

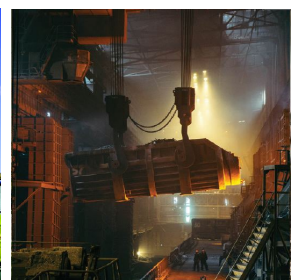
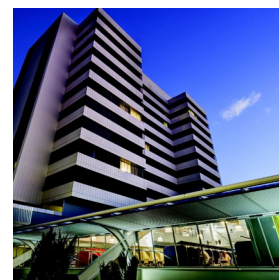


UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

# Faculty of Engineering, Built Environment and Information Technology

## Department of Industrial and Systems Engineering

# Postgraduate Guide 2024



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## Introduction

### Department of Industrial and Systems Engineering

Industrial Engineering is an extensive field of study since it consists of many diverse scientific disciplines with interfaces to various fields of study from the sciences, engineering and management. If one characteristic of Industrial Engineering has to be isolated then it may be the capability of the Industrial Engineer to integrate the contributions of all the other engineering disciplines into a final, functional and marketable product, at the lowest possible cost, by using system knowledge and understanding.

The Department of Industrial and Systems Engineering at the University of Pretoria is the oldest and biggest Industrial Engineering department in South Africa. The first Industrial Engineers graduated from the University of Pretoria in 1963. Up to 1974 Industrial Engineering was offered as a programme in the Department of Mechanical Engineering. In 1975 the Department of Industrial Engineering was established as an independent academic department.

## Research Focus Streams

The following research streams exist within the Department of Industrial and Systems Engineering, providing a suggested combination of modules, based on the modules offered in 2024.

For additional guidance on selecting additional modules outside the Department within the selected stream, please consult with the lecturers assigned within a particular stream.

### Modelling and Optimization

- BAN 780: Industrial Analysis
- BOZ 780: Operations Research
- BPZ 782: Manufacturing Planning and Control Systems

### Systems and Business Process Optimization

- BBA 781: Enterprise Engineering and Research Methods
- BSS 780: Systems Engineering
- BLK 781: Supply Chain Processes
- BVK 780: Supply Chain Design

### Logistics and Supply Chain Engineering

- BPZ 782: Manufacturing Planning and Control Systems
- BLK 781: Supply Chain Processes
- BVK 780: Supply Chain Design
- BGH 780: Quality Management

## Postgraduate Academic Programmes

Post-graduate programs offered consist of Honours, Masters and PhD. The admission requirements are stipulated in this brochure.

### Honours Programmes

#### **\*Important Information: Electives & Modules outside IE Department\***

**BEngHons Industrial Engineering students** have the opportunity to take up to 32 relevant credits from departments outside of Industrial Engineering, **while BScHons AplSci Industrial Systems students** can take up to 16 relevant credits outside their department.

#### **To pursue these external elective options, please follow the outlined procedure:**

1. Obtain approval from the Head of Department/Postgraduate Coordinator where you plan to take the elective module.
2. Once you have received approval, send an email to **Mrs Sehaam Brey on sehaam.brey@up.ac.za**, seeking approval from the Head of Department (Industrial Engineering Department).
3. If your request is approved by the IE Department Head, Mrs Brey will provide you with a module change form to complete, which is necessary for processing your request. Please return the completed form to her.
4. The completed form will be signed, stamped, and forwarded to Student Administration for processing.
5. Kindly refrain from submitting forms directly to Mr Roy Mashiloane, Student Administration or the Head of Department (IE), as your request will not be considered.

Please ensure that you adhere to these steps and obtain the required approvals and documentation for your desired outside electives.

### BEngHons Industrial Engineering (Plan code: 12240012)

A student is required to pass modules to the total value of 120 credits. The minimum duration of study is 1 year. The programme consists of one compulsory module (32 credits) with any *one* relevant *core prerequisite module* as Pre-requisite and the remainder of credits either core and/or elective modules. Students are allowed 32 relevant credits from outside the department. Students are advised to select modules in line with their desired research stream.

#### Course Curriculum

Semester 1	Semester 2
<b>Compulsory module</b>	
BCS 780 (32 credits) Industrial & Systems Engineering Research	BCS 780 (32 credits) Industrial & Systems Engineering Research
<b>Core prerequisite module (prerequisite for starting BCS 780)</b>	
BBA 781 (32 credits) Enterprise Engineering and Research Methods	BOZ 780 (32 credits) Operations Research
BPZ 782 (32 credits) Manufacturing Planning & Control Systems	-
<b>Core electives (IE Department)</b>	
BLK 781 (16 credits) Supply Chain Processes	BVK 781 (16 credits) Supply Chain Design
-	BGH 780 (16 Credits) Quality Management
-	BSS 780 (32 credits) Systems Engineering
<b>Core modules (Outside IE Department)</b>	
Elective module/s worth 32 credits allowed (NOTE: Please send email for approval to sehaam.brey@up.ac.za)	

#### Minimum Admission Requirements

A BEng degree awarded by the University of Pretoria

**or**

A relevant four-year bachelor's degree in engineering that the Engineering Council of South-Africa (ECSA) regards acceptable for registration as a Candidate Engineer and for eventual registration as a Professional Engineer.



## Selection Process

The departmental postgraduate committee reserves the right to make a thorough assessment of the applicant's academic transcript and Curriculum Vitae (CV), to decide if the applicant is suitable for postgraduate studies.

## Applications and Registration

Students may Apply Online via the University of Pretoria website - <https://www.up.ac.za/online-application>  
Once a student has been admitted he/she may register for modules. Online registrations open in January 2024.

## Closing Dates

South-African citizens: 30 November 2023  
International applicants: 30 June 2023

## BScHons AplSci Industrial Systems (Plan code: 12243002)

A student is required to pass modules to the total value of 120 credits. The minimum duration of study is 1 year. The programme consists of two compulsory modules (48 credits) with any *one* relevant *core prerequisite module* as Prerequisite and the remainder of credits either core and/or elective modules. Students are allowed 16 relevant credits from outside the department. Students are advised to select modules in line with their desired research stream.

## Course Curriculum

Semester 1	Semester 2
<b>Compulsory module</b>	
BCS 780 (32 credits) Industrial & Systems Engineering Research BAN 780 (16 credits) Industrial Analysis	BCS 780 (32 credits) Industrial & Systems Engineering Research
<b>Core prerequisite module (prerequisite for starting BCS 780)</b>	
BBA 781 (32 credits) Enterprise Engineering and Research Methods	BOZ 780 (32 credits) Operations Research
BPZ 782 (32 credits) Manufacturing Planning & Control Systems	-
<b>Core electives (IE Department)</b>	
BLK 781 (16 credits) Supply Chain Processes	BVK 781 (16 credits) Supply Chain Design
-	BGH 780 (16 Credits) Quality Management
-	BSS 780 (32 credits) Systems Engineering
<b>Core modules (Outside IE Department)</b>	
Elective module/s worth 16 credits allowed (NOTE: Please send email for approval to <a href="mailto:sehaam.brey@up.ac.za">sehaam.brey@up.ac.za</a> )	

## Minimum Admission Requirements

A three-year BSc degree in Natural Sciences with a weighted average of at least 65%, including required mathematical component.

**or**

An equivalent degree with a weighted average of at least 65%, including a required mathematical component.

**or**

An appropriate BTech/BEng Tech qualification, excluding the National Diploma, e.g. one offered by a department of industrial engineering at a university of technology in South Africa with a weighted average of at least 75% and no modules failed

**or**

A four-year engineering-based university degree **not** recognised by ECSA for registration as a Professional Engineer, according to Washington Accord.

**or**

A relevant Advanced Diploma qualification (NQF Level 7), excluding the National Diploma, for example, one offered by a department of Civil Engineering at a University of Technology in South Africa with a cumulative weighted average of at least 75% for the diploma and no modules failed in the Advanced Diploma.

## Selection Process

The departmental postgraduate committee reserves the right to make a thorough assessment of the applicant's academic transcript and Curriculum Vitae (CV), to decide if the applicant is considered suitable for postgraduate studies.

## Applications and Registration

Students may Apply Online via the University of Pretoria website - <https://www.up.ac.za/online-application>  
Once a student has been admitted he/she may register for modules. Online registrations open in January 2024.

## Closing Dates

South-African citizens: 30 November 2023  
International applicants: 30 June 2023

## Master's Programmes

A dissertation is required as deliverable. The dissertation must prove the student's ability to undertake scientific research and to report thereon. The minimum duration of study is 1 year.

A dissertation is acceptable if it proves that a student:

- is conversant with the nature and aim of the research,
- has a satisfactory knowledge of the literature concerned and can interpret it,
- has mastered the techniques relevant to his/her research,
- has sound knowledge of both the theory and the practice of scientific methodology,
- is able to evaluate the scientific relevance of his/her findings and
- can structure the report on the research scientifically with accountability

The student may not have previously submitted the dissertation for graduation purposes at another tertiary institution.

## Research Topic

A prospective student should select a research topic in collaboration with the staff of the Department of Industrial and Systems Engineering. Research topics may be chosen within the three research focus streams and other topics may be considered in consultation with the Head of Department.

The following are research focus streams within the Department of Industrial and Systems Engineering:

- **Modelling and Optimization**
- **Systems and Business Process Optimization**
- **Logistics and Supply Chain Engineering**

Some pre-defined topics may be available on the departmental website:

<https://www.up.ac.za/industrial-and-systems-engineering/article/2005687/masters-and-doctorate-research-topics>

Please consult with the concerned lecturer as indicated. Students may also provide their own research topic that should first be approved by the lecturer that will act as the study leader.

## Minimum admission requirements

### MEng Industrial Engineering

Plan code: 12250012, Module code: BIR 890

- **Degree Prerequisites (weighted averages):** 65% for B.Eng (Industrial Engineering) **OR** minimum 65% for B.Eng.Hons **OR** 65% for relevant 4-year degree (e.g. B.EngTech.Hons / PG.Diploma / BSc.Hons.Appl.Sc with adequate mathematical component).
- **Honours Module Prerequisites:** A student has to pass 2 mandatory modules: (1) Passing at least 1 **Core Prerequisite** (**BPZ 780 OR BOZ 780 OR BBA 781** (contribute 0 credits, need to pass the exam)); and (2) passing **BCS 780** (contribute 0 credits, need to pass the exam). In addition, the student has to pass supervisor-prescribed modules (if any).

- **Proposal Prerequisites:** M.Eng proposal approved by the person that will act as the supervisor for the Masters study i.e. a lecturer with PhD degree.

### Process for students with B.Eng (Industrial Engineering), minimum 65% weighted average

#### Preparation year

- Students need to consult with a **potential study leader** (i.e. a lecturer with PhD degree) to determine whether the topic area is aligned with the knowledge and expertise of the study leader and to receive instruction from the study leader regarding the required **Core Prerequisite** module and **other prerequisite honours modules** (if any) that should be taken during the Masters *preparation year*.
- The **BCS 780 module** is one of the prerequisite modules that serve as a vehicle for compiling a research proposal that should be approved by the study leader as a prerequisite to continue with the Masters study.
- For the *preparation year*, students *register for an Honours degree*, completing (and passing) the prerequisite modules and other modules prescribed by the **potential study leader**.
- A student has an option to continue in the subsequent year with honours modules and exit on honours if the student decides to continue with Honours rather than finishing the Masters.

#### Masters dissertation year

- For the subsequent year, once the Masters proposal has been approved by the **allocated study leader**, the student registers for the Masters degree.

### Process for students *with* Honours-related degree

- The departmental postgraduate committee may request evidence of knowledge of research methodology, since it is possible that the student did not complete an appropriate research methodology module as part of their Honours degree.
- The departmental postgraduate committee may require additional honours modules for non-degree purposes where background is considered insufficient.
- The departmental postgraduate committee reserves the right to make a thorough assessment of the applicant's academic transcript and Curriculum Vitae (CV), to decide if the applicant is considered suitable for postgraduate studies. This assessment may include an oral or written examination.

### Applications and research topic submission

Once a *Masters proposal* was approved by the **allocated study leader**, the student may apply and register for the relevant Master's degree.

## Doctorate Programmes

It requires the preparation of a thesis by the student based on his/her own independent and original research as a positive contribution towards the development of science and the existing body of knowledge of the area/knowledge domain. The requirements for the thesis are based on, but not limited to, the requirements for a dissertation, with the important addition of the student's ability to prove that he/she can plan, initiate, and execute independent and original research. The minimum duration of study is 2 years. The student may not have previously submitted the thesis for graduation purposes at another tertiary institution.

### Research Topic

A prospective student should select a research topic in collaboration with the staff of the Department of Industrial and Systems Engineering. Research topics may be chosen within the three research streams and other topics may be considered in consultation with the HoD.

The following are research focus streams within the Department of Industrial and Systems Engineering:

- **Modelling and Optimization**
- **Systems and Business Process Optimization**
- **Logistics and Supply Chain Engineering**

Some pre-defined topics may be available on the departmental website:

<https://www.up.ac.za/industrial-and-systems-engineering/article/2005687/masters-and-doctorate-research-topics>

Please consult with the concerned lecturer as indicated. Students may also provide their own research topic.

## Minimum admission requirements

### PhD Industrial Engineering

Plan code: 12263002, Module code: BIR 990

An MEng degree awarded by the University of Pretoria.

**or**

A research-based Master's degree in engineering awarded by another university.

The applicant must also meet the admission requirements for the BEng Hons degree.

**or**

An appropriate research-based Master's degree.

The applicant must also meet the admission requirements for the BScHons AplSci degree if not meeting with the requirements for the BEng Hons degree.

## Selection process

The departmental postgraduate committee may request evidence of knowledge of research methodology, a copy of the Master's dissertation and a list of published journal articles (if any).

The departmental postgraduate committee may require additional honours modules for non-degree purposes where background is considered insufficient. The departmental postgraduate committee reserves the right to make a thorough assessment of the applicant's academic transcript and Curriculum Vitae (CV), to decide if the applicant is considered suitable for postgraduate studies. This assessment may include an oral or written examination.

## Applications and research topic submission

Students have to submit their Doctorate proposal to the department and collaborate with a proposed/selected supervisor. Students may thereafter upon approval, apply and register for the relevant Master's/Doctorate degree. Please also read the **Research** section in this brochure.

## Research

The following section is applicable mainly to students enrolling for Master's and Doctorate studies.

### Research phases

An overview of the different research phases and required documents are given on the EBIT Lifecycle Website: <https://www.ebitpostgraduatelifecycle.website/>

### Proposal document

When a student enrolls for BCS 780 as part of an Honours, a student already completes a proposal document that needs to be approved for Masters studies by a study leader (permanent employer at the Department of Industrial Engineering).

A student may also start afresh with a new proposal (for either a Master's or PhD). The proposal document should include a complete project plan that addresses technical deliverables, time scales, and costs. A copy must be submitted to **Mrs Sehaam Brey on sehaam.brey@up.ac.za**. The problem/opportunity must be postulated clearly, and details must be furnished of the environment in which the study will be conducted. Sketches, photographs, and diagrams usually make it convenient for an outsider to understand the problem. The scope of the work, as well as the planned approach and the perceived route, are important. Any presentable work that has been completed beforehand (e.g. an overview model or prototype), should be presented as well.

The document should be within the range of 10 to 20 pages and should address the items as proposed in the following structure:

- **Introduction/Background**
- **Problem statement**
  - What is the problem/opportunity addressed by the student?
- **Purpose and scope of the research**
  - What does the student wish to achieve?
  - Who are the stakeholders that need to mandate the research?



- What are the boundaries for the research?
- Which specific deliverables will be presented and how will the problem be solved?
- **Research methodology**
  - Which steps will be taken in the execution of the research?
  - Which techniques/resources will be used and how will these be obtained?
  - What cost does the research entail, and how will it be covered through the solution's perceived advantages?

Please consult a possible supervisor at the Department for guidance on the proposal document.

### Library resources

Students who have already consulted with a supervisor in the department and who have been advised to utilize the University of Pretoria's library resources may apply and register for the following programme and gain access to the library with a student card (issued by the Student Service Centre 'SSC'):

#### Engineering Postgraduate (Non-degree purposes)

Plan code 12290001

- Master's students will be registered for the following module: ZZZ 777
- Doctorate students will be registered for the following module: ZZZ 888

### Policies, professional and ethical conduct

It is expected of students and lecturers to follow the University's policies and to display professional conduct in all activities related to post graduate studies, including matters such as: class conduct, plagiarism, copyright, referencing and students with special needs apply. Please visit the EBIT Faculty webpage on Research Ethics and Integrity: (<http://www.up.ac.za/en/faculty-of-engineering-built-environment-it/article/15815/faculty-committee-for-research-ethics-integrity>). Application forms, Declaration by researcher- and Informed consent forms may be downloaded from the above-mentioned webpage.

Students and lecturers that intend to do research using questionnaires or interacting with industries in related ways MUST obtain EBIT ethical clearance before compiling the questionnaires.

## General

### Fees and funding

Please refer to the "Fees and Funding webpage" (<http://www.up.ac.za/fees-and-funding>) which gives details regarding tuition fees, scholarships and loans. Student may contact Student Accounts at the Student Service Centre (SSC) for queries on the various fees such as application-, registration- and tuition fees. Contact detail:

Tel: 012 420 3111/4111, E-mail: [ssc@up.ac.za](mailto:ssc@up.ac.za)

### ClickUP

ClickUP is the online learning management system of the University of Pretoria that acts as a virtual classroom. All Postgraduate students (including Masters and PhD students) will have access to ClickUP once registered. Students will be able to login via "MyTUKS Login" from the Homepage on the University of Pretoria's website. Students will then be navigated to the "UP Student Portal" where his/her registered modules (ClickUP courses for each subject and the departmental ClickUP course) will be listed. Each module has a unique site that contains lecturer details, study guide, course structure, prescribed material, and announcements. It also hosts facilities to conduct online discussions and e-mail communication(s). Since ClickUP is the official means through which lecturers communicate to all students, students must visit ClickUP regularly and ensure that their latest e-mail addresses are registered in ClickUP.



Additional information may be obtained from the Student Help Desk at:

- E-mail: [studenthelp@it.up.ac.za](mailto:studenthelp@it.up.ac.za)
- Tel: +27 12 420 3837

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### \*Note:

*The most recent version of the brochure will be published on the departmental website as stated above. All matters pertaining to the administration of postgraduate activities is the responsibility of the Head of the Department IE **Although every attempt has been made to ensure that this brochure is correct and up to date at the time of publishing, the Department reserves the right to make any changes without prior notice and without prejudice. Due to the unavailability of lecturing staff, some modules may be discontinued or changed.***

## Appendices

### Contact Details

#### Department of Industrial and Systems Engineering

##### Honours, Master's and PhD enquiries: Curriculum and Class Timetables

Contact person Mrs Sehaam Brey  
 Office Engineering II, Room 3-13  
 Contact details Tel: +27(0)12 420 3762  
 Fax: +27(0)12 362 5103  
 E-mail: [sehaam.brey@up.ac.za](mailto:sehaam.brey@up.ac.za)  
 Webpage: <https://www.up.ac.za/industrial-and-systems-engineering>  
 Office hours Monday - Friday 07:30-16:00

#### Engineering Student Administration (EBIT)

##### Honours Programmes: Applications, Administration and Registration

Contact person Mr Roy Mashiloane  
 Office Engineering I, Room 6-9  
 Contact details Tel: +27(0)12 420 3656  
 Fax: +27(0)86 544 4640  
 E-mail: [roy.mashiloane@up.ac.za](mailto:roy.mashiloane@up.ac.za)

##### Master's & Doctorate Programmes: Administration, Applications and Registration

Contact person Mr Edward Masemola  
 Office Engineering I, Room 6-8.1  
 Contact details Tel: +27(0)12 420 3619  
 Fax: +27(0)86 544 4640  
 E-mail: [te.masemola@up.ac.za](mailto:te.masemola@up.ac.za)  
 Webpage: <http://www.up.ac.za/faculty-of-engineering-built-environment-it>  
 Office hours Monday - Friday 07:30-16:00

#### Student Service Centre (SSC)

##### Enquiries on Applications student accounts, fees & funding and Bursaries & Loans

Contact details Tel: +27(0)12 420 3111  
 Fax: +27(0)12 420 4555  
 E-mail: [ssc@up.ac.za](mailto:ssc@up.ac.za)  
 Webpage: <http://www.up.ac.za/enquiry>  
 Office hours Monday - Friday 08:00 - 16:00

## Module Descriptions

### BAN 780 Industrial analysis (Compulsory module, BSc Hons) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

*\*\*Compulsory only for BSc(Hons) AplSci students. Can be taken as elective module by Engineering students who did not complete an Industrial Engineering undergraduate degree. It CANNOT be taken by students who completed an Industrial Engineering undergraduate degree \*\**

#### Module content:

- Descriptive modelling: Engineering Statistics (self-study)
- Predictive modelling: Simulation Modelling
- Prescriptive modelling: Operations Research

*Note that the Descriptive modelling theme is assessed during the first scheduled class in block-week 1 and counts 50% of the semester mark. Study material for the theme is available on ClickUP.*

*BAN 780 serves as Prerequisite for BDE 780.*

### BAO 780 Advanced aspects of Operations Research (Elective module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

Decision makers are frequently faced with complex problem environments. The module introduces two advanced topics in the field of Operations Research that can assist in the development of more relevant decision support models. The first topic deals with multi objectivity and introduces a variety of interventions to incorporate the competing objectives into mathematical programming models. Secondly, the topic of Data Envelopment Analysis (DEA) is introduced, a non-parametric method used to empirically measure the productive efficiency of decision-making units. This linear programming methodology allows the decision maker to measure the productivity in complex environments with multiple inputs and outputs; uncover often-overlooked relationships between in- and outputs; and analyse and quantify the inefficiencies of every unit evaluated.

### <sup>1</sup>BAR 780 Solution Algorithms in Operations Research (Core elective module) - Credits: 32

Academic organisation: Industrial and Systems Engineering  
 \*Prerequisite: BAN 313 or BAN 780  
 Contact time: 36 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

When developing decision-support models using optimisation, the computational burden is often so great that exact optimal solutions are not attainable, or not efficiently found, especially in combinatorial and discrete optimisation problems. Often approximate solutions are adequate and can provide superior solutions to the current state-of-practice decision approaches. The module introduces a selection of heuristics and metaheuristics applied to a variety of problems frequently faced by Industrial Engineers. The module also introduces a methodology to test and validate heuristics to ensure robust and reliable application. The module will focus on exact, heuristic and meta-heuristic optimisation algorithms, and introducing research methodologies specifically applicable to the field of operations research.

<sup>1</sup>*Students are encouraged to take this module in conjunction with BDE 780 and BOZ 780*

### BBA 781 Enterprise engineering & research methods (Core prerequisite module) - Credits: 32

Academic organisation: Industrial and Systems Engineering  
 \*Prerequisite: Information systems design (BID 320)  
 Contact time: 36 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module Content:

Enterprise Engineering can be defined as the body of knowledge, principles, and practices to design an enterprise. Due to their complexity and the continuously changing environment, enterprises need new approaches, tools and techniques to deliver innovative products and services to new markets in competitive environments. This module offers an introduction to the engineering design process applied to the enterprise as a system, and present existing approaches for designing, aligning and governing the enterprise. Within the design paradigm, the module also offers research methods (e.g. design research, case study research, action research, action design research) that are relevant for doing research within the enterprise engineering discipline.

#### The module covers:

- Background on systems thinking
- Systems design and systems engineering
- Prominent approaches for creating an enterprise engineering capability (e.g. Zachman, The Open Group, Dietz/Hoogervorst).
- Mechanisms and practices associated with different phases of enterprise design (e.g. enterprise modelling, languages, road maps, maturity assessment etc.)
- Research methods and techniques to validate and extend the EE knowledge base
- Case studies
- Change management

\* A prerequisite-knowledge test will be conducted at the start of the semester to evaluate whether the student has sufficient prerequisite knowledge to continue with the module.

### BCI 780 Supply chain information & decision technology (Elective module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

Information technology is an important enabler of effective supply chain management, typically spanning the extended value chain from suppliers to customers. The timeliness and availability of relevant information are critical when applying supply chain strategies that increase service levels of and reduce cost and lead times. Value-added IT-based services are increasingly used to differentiate and develop relationships with customers.

#### The objective of the course is:

- To develop a sound understanding of components and priorities
- IT investment to enable supply chain integration and efficiency
- The impact of business process change on IT implementation and selection of decision support systems
- The value of information
- Leveraging financial information
- Advanced supply chain planning and execution
- Decision support systems
- IT capabilities for supply chain excellence
- Enterprise resource planning
- Systems advanced planning and scheduling systems
- Identification technology
- Integrating supply chain IT



### BCS 780 Industrial and systems engineering research (Compulsory module) - Credits: 32

**Academic organisation:** Industrial and Systems Engineering  
**\*Prerequisites:** Within chosen study field – Any one of the following *core prerequisite modules*: BBA 781, BPZ 782, BOZ 780.  
**Contact time:** 24 contact hours per semester  
**Research percentage:** Approximately 40%  
**Period of presentation:** Semester 1 or 2  
**Language of instruction:** English

#### Module content:

The module affords an individual student the opportunity of studying a designated area of coherent knowledge under the tutorship of a senior staff member of the Department of Industrial and Systems Engineering. Eligibility, topic and scope of the intended project must be determined in consultation with the proposed supervisor.

### BDE 780 Design and analysis of experiments (Elective module) - Credits: 16

**Academic organisation:** Industrial and Systems Engineering  
**\*Prerequisites:** BES 220 or BAN 780 or equivalent as approved by the Head of the Department. Students who have completed another statistical course must apply for acceptance to this module by writing a letter, which demonstrates equivalence of courses.  
**Contact time:** 24 contact hours per semester  
**Period of presentation:** Semester 1 or 2  
**Language of instruction:** English

#### Module content:

The design of an experiment may be defined as ‘the logical construction of an experiment in which the degree of uncertainty with which the inferences are drawn may be well defined’.

#### The module covers:

- Principles of experimental design (randomisation, replication and blocking, local control)
- One-Factor-Two-level factorial designs
- One-Factor-Multi-level factorial designs
- Completely Randomised Design (CRD) and introduction to ANOVA
- Randomised Complete Block Design (RBD)
- Latin Square Design (LSD)
- Balanced Incomplete Block Design (BIBD)
- Factorial experiments (2<sup>nd</sup> and 3<sup>rd</sup> factorial experiments)
- Blocking and confounding in factorial designs
- Overview of fractional factorial designs

### BEE 780 Inventory modelling (Elective module) - Credits: 16

**Academic organisation:** Industrial and Systems Engineering  
**Contact time:** 24 contact hours per semester  
**Period of presentation:** Semester 1 or 2  
**Language of instruction:** English

#### Module content:

- Theory of Inventory Systems: Inventory models and modelling including time and certainty complexities, linear and non-linear systems and feedback systems
- Review of inventory models: Types and representations (classic, shortage, capacity constraint, time
- Review of important inventory papers, their approaches and their focus
- Modelling and solution techniques: characterisation and assumptions, mathematical modelling, mathematical programming, heuristics, simulation models, Control Theory and other approaches
- State of the art of modelling: current challenges and research trends
- Technological solutions of inventory modelling and management: algorithms and software, integration to MRP, ERP and scheduling modules, integration to WMS modules, and demonstrations

### BES 780 Applied engineering statistics (Elective module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

This module presents an applied approach to solve real-world engineering problems. The premise of the course is that data analysis, and thus, applied statistics, is an inseparable part of conducting research and solving engineering problems. The module presents the elements of different types of statistical studies as they relate to different industrial settings. The aim of the module is to promote inductive reasoning through the gathering, analysing and interpreting of diverse types of observational data. The outcome of the module is an engineer equipped to select and apply statistical methods appropriate to an industrial setting.

#### The module covers:

- Contextualisation: different types of industrial processes and research settings, related types of statistical studies and a framework for understanding and applying statistics, principles of probabilistic and rational data gathering
- The use of common and specialised probability distributions (such as the Gamma, Exponential and Weibull distributions) in solving real-life problems, conducting scientific research and analysing stochastic and deterministic processes
- Data transformations: when and how to transform data
- Bridging the gap between technology and statistical analysis: The use of EXCEL in resolving basic and advanced statistical problems

### BGH 780 Quality management (Core elective module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

Professionally, engineers are confronted with issues related to product quality and performance or organisational excellence. The intention of this course is to provide an overview of the domain of modern quality management and to equip the student with theory, methodologies and tools and techniques to improve and achieve product quality and performance excellence.

#### The module covers:

- Contextualisation: the history, guru's, principles, industrial setting and the domain of Quality Management
- Practices of improving and achieving product quality: role in industrial engineering, online and offline quality control practices
- Frameworks of improving organisational excellence: National Quality Awards, ISO 9000 and other frameworks
- Practices of improving performance excellence: quality and competitive advantage, customer and supplier relationships, people empowerment and motivation, quality Leadership and organisational change

### BHM 780 Probability models (Elective module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

The objective of the module is that students be exposed to probability theory, learn the ability to follow fairly involved theoretical reasoning, continue to learn how to reason mathematically, and solve problems of a more practical nature.

#### The module covers:

- Probability theory: random variables and random vectors, Sequence of random variables, transformation of

probability distributions, stochastic processes: examples of stochastic processes; various types of stochastic processes

- Poisson processes: homogeneous and non-homogeneous stochastic processes with examples
- Renewal processes: renewal functions; ordinary and delayed renewal processes; regenerative stochastic processes
- Discrete-time Markov chains: continuous time Markov chains with focus on examples in reliability, queuing and inventory models

### BIS 780 Information systems (Elective module) - Credits: 16

**Academic organisation:** Industrial and Systems Engineering

**\*Prerequisites:** Information systems design BID 320, Production BPZ 410 – for Industrial Engineering students prior to 2003. Similar course presented by Information Technology

**Contact time:** 24 contact hours per semester

**Period of presentation:** Semester 1 or 2

**Language of instruction:** English

#### Module content:

To introduce the student with a background in transactional application software development to a variety of aspects in the wider field of information technology. Emphasis is on the functional design of Business Intelligence systems from an Industrial Engineering perspective. The aim is to enable the student to appreciate the scope of management challenges in the integrated environment of business processes, transactional application software, data, IT infrastructure and telecommunications, data warehousing, and the necessary management information needed at various levels in an organization.

#### The module covers:

- Technology trends
- Context diagram of application software portfolio
- Review of typical transactional information systems
- Role of Business Intelligence and data warehousing
- Business dimensional lifecycle
- Business requirement definition
- Basic elements of the data warehouse
- Extraction, Transformation and Loading processes
- Dimensional modelling (star schema)
- Metadata
- Information delivery

### BLC 780 Lean supply chain strategies and systems (Elective module) - Credits: 16

**Academic organisation:** Industrial and Systems Engineering

**Contact time:** 24 contact hours per semester

**Period of presentation:** Semester 1 or 2

**Language of instruction:** English

#### Module content:

Supply chain executives need to contribute and support long-term strategic objectives by providing a competitive edge through an aligned supply chain strategy. The course addresses the impact of lean principles in supply chain management and practical approach to implementing lean thinking and demand driven supply chains. The course provides a framework for the strategic supply chain decisions, both in designing and managing an efficient extended supply chain. The latest innovations, trends and challenges in agile supply chain strategies and systems are reviewed. Team leadership skills are developed through practical applications, approaches and best practices of lean supply chain design and management. Supply chain leadership perspectives will be provided by executives and managers from industry and team-based simulation games.

#### The module covers:

- Fundamentals of lean management
- Lean thinking and supply chain (SC) management
- Customer value
- Network design strategies
- Supply chain integration and barriers to integration

- SC performance measurement
- Extended value chain and value stream mapping
- Eliminating waste in the supply chain
- Applying lean principles to supply chain operations
- Inventory positioning approaches
- Operational executive problems
- A3 Performance Management

### BLK 781 Supply chain processes (Core module) - Credits: 16

**Academic organisation:** Industrial and Systems Engineering  
**Contact time:** 24 contact hours per semester  
**Period of presentation:** Semester 1 or 2  
**Language of instruction:** English

#### Module content:

A key objective of supply chain management is to develop competitiveness and achieve a market advantage through the implementation of cross-functional processes as the mechanism to coordinate internal and external activities. The course aims to create an understanding of the importance of integrating key supply chain business processes and to develop the ability to analyse and implement such processes across functional and corporate silos. Standardised process definitions and practices, including strategic and operational sub-processes and key performance measurements, are considered.

#### The module covers:

- Customer relationship management process
- Supplier relationship management process
- Customer service management process
- Demand management process
- Order fulfilment process
- Manufacturing flow management (planning & control) process
- Product development and commercialisation process
- Returns management process
- Assessment of Supply Chain Management (SCM) processes
- Implementing and sustaining SCM processes
- Supply chain mapping approaches
- Supply chain performance measurement

### BMK 780 Process optimization (Elective module) - Credits: 16

**Academic organisation:** Industrial and Systems Engineering  
**\*Prerequisites:** Module only available to students with a BEng Industrial degree  
**Contact time:** 24 contact hours per semester  
**Period of presentation:** Semester 1 or 2  
**Language of instruction:** English

#### Module content:

Process optimisation is an engineering discipline, which focuses on the tools and techniques used specifically for business process analysis, design, and optimisation. As physics determines the physical behaviour of tangibles, process physics forms the foundation of business process behaviour. Traditionally, operations research techniques are used by Industrial Engineers to optimise business processes, process optimisation provides a more focused approach using techniques such as Social Network Analysis, System Dynamics, image profiling and process mining to uncover analytical models. The outcome of this course is to enable the student to create an integrated, analytical business process behaviour profile. This supports the analysis, design and optimisation of business processes in a Business Engineering lifecycle. Process optimisation requires an understanding of operations research within the business engineer framework. This course requires a full understanding of undergraduate Industrial Engineering modules as well as a postgraduate understanding of resource optimisation and enterprise architecture.

#### The module covers:

- Standard process physics principles, facts and models
- Process Intelligence
- Adaptive process control and SMART processes

- Robustness and complexity analysis
- Process mining
- Social network analysis

### **<sup>2</sup>BOZ 780 Operations research (Core module) - Credits: 32**

Academic organisation: Industrial and Systems Engineering  
 Contact time: 36 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

Building on undergraduate modules in Operations Research, the module aims to extend the mathematical programming and optimisation capabilities by introducing uncertainty. Many decision makers are confronted with complex environments in which data is not known with certainty, or in which the decision constraints are uncertain. For cases where one knows the shape, or can assume that the uncertainty follows a known probabilistic distribution, stochastic programming can be used. In the module both chance-constrained programming and fixed recourse are introduced. Fuzzy optimisation is introduced for cases where the shape and/or distribution of the uncertainty are not known. The module also addresses the uncertainty when a decision maker is confronted with multiple, competing objectives.

### **BPZ 782 Manufacturing planning & control systems (Core prerequisite module) - Credits: 32**

Academic organisation: Industrial and Systems Engineering  
 \*Prerequisite: Operations Management and Operations Research (advisable but not mandatorily required)  
 Contact time: 36 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

Review of MPC, Agile Manufacturing Processes, Models of MPC (Details in the attached document).

Section 1: Review of MPC Theories and Framework

Section 2: Research Framework for Problems in Manufacturing Systems

- Mathematical Model based Problems and their techniques
- Estimation and Hypothesis based Problems and their techniques
- Section 3: Introduction to MPC Problems and sample Models
- Forecasting models
- Aggregate planning models
- Lot sizing and disaggregation models
- Finite Scheduling models
- Lean Manufacturing Models
- Basic Distribution and Replenishment Models
- Basic Supply Chain Structural Analysis and Performance Models
- Section 4: Agile Panning Problems and Techniques
- Multi-Level Master Scheduling Techniques
- Constraint Scheduling – (TOC theory, applications and optimisation)
- Lean Manufacturing Implementation (from Flow Lean to Process Kaizen)
- Introduction to CONWIP ideology
- Introduction to Demand Driven MRP

### **BSI 780 Business engineering (Elective module) - Credits: 16**

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:



Organisations are complex systems, which consist of people, processes, customers, resources and regulatory environments. Business Engineering (BE) is a discipline which uses an engineering approach towards introducing planned business change into the organisation. This includes formal analysis, design, implementation and maintenance of the holistic business system; requiring a deep understanding and knowledge of the interaction and balance of complex business system elements. The outcome of the course is to enable the student to understand the art and science of engineering complex business systems. Business engineering is the ultimate pinnacle of industrial engineering competency – being able to construct business systems serving complicated organisational value propositions. The course requires a full understanding of undergraduate Industrial Engineering modules as well as a post-graduate understanding of resource optimisation, enterprise architecture, and supply chain engineering.

#### The module covers:

- BE principles for design, implementation and optimisation of complex business systems
- BE programme process which governs the implementation of holistic business changes
- BE programme and project structures
- BE Tools and techniques used throughout the BE lifecycle for engineering modelling and optimisation.
- Business
- Models and innovation approaches
- Integrated Business planning
- Business Process reference models for strategic, tactical, core and support processes.

### BSS 780 Systems Engineering (Elective Module) - Credits: 32

**Academic organisation:** Industrial and Systems Engineering

**\*Prerequisite:** BBA 781

**Contact time:** 36 contact hours per semester

**Period of presentation:** Semester 1 or 2

**Language of instruction:** English

#### Module content:

Systems engineering is a multi-disciplinary engineering profession that focuses on the conceptualisation, design, analysis, synthesis, development, architecting and management of complex systems over their life cycle. It does this by creating, executing and coordinating an interactive platform for all stakeholders viz: clients, consumers, design team/technical crew and management team amongst others. Complexity of systems hinges on diversity, multiplicity and intricacy of intra- and inter-connectivity of system entities. This module will commence briefly with some introductory catch up lectures prior to diverting into intermediate and advanced concepts with specific attention given to case studies, development and application of models and emergence of research opportunities. The module will focus on both the management and technical components of systems engineering. Specific AI based systems would be explored in a bid to address technical process systems engineering.

#### The module covers:

##### **Systems Engineering Management Process:**

**Systems Engineering Management Plan (SEMP) covering (Case Based Systems)** with discussions spanning across:

- **Systems Conceptual Design:** Identifying requirements, Analysing Requirements, Defining Concepts, Exploring Concepts, Evaluating Concepts, Deployment of CORE9/GENESYS for Systems Architecting and Integration; Systems Engineering Analysis
- **Engineering Design:** Understanding and exploring the phases of the engineering design stage
- **Post-Development Considerations:** Reliability in Production and Operations of Systems in the post development stage of a System; Life Cycle modelling and analysis; Risk Modelling throughout a System's life cycle

##### **Systems Thinking & Dynamics for Complex Societal Problem Solving:**

- **Modelling of Case Study Dynamical Systems covering such topics as:** Internet of things (IoT), Relationship of things (RoT), Interaction Dynamics, Social Engineering Thinking, Complexity of Interaction in Systems and complexity Issues in System Dynamics, Reconfiguration and Optimal Network Selection in System Dynamics.

##### **Systems Engineering Technical Process:**

###### **Intelligent Systems:**

- Overview of human-machine systems Interaction; Intelligent systems modelling spanning across: robotic arm kinematics, dynamics; Robotic vehicle modelling; Machine learning applications in robotics systems control.

### BTH 780 Reliability engineering (Elective module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

To make students conversant with the concepts, tools and techniques of reliability engineering

The module covers:

- Introduction to reliability engineering
- Reliability mathematics
- Probability plotting
- Reliability prediction for design
- Reliability testing
- Reliability growth
- Maintainability
- Reliability management

### BUY 780 Simulation modelling (Core elective module) – Credits: 32

Academic organisation: Industrial and Systems Engineering  
 \*Prerequisite: BAN 313 or BAN 780  
 Contact time: 36 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Research percentage: Approximately 40%  
 Language of instruction: English

#### Module content:

In recent years the boundaries between different simulation paradigms such as discrete event simulation, system dynamics and agent-based models have become less distinct. Improvements in computational efficiency also allow much richer and complex models to be built. This course introduces agent-based models (ABM) as a class of computational models that deal with autonomous agents and their interactions with other agents, and their surrounding environments. Course content covers basic theoretical foundations of ABM and then focuses on a few specific application areas where ABM is used for decision-making; pedestrian and transport models; production and logistics; as well as biology.

### BVK 780 Supply chain design (Core module) - Credits: 16

Academic organisation: Industrial and Systems Engineering  
 \*Prerequisites: BLK 781 Supply chain processes  
 Contact time: 24 contact hours per semester  
 Period of presentation: Semester 1 or 2  
 Language of instruction: English

#### Module content:

Strategic design of supply chain networks, inventory management and supply chain integration. Framework for strategic alliances and third-party logistics. Analysis and application of alternative supply chain reference models as the basis for modelling, analysis and improvement.

#### The module covers:

- Supply chain network design
- Strategic management of inventory
- Supply chain integration
- Strategic alliances
- Coordinated product and supply chain design
- Supply chain modelling (SCOR, VRM)

**The following modules are currently NOT offered:**

• Advanced aspects of operations research	BAO 780	(Elective module)
• Solution algorithms in operations research	BAR 780	(Core elective module)
• Supply chain information & decision technology	BCI 780	(Elective module)
• Design and analysis of experiments	BDE 780	(Elective module)
• Inventory modelling	BEE 780	(Elective module)
• Applied engineering statistics	BES 780	(Elective module)
• Probability models	BHM 780	(Elective module)
• Information systems	BIS 780	(Elective module)
• Lean supply chain strategies and systems	BLC 780	(Elective module)
• Process optimization	BMK 781	(Elective module)
• Business engineering	BSI 780	(Elective module)
• Simulation modelling	BUY 780	(Core elective module)
• Reliability engineering	BTH 780	(Elective module)

# Honours Class Timetable - 2024

Subject	Contact	Time	Apr (*BW 1)				May (*BW 2)				Jun (*BW 3)				Jul (Exam)				Venue:						
			8	9	10	11	12	13	14	15	16	17	18	19	10	11	12	13		14	15	16	17		
Industrial Analysis (BAN 780)	Prof <del>W</del> Bean & <del>A</del> Brian Ndlovu	08:00-12:00																					Dates & venue to be confirmed	ENG NW 11 Project Lab (08 & 09 April)	
		13:00-17:00																							
Supply Chain Processes (BLK 781)	<del>A</del> Johan de Villiers	08:00-12:00																						Dates & venue to be confirmed	ENG 11 3-31 (08 & 09 April)
		13:00-17:00																							
Enterprise Engineering (BBA 781)	Prof Mame de Vries	08:00-12:00																						Dates & venue to be confirmed	Mineral Sciences Building Labs 3rd Floor (10 - 12 April)
		13:00-17:00																							
Manufacturing Planning & Control Systems (BPZ 782)	Prof Olufemi <del>A</del> <del>A</del>	08:00-12:00																						Dates & venue to be confirmed	ENG 11 3-31 (10 - 12 April)
		13:00-17:00																							

\*BC 8 730 (Industrial & Systems Engineering Research) **Information Session** Video Recording available at the following link: <http://www.up.ac.za/en/industrial-and-systems-engineering/article/46575/postgraduate>

Second Semester 2024																									
Subject	Contact	Time	Aug (*BW 1)				Oct (*BW 2)				Nov (*BW 3)				Dec (Exam)				Venue:						
			26	27	28	29	30	14	15	16	17	18	11	12	13	14	15	2		3	4	5	6	8	
Operations Research (BOZ 780)	Prof <del>W</del> Bean	08:00-12:00																						Dates & venue to be confirmed	To be confirmed
		13:00-17:00																							
Systems Engineering (BSS 780)	Dr Michael <del>A</del> <del>A</del>	08:00-12:00																						Dates & venue to be confirmed	To be confirmed
		13:00-17:00																							
Supply Chain Design (BVK 780)	<del>A</del> Johan de Villiers	08:00-12:00																						Dates & venue to be confirmed	To be confirmed
		13:00-17:00																							
Quality Management (BGH 780)	Dr <del>A</del> <del>A</del> <del>A</del>	08:00-12:00																						Dates & venue to be confirmed	To be confirmed
		13:00-17:00																							

\*BC 8 730 (Industrial & Systems Engineering Research) **Information Session** Video Recording available at the following link: <http://www.up.ac.za/en/industrial-and-systems-engineering/article/46575/postgraduate>

\*BW Refers to Block Week

\*BC 8 730 is compulsory for all ~~A~~ ~~A~~ ~~A~~ students - please refer to page 12 of the PG Guide for pre-requisites.

\*BAN 730 is compulsory for all ~~A~~ ~~A~~ ~~A~~ students

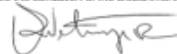
Class sessions are scheduled from either 08:00 - 12:00 AM or 13:00 - 17:00 PM

Class Sessions   
 Exams

**IMPORTANT NOTE:**

1. Please ensure to check for timetable clashes when choosing electives from other Departments, it will not be the obligation of the Department

Last Updated: 2024/14/03



Prof. Olufemi ~~A~~ ~~A~~  
 : Department of Industrial and Systems Engineering