1. Problem solving 2. Engineering design 3. Sustainability and the impact of engineering activity			
14	**Module content**	1. Basic Statistical Concepts 2. Introduction to Factorial Designs 3. The 2k Factorial Design 4. Blocking and Confounding in the 2k Factorial Design 5. Two-Level Fractional Factorial Designs 6. Additional Design and Analysis Topics for Factorial and Fractional Factorial Designs 7. Fitting Regression Models 8. Response Surface Methods and Designs 9. Robust Parameter Design and Process Robustness Studies 10. Experiments with Random Factors 11. Nested and Split-Plot Designs 12. Other Design and Analysis Topics			
15	**Teaching and learning**	The module uses a combination of lectures, computer labs, selected paper readings, an accompanying textbook and a project in design and analysis			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments, case studies and projects.			

Faculty	Engineering and the Built Environment		**Department**	Industrial Engineering	
1	**Module title**	**IT Design and applications**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This course is designed to enable students to achieve a comprehensive and greater understanding of information technology in specialized technical or management areas.			
12	**Learning outcomes**	To achieve success in this module the students need to demonstrate the following: 1. Analyze users' needs, then design, test and develop software to meet those needs 2. Recommend software upgrades for customers' existing programs and systems 3. Design each piece of the application or system and plan how the pieces will work together 4. Create a variety of models and diagrams (such as flowcharts) that instruct programmers how to write the software code 5. Ensure that the software continues to function normally through software maintenance and testing 6. Document every aspect of the application or system as a reference for future maintenance and upgrades			
13	**Graduate attributes developed and/or assessed in this module**	Graduate attributes as per ECSA elo's 4. Engineering methods, skills and tools, including information technology 5. Engineering Management			
14	**Module content**	1. Software technology: The Future Now 2. Software : Tools for Productivity & Creativity 3. The Era of big data: Databases, Information Systems, & Artificial Intelligence 4. Building systems and applications: Software Development, Programming, & Languages			
15	Teaching and learning	The module uses a combination of lectures, computer labs, selected paper readings, an accompanying textbook and a project in design and analysis			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments, case studies and projects.			

Faculty	Engineering and the Built Environment		Department	Industrial Engineering	
1	**Module title**	**Quality and Reliability Engineering**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	Quality and reliability engineering provides the theoretical and practical methodologies to improve the capability of systems to perform their designated functionalities, to predict the probability of their functioning without failures in certain environments for desired periods, to assess their maintainability, availability and safety based on sampled data, and to make decisions on corrective and mitigation actions. Quality & Reliability Engineering module prepare students with formal training for career opportunities in quality and reliability engineering involved in product development, engineering design, manufacturing process control, and service realization. This module specialty focus on design of experiment, statistical process control and reliability engineering, which can be deployed in a wide range of industrial and business settings. Students formally trained can also independently develop novel solutions to problems that are unique to specific environment			
12	**Learning outcomes**	To achieve success in this module the students need to demonstrate the following: 1. Apply statistical methods and analysis to quality and productivity design and improvement, such as constructing control charts to assess system performance 2. Use contemporary methods of reliability engineering to analyse system 3. Design and use a reliability model to calculate figures of merit for various design “what-ifs” and hypothetical manufacturing and use specifications. 4. Use Monte-Carlo simulation to model complicated real-world scenarios, which are intractable by classical statistical methods.			
13	**Graduate attributes developed and/or assessed in this module**	Graduate attributes as per ECSA elo’s 5. Problem Solving 6. Research, investigations, experiments and data analysis 7. Sustainability and the impact of engineering activity			
14	**Module content**	Introduction to probabilistic distributions, computation of system reliability, building reliability models and optimisation of system reliability; Fault Tree Analysis; Failure Modes, Effects and Criticality Analysis (FMECA), Monte Carlo Simulation; probability-based design			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyse a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

Faculty	Engineering and the Built Environment		Department	Industrial Engineering	
1	**Module title**	**IT Design and applications**	2 6	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	This course is designed to enable students to achieve a comprehensive and greater understanding of information technology in specialized technical or management areas.			
12	**Learning outcomes**	To achieve success in this module the students need to demonstrate the following: 7. Analyze users' needs, then design, test and develop software to meet those needs 8. Recommend software upgrades for customers' existing programs and systems 9. Design each piece of the application or system and plan how the pieces will work together 10. Create a variety of models and diagrams (such as flowcharts) that instruct programmers how to write the software code 11. Ensure that the software continues to function normally through software maintenance and testing 12. Document every aspect of the application or system as a reference for future maintenance and upgrades			
13	**Graduate attributes developed and/or assessed in this module**	Graduate attributes as per ECSA elo's 6. Engineering methods, skills and tools, including information technology 7. Engineering Management			
14	**Module content**	5. Software technology: The Future Now 6. Software : Tools for Productivity & Creativity 7. The Era of big data: Databases, Information Systems, & Artificial Intelligence 8. Building systems and applications: Software Development, Programming, & Languages			
15	Teaching and learning	The module uses a combination of lectures, computer labs, selected paper readings, an accompanying textbook and a project in design and analysis			
16	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments, case studies and projects.			

MENG (Electrical Engineering) Module Descriptors

Faculty	Engineering and the Built Environment		**Department**	Electronic Engineering	
1	**Module title**	**Cyber-Physical Systems**	2	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	The course introduces model-based design and analysis of cyber-physical systems. It introduces key concepts in several topics/areas, including vector calculus and differential equations, physical modelling (with focus on mechanical and electrical systems), control theory (error, feedback, stability), hybrid systems (automata and hybrid automata), modelling computational systems (quantization, discretization, delays), game theory, and communication (channel error, delay, and bandwidth).			
12	**Learning outcomes**	Specific Outcomes of Instruction • Recognize the scope and scale of the potential impact of CPS innovation. • Understand why many of tomorrow’s innovations will be in CPS. • Develop lifelong, sustainable skills and sensibilities for the analysis and design of innovative cyber-physical systems, including back-of-the-envelope estimation, familiarity with the fundamental sources of complexity in CPS design (such as system size, nature of continuous dynamics, discrete state size, different types of uncertainty), and facility with virtual experimentation. • Gain experience with the mathematical modelling and simulation of hybrid systems and the issues that arise when building and validating of such models. • Assimilate a conceptual model of the CPS development process and master the terminology and communication skills required to reflect on, analyse, and critique development processes. • Develop an awareness of the different aspects of CPS, including scientific, engineering, and social aspects. • Use tools for simulation of hybrid differential models • Create hybrid differential models of cyber-physical systems • Model and control a variety of physical components and systems			
13	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Ability to use a wide range of specialist skills to identify, conceptualise, design and implement methods of enquiry to solve complex and challenging engineering problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialised context. • Ability to apply specialist knowledge of mathematics, natural science and engineering sciences to solve complex engineering problems, conceptualize models and enable engagement with and critique of current and emerging research and practices. • Ability to perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes, demonstrate the ability to propose interventions at an appropriate level within a system based on an understanding of interdependent relations and address intended and unintended consequences of interventions. • Demonstrate competence to conduct research, execute detailed technical investigations, implement strategies for the processing and management of information, including the review of current advances in the field, to produce new insights and solve complex engineering problems • Demonstrate competence to develop, select and apply appropriate and creative techniques, resources, and modern engineering tools, including information technology, prediction and modelling, for the solution of complex engineering problems, with an understanding of the limitations, restrictions, premises, assumptions and constraints. • Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment. • Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.			

		• Demonstrate the ability to develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.
14	**Module content**	• What is a Cyber-Physical System: examples and characteristics of cyber-physical systems (CPS); how CPS brings together several previously distinct fields such as embedded systems, control theory, and mechatronics. • Modelling Physical Systems: principles for modelling physical systems; differential equations, with a focus on ODE IVPs; prototypes for different classes of ODEs; systems of equations; vector calculus; ohmic and linear circuits; one-, two- and three-dimensional mechanical systems (statics and dynamics); and resistive and linear electric circuits. • Hybrid Systems: hybrid automata; discrete events; zero crossing and decidability; mode switching and its effect on derivatives; discrete transitions; and Zeno behaviour. • Control Theory: error, feedback (negative and positive), and stability; static (time-invariant) systems (op amp) and in dynamic (time-varying) systems; PID controller design; finite representations of values (N bits to represent values) and time (being able only to sample and actuate clock ticks). • Modelling Computational Systems: sense-compute-actuate modelling of implementing controllers; physical aspects of implementing computation, both for analogue computers and digital computers; quantization (and quantization levels); discretization (and sampling); the Nyquist-Shannon Theorem; embedded hardware and software; and real-time systems and constraints. • Game Theory: introduces basic concepts from game theory, such as the notions of autonomous choice, utility, rationality, and intelligence.
15	Teaching and learning	The module uses a combination lectures (face-to-face and distance), blended learning tools, case discussions, selected readings and hands-on projects. The student will learn to use the appropriate scientific and mathematical techniques applied to CPS. In the individual and group research projects, students will use real-world data to analyse, design, simulate and report on a CPS.
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, tutorials, assignments and/or mini-projects / case studies.

<table>
<tr><td>Faculty</td><td colspan="2">Engineering and the Built Environment</td><td colspan="2">Department</td><td>Electronic Engineering</td></tr>
<tr><td>1</td><td>Module title</td><td>Autonomous Systems</td><td>2</td><td>Module code</td><td>TBC</td></tr>
<tr><td>5</td><td>HEQSF level</td><td>9</td><td>6</td><td>HEQSF Credits</td><td>16</td></tr>
<tr><td>7</td><td>Annual/semester</td><td>Semester</td><td>8</td><td>Compulsory or elective</td><td>Compulsory</td></tr>
<tr><td>9</td><td>Total notional hours</td><td>160</td><td>10</td><td>Contact hours</td><td>48</td></tr>
<tr><td>11</td><td>Purpose of this module in relation to the programme/s</td><td colspan="4">Autonomous Systems provides a broad understanding of the wide area of autonomous systems and the foundational knowledge in the topic areas required to understand and develop autonomous systems. The course will also present recent advances made in the field of sensors. A broad overview includes optical, infrared, terahertz, magnetic, chemical, acoustic, radiation, and MEMS sensors. The course will examine basic sensor operation and the implementation of sensors in measurement systems. Other topics to be covered are physical principles of sensing, interface electronic circuits, and sensor characteristics.</td></tr>
<tr><td>12</td><td>Learning outcomes</td><td colspan="4">Specific Outcomes of Instruction
Explain what autonomy is and what makes a system autonomous.
Explain how an autonomous system works and describe important components.
Analyse how different components contribute to the autonomy of a system.
Explain and apply common techniques and the theory with regards to control and decision making, and sensing and perception.
Analyse the industrial and societal impact of autonomous systems.
Analyse the ethical and moral issues related to autonomous systems.</td></tr>
<tr><td>13</td><td>Graduate attributes developed and/or assessed in this module</td><td colspan="4">Student Outcomes Addressed by the Course
Ability to use a wide range of specialist skills to identify, conceptualise, design and implement methods of enquiry to solve complex and challenging engineering problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialised context.
Demonstrate competence to conduct research, execute detailed technical investigations, implement strategies for the processing and management of information, including the review of current advances in the field, to produce new insights and solve complex engineering problems
Demonstrate competence to develop, select and apply appropriate and creative techniques, resources, and modern engineering tools, including information technology, prediction and modelling, for the solution of complex engineering problems, with an understanding of the limitations, restrictions, premises, assumptions and constraints.
Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment.
Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.
Demonstrate the ability to develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.</td></tr>
<tr><td>14</td><td>Module content</td><td colspan="4">Introduction to Autonomous Systems
Autonomy
Control and decision-making overview
Modelling and control
Optimal control
Planning
Vision as enabler for autonomous driving
Sensor fusion
Overview of sensing and perception
Optical sensors
Bio-chem sensors
Terahertz and millimetre-wave sensors
RADAR and radiation sensors
Magnetic sensors</td></tr>
</table>

		• Microscopy sensor, such scanning electron microscopy (SEM) • Acoustic sensors • MEMS sensors • Fiber-optic sensors • Biometrics • Vision-based perception (detection, tracking and classification) • Localization and positioning • Mapping and situation awareness (visual SLAM, structure from motion)
15	Teaching and learning	The module uses a combination lectures (face-to-face and distance), blended learning tools, case discussions, selected readings and hands-on projects. The student will learn to use the appropriate scientific techniques applied to autonomous systems. In the individual and group research projects, students will use real-world data to analyse and critically comment and report on social, economic, environmental and political problems relating to autonomous systems.
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, tutorials, assignments and/or mini-projects / case studies.

MENG (Civil Engineering) Module Descriptors

Faculty	Engineering and the Built Environment		**Department**	Civil Engineering and Geomatics	
1	**Module title**	**Engineering Management**	**2**	**Module code**	TBC
3	**HEQSF level**	9	**4**	**HEQSF Credits**	16
5	**Annual/semester**	Semester	**6**	**Compulsory or elective**	Compulsory
7	**Total notional hours**	160	**8**	**Contact hours**	48
9	**Purpose of this module in relation to the programme/s**	• Used in the leadership and management of engineering projects, both locally and abroad. • Understanding of phenomena to aid in enhancing the management of engineering projects for socio-technical systems. • Development of analytical and processing techniques to measure the progress and performance of engineering projects. Engineering Management is a field that focuses on the application of engineering principles for effective planning and efficient processes of managing engineering projects/operations. Engineering Management integrates engineering, business management, science and technology to solve complex engineering related problems within a globalised context.			
10	**Learning outcomes**	• Explore leadership in a project management context within the framework of engineering management. • Identify, assess and conduct research on the factors that contribute to the effective management of engineering project teams. • Examine the outsourcing of civil engineering projects and illuminate the approaches to managing inter-organizational relations. • Identify, evaluate and utilize appropriate methods to measure the progress and performance of civil engineering projects. • Employ research methods and techniques to explore the nature of international civil engineering and related projects with particular emphasis on environmental, cross-cultural and training aspects.			
11	**Graduate attributes developed and/or assessed in this module**	• Assess the impact of engineering management solutions in a global, economic, environmental and social context. • Ability to identify, formulate and solve engineering project problems. • Ability to utilize the knowledge, skills and techniques to effectively lead complex engineering projects. • Engage in reflective analysis and creative thinking to work collaboratively to resolve complex issues in engineering.			
12	**Module content**	• The role of leadership in project management - managing project stakeholders, influence as exchange, social network building, ethics and project management, building trust and the qualities of an effective project manager. • Managing project teams – the team development model, situational factors affecting team development, building high performance project teams (including aspects such as creating vision, decision-making, managing conflict and rejuvenation of the project team), managing virtual project teams and project team pitfalls. • Outsourcing and managing inter-organizational relations – outsourcing civil engineering project work, the art of negotiating, contract management and case studies. • Progress and performance measurement and evaluation – structure of an project monitoring system, the project control process, monitoring time performance, development of an earned value cost/schedule system, developing a status report, indexes to monitor progress, forecasting final project cost and other control issues. • International projects – environmental factors (including legal/political, security, geography, economic, infrastructure and culture), project site selection, cross-cultural considerations (including working in selected countries, culture shock and coping with culture shock), selection, training for international projects and case studies.			
13	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected readings, computer-based projects and industrial applications.			

14	**Assessment and moderation**	The assessment for this module will include a combination of tests, assignments and/or mini-projects/case studies.

Faculty	Engineering and the Built Environment			Department	Civil Engineering & Geomatics
1	**Module title**	**Materials**	2	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	To provide a student with fundamental knowledge/concept of Bitumen and Asphalt and Concrete Pavement Technologies.			
12	**Learning outcomes**	nt who successfully completes this course will be able to: • Understand the underlying principles and methods of Bitumen and Ashalt and Concrete Pavements Technology. • Specify the most suitable method/s of maintenance of Bitumen and Ashalt and Concrete Pavements; and • Critically evaluate/review specifications for maintenance of Bitumen and Ashalt and Concrete Pavements.			
13	**Graduate attributes developed and/or assessed in this module**	Ability to use engineering methods, skills, tools, including information technology monstrate the knowledge and understanding of the impact engineering activities, society, and economy, industrial and physical environment. monstrate competence in independent Learning			
14	**Module content**	**1. Bitumen and Ashalt [The Shell Bitumen Handbook Sixth Edition 2015 ICE Publishing ISBN978-0-7277-5837-8]** nufacture and storage of bitumens ndling, health, safety and environmental nstitution and structure of bitumens ecifying bitumens and checking their quality utine testing and mechanical properties eology of bitumens lymer modified bitumens and other modified binders umen emulsions gregates in asphalts oosing asphalts for use in flexible pavement layers sign of asphalt mixtures sign of flexible pavements phalt production plants nsport, laying and compaction of asphalts boratory testing of asphalts operties of asphalts luence of binder properties on the performance of asphalts			

		hesion of bitumen and moisture damage in asphalts rability of bitumens and asphalts rface treatments ernative asphalts rtification of bitumens and asphalts her important uses of bitumens and asphalts **2. Concrete Pavement and Gravel Roads** vements purpose and scope sponsibilities, Strength, and Air content ment, Aggregates, and Admixtures zzolans, Miscellaneous materials, and Proportioning tching and Mixing, Placing, and Field Test Specimens ishing, Curing, and Grade and Smoothness requirements lerances in pavement thickness pairs of defective pavement slabs Joints vement Protection utine Maintenance and Rehabilitation ainage st Control/Stabilization ovations
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected readings, hands-on projects and industrial applications.
16	**Assessment and moderation**	Course Mark: 40% of Final Mark Assessment 1 - (Test 1) will contribute 20% of Final Mark Assessment 2 - (Test 2) will contribute 20% of Final Mark Examination Mark: 60% of Final Mark Assessment 3 - (Examination) will contribute 60% of Final Mark Moderation of the examination will be carried out in accordance with the DUT guideline document “Examination Procedures”.

Faculty	Engineering and the Built Environment		**Department**	Civil Engineering and Geomatics	
1	**Module title**	**Advanced Hydraulics and Hydrology**	2	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	Used in engineering decision making Used in feasibility study in engineering design Development of mathematical techniques Understanding of phenomena to assist in better engineering design for socio-technical systems			
12	**Learning outcomes**	dent will be able to: • Apply modern technology in treatment methods • Find the solution of current water crisis • Analysis and understanding of impact by applied technology • Choose the appropriate technology			
13	**Graduate attributes developed and/or assessed in this module**	• Ability to apply knowledge of mathematics, science, and engineering . • Ability to identify, formulate and solve engineering problems. • Assess the impact of engineering solutions in a global, economic, environmental and societal context. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• Advanced Hydraulics • Hydraulic process: Open channel flow • Hydraulic process: Groundwater flow • Engineering hydrology • Hydrologic modelling • - Surface and groundwater flow modelling • - Geo-chemical modelling • Groundwater hydrology and pollution • Remote sensing and GIS in hydrology			
15	Teaching and learning	The module uses a combination of lectures, case discussions, selected readings, hands-on projects and industrial applications. In the team project, students will solve a socio-technical problem using techniques discussed in class, and interpret the solution for management.			
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, assignments and/or mini-projects / case studies.			

Faculty	Engineering and the Built Environment		Department	Civil Engineering & Geomatics	
1	**Module title**	**Structural Rehabilitation**	**2**	**Module code**	TBC
5	**HEQSF level**	9	**6**	**HEQSF Credits**	16
7	**Annual/semester**	Semester	**8**	**Compulsory or elective**	Elective
9	**Total notional hours**	160	**10**	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	To provide a student with fundamental knowledge/concept of: • Assessment of existing structures (SANS 13822) • Maintenance and repair strategies • Serviceability and durability of concrete • Materials and techniques for repair • Repairs, rehabilitation and retrofitting of structures • Demolition techniques • Concrete recycling			
12	**Learning outcomes**	A student who successfully completes this course will be able to: • Understand the underlying principles and methods of rehabilitating concrete structures. • Specify the most suitable method/s to rejuvenate concrete structural members; and Critically evaluate/review specifications to rehabilitate deteriorated concrete structures.			
13	**Graduate attributes developed and/or assessed in this module**	Ability to use engineering methods, skills, tools, including information technology monstrate the knowledge and understanding of the impact engineering activities, society, and economy, industrial and physical environment. monstrate competence in independent Learning			
14	**Module content**	1. Concrete structures - damage and its causes 2. Non-destructive tests 3. Destructive tests 4. Environmental parameters 5. Influence of cracks 6. Modelling of corrosion rate 7. Modelling of corrosion induced deterioration of concrete 8. Evaluation of actual capacity 9. Routine Maintenance 10. Repair techniques			
15	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected readings, hands-on projects and industrial applications.			
16	**Assessment and moderation**	Course Mark: 40% of Final Mark Assessment 1 - (Test 1) will contribute 20% of Final Mark Assessment 2 - (Test 2) will contribute 20% of Final Mark Examination Mark: 60% of Final Mark Assessment 4 - (Examination) will contribute 60% of Final Mark Moderation of the examination will be carried out in accordance with the DUT guideline document “Examination Procedures”.			

Faculty	Engineering and the Built Environment	Department	Civil Engineering and Geomatics

1	**Module title**	**Transportation Design**	2	**Module code**	
3	**HEQSF level**	9	4	**HEQSF Credits**	16
7	**Annual/Semester**	Semester	8	**Compulsory or elective**	Elective
9	**Total notional hours**	160	10	**Contact hours**	48

11	**Purpose of this module in relation to the programme/s**	Demonstrate competence to apply knowledge of mathematics, natural science and engineering sciences to wide practical procedures and practices to solve well-defined Urban development engineering problems.
12	**Learning outcomes**	Critically evaluate the design of signals, priority junctions and road links in terms of capacity and safety; assess important environmental impacts; understand the need for transport planning and new forms of transport; evaluate materials and specifications for durable and sustainable pavements. Acquire and interpret traffic flow, speed and accident data; use engineering methods to design simple priority and signal controlled junctions, assess noise impacts and road pavements. Interpret and present data. Pavement design, maintenance, low noise surfaces and earthworks.
13	**Graduate attributes developed and/or assessed in this module**	Design problem to conform to the definition of a *complex* engineering problem Engineering methods, skills, tools & IT: Demonstrate competence to use appropriate techniques, resources, and modern engineering tools, including information technology, prediction and modelling, for the solution of *complex engineering problems* Demonstrate knowledge and understanding of the impact of engineering activities society, economy, industrial and physical environment.
14	**Module content**	rvey techniques. Need for traffic engineering, collecting speed and traffic flow data and analysis and presentation of survey data. Design of routes using speed flow theory, analyses by speed control, traffic calming and signalling. Design of Priority lanes. General and grade separated intersections, assessing capacity and accidents and use of software. Design of Signal Control Junctions: Suitability and layout, signal design (saturation flow, cycle time, phases and delays). Environmental Assessment. Need for sustainable roads and feasible assessment Calculation of Road Traffic Noise. Transport Planning and modelling, cost benefit and future transport needs. Transport Infrastructure, earthworks and maintenance.
15	**Teaching and learning**	Learning takes place on a range of levels but not limited to lectures and class discussions. Constant reference is made to industry/practical examples, selected paper readings, case studies. In the assignment, students will analyse a real industrial problem, and using urban design techniques justify their design solution. Application of equations : worked examples from past tests and exams
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, assignments and/or mini-projects/case studies.

Faculty	Engineering and the Built Environment		Department	Civil Engineering and Geomatics	
1	**Module title**	**Urban Design**	2	**Module code**	TBC
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual/semester**	Semester	8	**Compulsory or elective**	Elective
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	Demonstrate competence to apply knowledge of mathematics, natural science and engineering sciences to wide practical procedures and practices to solve well-defined Urban development engineering problems. To understand, analyse and review the design principles used and needed for the design of all services of a modern residential township.			
12	**Learning outcomes**	dent will be able to: • Apply fundamental design techniques relevant to the field of urban design for a residential township. • Conduct research in a specific topic in urban design such as provision of services and layout design. • Investigate and apply new design techniques to a problem from a specific urban design project and interpret the results. • Implement a solution to the urban design problems encountered by previous built residential townships.			
13	**Graduate attributes developed and/or assessed in this module**	• Ability to apply knowledge of mathematics, science, and engineering science. • Ability to identify, formulate and solve engineering problems. • Assess the impact of engineering solutions in a global, economic, environmental and societal context. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	Urban Planning Process Land use. Urban Water Reticulation Urban Road Geometric Design Residential Township Planning and Development Urban Traffic Safety Urban Solid Waste Management. Urban Storm Water Management Design and Maintenance of Streets. Urban Environmental Aspects.			
15	Teaching and learning	Learning takes place on a range of levels but not limited to lectures and class discussions. Constant reference is made to industry/practical examples, selected paper readings, case studies. In the assignment, students will analyse a real industrial problem, and using urban design techniques justify their design solution.			
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, assignments and/or mini-projects / case studies.			

Faculty	Engineering and the Built Environment		**Department**	Civil Engineering and Geomatics	
1	**Module title**	**Water and Wastewater Treatment Technology**	**2**	**Module code**	TBC
5	**HEQSF level**	9	**6**	**HEQSF Credits**	16
7	**Annual/semester**	Semester	**8**	**Compulsory or elective**	Compulsory
9	**Total notional hours**	160	**10**	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	Used in engineering decision making Used in feasibility study in engineering design Development of mathematical techniques Understanding of phenomena to assist in better engineering design for socio-technical systems			
12	**Learning outcomes**	dent will be able to: • Apply modern technology in treatment methods • Find the solution of current water crisis • Analysis and understanding of impact by applied technology • Choose the appropriate technology			
13	**Graduate attributes developed and/or assessed in this module**	• Ability to apply knowledge of mathematics, science, and engineering . • Ability to identify, formulate and solve engineering problems. • Assess the impact of engineering solutions in a global, economic, environmental and societal context. • Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.			
14	**Module content**	• Wastewater microbiology • Primary treatment • Secondary treatment by suspended growth and attached growth processes • Secondary settling, disinfection and post aeration • Tertiary treatment • Water reuse • Water treatment chemistry • Ion-exchange • Reverse osmosis and Nano filtration • Membrane filtration • Water Desalination from sea water			
15	Teaching and learning	The module uses a combination of lectures, case discussions, selected readings, hands-on projects and industrial applications. In the team project, students will solve a socio-technical problem using techniques discussed in class, and interpret the solution for management.			
16	**Assessment and moderation**	The assessment for this module will include a combination of tests, assignments and/or mini-projects / case studies.			

Faculty	**Engineering and the Built Environment**		**Department**	Civil Engineering & Geomatics	
1	**Module title**	**Advanced Structures**	2	**Module code**	
5	**HEQSF level**	9	6	**HEQSF Credits**	16
7	**Annual / Semester**	Semester	8	**Compulsory or elective**	Elective
9	**Total notional hours**	160	10	**Contact hours**	48
11	**Purpose of this module in relation to the programme/s**	To enable a student to design an advanced type structure, understanding and applying all of the theoretical and practical aspects required.			
12	**Learning outcomes**	The learner must be able to: Load, model, analyse and design an advanced type of structure.			
13	**Graduate attributes developed and/or assessed in this module**	Ability to identify, formulate and solve engineering problems. Ability to apply knowledge of mathematics, science and engineering Demonstrate competence to solve complex engineering problems Conduct investigation of complex engineering problems Ability to use engineering methods, skills, tools, including information technology Assess the impact of engineering solutions in a global, economic, environmental and social context. Engineering professionalism			
14	**Module content**	The exact content of the course will depend on the topic being offered, which will be selected from (but not limited to) advance structures such as: Bridges Tall buildings Light-weight steel structures Silos Heavy industrial buildings (with cranes) Advanced plate structures The selection of the topic will be dependent on the availability of a suitably qualified person at the time of offering.			
15	**Teaching and learning**	**Learning activity**	**% learning time**		
		Lectures **Independent study**	**20%** **80%**		
16	**Assessment and moderation**	Does assessment include a final examination? **No**			
		The actual assessment will depend of the specialised module being offered, and could consist of a combination of tests, assignments and a project. Moderation will be carried out in accordance with the DUT guideline document "Examination Procedures".			

MBE (Construction) Module Descriptors

Faculty	Engineering and the Built Environment		**Department**	Construction Management and Quantity Surveying	
1	**Module title**	**Artificial Intelligence in Construction**	2	**Module code**	TBC
3	**HEQSF level**	9	4	**HEQSF Credits**	16
5	**Annual/semester**	Semester	6	**Compulsory or elective**	Compulsory
7	**Total notional hours**	160	8	**Contact hours**	48
9	**Purpose of this module in relation to the programme/s**	The purpose of this module is to develop the students' ability to identify, assess, formulate and solve convergent and divergent construction problems using Artificial Intelligence. The students will be equipped to apply a systematic problem solving method in a number of varied instances with Artificial Intelligence. They will develop the knowledge and skills pertaining to Artificial Intelligence to advance the construction industry. The module will equip the students to utilise Artificial Intelligence to solve construction problems by using an appropriate mix of: a) Formal analysis and modelling Artificial Intelligence components in construction, systems or processes; b) Communicating concepts, ideas and theories with the aid of Artificial Intelligence in solving construction issues; and c) Reasoning about and conceptualising Artificial Intelligence systems and processes using Artificial Intelligence concepts.			
10	**Learning outcomes**	Outcomes of Instruction • Analyse and define the problem, identify the criteria for an acceptable solution using AI as the source of knowledge • Identify necessary information and applicable AI instruments and other knowledge and skills • Generate and formulate possible approaches to solution of problem • Model and analyse possible solution(s) • Evaluate possible solutions and select best solution • Formulate and present the solution in an appropriate form			
11	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Critical and creative thinkers who work independently and collaboratively • Knowledgeable practitioners • Effective communicators • Culturally, environmentally and socially aware within a local and global context • Active and reflective learners			
12	**Module content**	• Artificial Intelligence defined • Artificial Intelligence in construction • The value of Artificial Intelligence in the construction industry • Leveraging Artificial Intelligence in the construction sector • Current practices of Artificial Intelligence in construction • Emerging trends of Artificial Intelligence in construction • Artificial Intelligence in the future of construction			
13	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.			
14	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

<table>
<tr><td>Faculty</td><td colspan="2">Engineering and the Built Environment</td><td colspan="2">Department</td><td>Construction Management and Quantity Surveying</td></tr>
<tr><td>1</td><td>Module title</td><td>BIM in Design, Construction and Operations</td><td>2</td><td>Module code</td><td>TBC</td></tr>
<tr><td>3</td><td>HEQSF level</td><td>9</td><td>4</td><td>HEQSF Credits</td><td>16</td></tr>
<tr><td>5</td><td>Annual/semester</td><td>Semester</td><td>6</td><td>Compulsory or elective</td><td>Compulsory</td></tr>
<tr><td>7</td><td>Total notional hours</td><td>160</td><td>8</td><td>Contact hours</td><td>48</td></tr>
<tr><td>9</td><td>Purpose of this module in relation to the programme/s</td><td colspan="4">This module introduces advanced concepts of Building Information Modelling (BIM) to develop students with high-level knowledge and understanding of BIM. Students will not only develop a comprehension of how the tools and techniques operate, but also how these can be implemented within the business context of integrated construction teams in the construction sector. The students will be equipped with knowledge to ensure BIM alignment with business strategy. The students will develop a holistic approach to everything from design and construction to maintenance, operation, and sustainability using BIM software. Students will learn to understand the complete building lifecycle, exploring innovative, sustainable and collaborative practices in building information modelling and management, and examine a range of existing and emerging BIM issues.</td></tr>
<tr><td>10</td><td>Learning outcomes</td><td colspan="4">Outcomes of Instruction
• Demonstrate a systematic understanding and critical awareness of current and emerging BIM technologies in relation to the construction industry
• Select and effectively implement an appropriate range of advanced software tools in order to produce architectural design and construction documentation including drawings, visualisations and presentations
• Demonstrate high level skills and abilities to make use of generic and bespoke software tools, solving complex design problems and developing appropriate solutions for presentation to a range of audiences</td></tr>
<tr><td>11</td><td>Graduate attributes developed and/or assessed in this module</td><td colspan="4">Student Outcomes Addressed by the Course
• Critical and creative thinkers who work independently and collaboratively
• Knowledgeable practitioners
• Effective communicators
• Culturally, environmentally and socially aware within a local and global context
• Active and reflective learners</td></tr>
<tr><td>12</td><td>Module content</td><td colspan="4">• BIM Theory and Application
• BIM for Integrated Project Delivery
• Implementing and Managing BIM and CAD Systems
• BIM and Integrated Project Collaboration
• BIM and Sustainable Design Analysis
• BIM in Design Co-ordination
• BIM in Construction Operation
• BIM in Business and Practice
• BIM in Operation and Maintenance
• Low/Zero-Impact Buildings
• nD Modelling and Interoperability in BIM environment
• BIM programming (incl. visual programming)</td></tr>
<tr><td>13</td><td>Teaching and learning</td><td colspan="4">The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.</td></tr>
<tr><td>14</td><td>Assessment and moderation</td><td colspan="4">The assessment for this module may be a combination of test, assignments and mini-projects / case studies.</td></tr>
</table>

Faculty	Engineering and the Built Environment		Department	Construction Management and Quantity Surveying	
1	**Module title**	**Decision Science**	**2**	**Module code**	TBC
3	**HEQSF level**	9	**4**	**HEQSF Credits**	16
5	**Annual/semester**	Semester	**6**	**Compulsory or elective**	Compulsory
7	**Total notional hours**	160	**8**	**Contact hours**	48
9	**Purpose of this module in relation to the programme/s**	This module introduces students to decision making theory and the tools that might be used to aid decision making and problem solving. It will equip the students to develop an understanding of different approaches to analytical decision making. Students will develop the ability to gather and analyse relevant information and identify critical issues from a base of information; relating and comparing data from different sources. They will develop the knowledge and skills to identify cause - effect relationships; determine and evaluate risk; understand the different roles and responsibilities of the individuals involved in decisive decision making and draw conclusions using different analytical decision making tools and techniques to support analytical thinking and problem solving required in complex and effective decision making.			
10	**Learning outcomes**	Outcomes of Instruction • Develop an in-depth knowledge of decision making theory • Critically evaluate different approaches to analytical decision making • Gather and evaluate data to support analytical thinking and decision making • Recognize the human variable in problem solving and decision making • Demonstrate the ability to apply tools, techniques and practices to complex problems (identify, investigate, formulate, and advocate novel and creative solutions and ideas) • Critically evaluate the various factors which impact on effective decision making			
11	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Critical and creative thinkers who work independently and collaboratively • Knowledgeable practitioners • Effective communicators • Culturally, environmentally and socially aware within a local and global context • Active and reflective learners			
12	**Module content**	• Theories of decision making • Tools and techniques of decision making • Categories of decision making • Decision making process • Ethics in decision making			
13	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.			
14	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

DURBAN UNIVERSITY OF TECHNOLOGY

Faculty		Engineering and the Built Environment	**Department**		Construction Management and Quantity Surveying
1	**Module title**	**Value Engineering in Construction**	**2**	**Module code**	TBC
3	**HEQSF level**	9	**4**	**HEQSF Credits**	16
5	**Annual/semester**	Semester	**6**	**Compulsory or elective**	Compulsory
7	**Total notional hours**	160	**8**	**Contact hours**	48
9	**Purpose of this module in relation to the programme/s**	This module introduces students to value engineering, a creative and organised exertion to analyse the requirements of a project for the purpose of achieving the essential functions at the best value (capital, energy and maintenance) over the life of the project. Value engineering is therefore a systematic method to improve the value of the product or service. The students will be equipped to identify, assess, formulate and solve convergent and divergent problems in the design of buildings using value engineering principles to improve the value. The module will equip the students to utilise value engineering analysis and statistical knowledge and methods to solve construction problems by using an appropriate mix of: a) Formal analysis and modelling of value engineering in design and construction, systems or processes; b) Communicating concepts, ideas and theories with value engineering in solving design and construction issues; and c) Reasoning about and conceptualising value engineering systems and processes.			
10	**Learning outcomes**	Outcomes of Instruction • Analyse and define the problem, identify the criteria for an acceptable solution using the stages of value engineering as the source of knowledge • Identify necessary information and applicable value engineering instruments and other knowledge and skills • Generate and formulate possible approaches to solution of problems • Model and analyse possible solution(s) • Evaluate possible solutions and select best solution • Formulate and present the solution in an appropriate form			
11	**Graduate attributes developed and/or assessed in this module**	Student Outcomes Addressed by the Course • Critical and creative thinkers who work independently and collaboratively • Knowledgeable practitioners • Effective communicators • Culturally, environmentally and socially aware within a local and global context • Active and reflective learners			
12	**Module content**	• Historical development of value engineering • Value engineering • Value management • Value planning • Value analysis • Benchmarking • Cost plans • Key performance indicators • Overcoming difficulties in value management • Sustainability • Whole life value			
13	**Teaching and learning**	The module uses a combination of lectures, case discussions, selected paper readings, an accompanying textbook, hands-on projects, optimization challenges and industrial applications. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.			
14	**Assessment and moderation**	The assessment for this module may be a combination of test, assignments and mini-projects / case studies.			

APPENDIX D

Comparative Matrix of the EURACE and ECSA exit level outcomes/desired graduate attributes

EURACE ELOs	ECSA	**ELO 1: Problem Solving** Use a wide range of specialist skills to identify, conceptualise, design and implement methods of enquiry to solve *complex* and *challenging* engineering problems creatively and innovatively with an understanding of the consequences of any solutions or insights generated within a specialised context.	**ELO 2: Application of scientific and engineering knowledge** Apply specialist knowledge of mathematics, natural science and engineering sciences to solve *complex engineering problems*, conceptualize models and enable engagement with and critique of current and emerging research and practices	**ELO 3:Engineering design** Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes, demonstrate the ability to propose interventions at an appropriate level within a system based on an understanding of interdependent relations *and* address intended and unintended consequences of interventions.	**ELO 4: Research, investigations, experiments and data analysis** Demonstrate competence to conduct research, execute detailed technical investigations, implement strategies for the processing and management of information, including the review of current advances in the field, to produce new insights and solve *complex*	**ELO 5: Engineering methods, skills and tools, including information technology** Demonstrate competence to develop, select and apply appropriate and creative techniques, resources, and modern engineering tools, including information technology, prediction and modelling, for the solution of *complex engineering problems*, with an understanding of the limitations, restrictions, premises, assumptions and constraints.	**ELO 6: Professional and technical communication** Demonstrate an ability to use the resources of academic, professional and occupational dismodules to communicate and defend substantial ideas that are products of research, investigation or development in an area of specialization; and a range of advanced and specialized skills and dismodules appropriate to the field, discipline or practice, to communicate to a range of audiences with different levels of knowledge or expertise.	**ELO 7: Sustainability and the impact of engineering activity** Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment.	**ELO 8: Individual, team and multidisciplinary working** Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.	**ELO 9: Independent learning ability** Demonstrate the ability to develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.	**ELO 10: Engineering professionalism** Demonstrate critical awareness of the need to act professionally and ethically, to exercise judgment and take responsibility within own limits of competence and where appropriate to account for leading and initiating processes and implementing systems,	**ELO11: Engineering Management** Demonstrate knowledge and understanding of engineering management principles and economic decision making.
Knowledge and Understanding The learning process should enable **Master Degree graduates to demonstrate**:	• in-depth knowledge and understanding of mathematics and sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes;		X									
	• in-depth knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes;		X		X							

	• critical awareness of the forefront of their specialisation;		X		X							
	• critical awareness of the wider multidisciplinary context of engineering and of knowledge issues at the interface between different fields.			X					X			
Engineering Analysis The learning process should enable **Master Degree graduates to demonstrate**:	• ability to analyse new and complex engineering products, processes and systems within broader or multidisciplinary contexts; to select and apply the most appropriate and relevant methods from established analytical, computational and experimental methods or new and innovative methods; to critically interpret the outcomes of such analyses	X		X	X							
	• ability to conceptualise engineering products, processes and systems;			X	X							
	• ability to identify, formulate and solve unfamiliar complex engineering problems that are incompletely defined, have competing specifications, may involve considerations from outside their field of study and non-technical – societal, health and safety, environmental, economic and industrial – constraints; to select and apply the most appropriate and relevant methods from established analytical, computational and experimental methods or new and innovative methods in problem solving;	X	X			X		X				X
	• ability to identify, formulate and solve complex problems in new and emerging areas of their specialisation.	X	X		X							
Engineering Design The learning process should enable **Master Degree graduates to demonstrate**:	• ability to develop, to design new and complex products (devices, artefacts, etc.), processes and systems, with specifications incompletely defined and/or competing, that require integration of knowledge from different fields and non-technical - societal, health and safety, environmental, economic and industrial commercial – constraints; to select and apply the most appropriate and relevant design methodologies or to use creativity to develop new and original design methodologies.			X	X			X				X
	• ability to design using knowledge and understanding at the forefront of their engineering specialisation.		X	X								

Investigations The learning process should enable Master Degree graduates to demonstrate:	• ability to identify, locate and obtain required data;				X		X					
	• investigations and research of complex technical issues;				X							
	• ability to conduct searches of literature, to consult and critically use databases and other sources of information, to carry out simulation in order to pursue detailed				X		X					
	• ability to consult and apply codes of practice and safety regulations;				X							
	• advanced laboratory/workshop skills and ability to design and conduct experimental investigations, critically evaluate data and draw conclusions;				X							
	• ability to investigate the application of new and emerging technologies at the forefront of their engineering specialisation.		X		X							
Engineering Practice The learning process should enable Master Degree graduates to demonstrate:	• comprehensive understanding of applicable techniques and methods of analysis, design and investigation and of their limitations;			X		X						X
	• practical skills, including the use of computer tools, for solving complex problems, realising complex engineering design, designing and conducting complex investigations;					X						
	• comprehensive understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations;					X						
	• ability to apply norms of engineering practice;					X						
	• knowledge and understanding of the non-technical – societal, health and safety, environmental, economic and industrial - implications of engineering practice;								X			X
	• critical awareness of economic, organisational and managerial issues (such as project management, risk and change management)										X	X
Making Judgements The learning process should enable Master Degree graduates to demonstrate:	• ability to integrate knowledge and handle complexity, to formulate judgements with incomplete or limited information, that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgement;	X	X						X		X	X
	• ability to manage complex technical or professional activities or projects that can			X	X						X	X

	require new strategic approaches, taking responsibility for decision making.											
Communication and Team-working The learning process should enable Master Degree graduates to demonstrate:	• ability to use diverse methods to communicate clearly and unambiguously their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences in national and international contexts;						X					
	• Ability to function effectively in national and international contexts, as a member or leader of a team, that may be composed of different disciplines and levels, and that may use virtual communication tools.						X		X			X
Lifelong Learning The learning process should enable Master Degree graduates to demonstrate:	• ability to engage in independent life-long learning;			X	X					X		
	• Ability to undertake further study autonomously.				X					X		

APPENDIX E: Industrial Advisory Boards

A. Industry Advisory Board for the Department of Construction Management and Quantity Surveying:

1. The South African Council for Project and Construction Management Professions
2. Master Builders Association
3. Royal Institute of Chartered Surveyors
4. eThekwini Municipality
5. Association of South African Quantity Surveyors
6. Grinaker Lta
7. WBHO Construction
8. Enza Construction
9. Stefanutti Stocks Holdings Limited
10. Ash Maharaj and Associates
11. Jay Jaganath and Associates
12. HL Patel Quantity Surveyors and Project Managers

B. Industry Advisory Board for the Department of Chemical Engineering:

1. Illovo Sugar Africa (Pty) Ltd
2. Tongaat Hulett (Pty) Ltd
3. Chemical Industry Education and Training Authority (Chieta)
4. Improsys (Pty) Ltd
5. Paper Manufacturers Association of South Africa (*PAMSA*)
6. Umgeni Water
7. South African Petroleum Refiners (Pty) Ltd
8. NCP Alcohols (Pty) Ltd

C. Industry Advisory Board for the Department of Industrial Engineering:

1. Chevron S A (Pty) Ltd
2. Mult- Colour Global label solutions
3. **Fibre-Wound Holdings Limited**
4. Hesto Harnesses (Pty) Ltd
5. Quality Training and Consulting
6. Whirlpool S.A. (Pty) Ltd
7. BEAPO consulting
8. Productivity S.A. Corporation
9. Mpact Plastics (Pty) Ltd
10. Price Waterhouse Coopers
11. Council for Scientific and Industrial Research (CSIR)

D. Industry Advisory Board for the Department of Civil Engineering and Geomatics

1. Young and Satharia Structural Consulting Engineers
2. Ethekweni Municipality
3. Department of Water & Sanitation
4. Makhoatse, Narasimulu & Assoc Consulting Engineers
5. Ibhongo Consulting Engineers
6. Stefanutti Stocks/ SAFCEC
7. Vijay Ori & Associates Consulting Engineers & Project Management
8. PMA Consulting Engineers
9. Bosch Stemele Consulting Engineers

E. Industry Advisory Board for the Department of Electronic and Electrical Engineering:

1. 2Cana Solutions (Pty) Ltd
2. Air Traffic and Navigation Services (ATNS) SOC Limited
3. Automation Techniques (Pty) Ltd
4. Conlog (Pty) Ltd
5. Council for Scientific and Industrial Research (CSIR)
6. Cube Technologies (Pty) Ltd
7. Endress & Hauser (Pty) Ltd
8. eThekwini Metropolitan Municipality
9. Gold Reef Speciality Chemicals (Pty) Ltd
10. Hulamin (Pty) Ltd
11. Illovo Sugar Africa (Pty) Ltd
12. Metrohm SA (Pty) Ltd
13. MTN Group Limited
14. PFK Electronics (Pty) Ltd
15. Preformed Line Products SA (Pty) Ltd
16. Production Logix (Pty) Ltd
17. Pulse Control Systems CC
18. Reutech (Pty) Ltd
19. Rockwell Automation (Pty) Ltd
20. Runrite Electronics (Pty) Ltd
21. South African Broadcasting Corporation (SABC)
22. Safal Steel (Pty) Ltd
23. Sappi Limited
24. Sappi Saiccor (Pty) Ltd
25. South African Petroleum Refiners (Pty) Ltd
26. Sunshine Bakery (Pty) Ltd
27. Telkom (Pty) Ltd
28. ThoroughTec Simulation (Pty) Ltd
29. TM Electronics CC
30. Toyota South Africa Motors (Pty) Ltd
31. Unilever South Africa (Pty) Ltd

32. Yokogawa South Africa (Pty) Ltd

F. Industry Advisory Board for the Department of Mechanical Engineering:

1. AB Projects (Pty) Ltd
2. Design Group (Pty) Ltd
3. Durban University of Technology
4. Duys Engineering Group
5. Federal Mogul (pty) Ltd
6. Auria Feltex (Pty) Ltd
7. Festo (Pty) Ltd
8. Fibrewound (Pty) Ltd
9. FP Engineering (Pty) Ltd
10. G B Bearings (Pty) Ltd
11. Grindrod (Pty) Ltd
12. GUD Fliters (Pty) Ltd
13. Kairos Engineering (Pty) Ltd
14. Machine Tool Refabrication & Sales CC
15. MAXE, a division of KAP Diversified Industrial Pty (Ltd)
16. Mangosuthu University of Technology
17. National Business Initiative
18. NCP Alcohols Pty (Ltd)
19. Profibre Pty (Ltd)
20. Purple Rain Digital Printing Pty (Ltd)
21. R and N Engineering Pty (Ltd)
22. South African Institute of Mechanical Engineers
23. SBS Tanks Pty (Ltd)
24. Smiths Plastics Pty (Ltd)
25. SRI Group Pty (Ltd)
26. Steel Vision Pty (Ltd)
27. Tekmation Training Institute Pty (Ltd)
28. Technology Localisation Implementation Unit, an initiative of the Department of Science and Technology
29. Tongaat Hulett Pty (Ltd)
30. Transnet Pty (Ltd)
31. Unicorn Shipping Pty (Ltd)
32. Unilever Pty (Ltd)
33. Vision Elevators Pty (Ltd)
34. Volvo Pty (Ltd)