Faculty of Natural and Agricultural Sciences

Fakulteit Natuur- en Landbouwetenskappe

Lefapha la Disaense tša Tlhago le Temo

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Department of Statistics

Postgraduate study

Why do postgraduate studies in Statistics?

There are plenty of oppurtunities ahead. This is really a GOLDEN age for Statistics.

Sara van den Geer- President of the Bernoulli Society (May 2017)

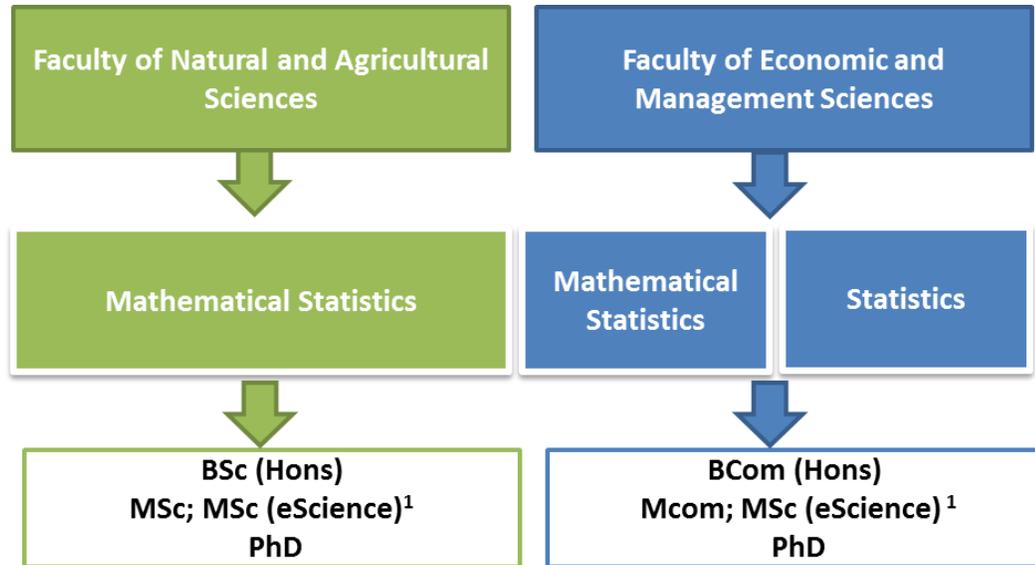|		
"**A LinkedIn survey in 2016 indicates that the number one skill that can get you hired in South Africa right now, is statistical analysis and data mining.**	US News ranked Statisticians as #1 in the Best Business Jobs listing.	*A 2016 Fortune magazine article indicates that having a master's degree in Biostatistics or in Statistics will ensure you of excellent employment with above average remuneration.*

A career in Statistics is a highly rewarding one. Statisticians' skills are applied in actuarial science, atmospheric science, bioinformatics, biomathematics, biostatistics, economics and econometrics, environmental sciences, financial engineering, government service, industrial statistics, medicine, meteorology, official statistics, retail market, pharmaceutical research, public health, quality improvement, reliability, risk analysis, risk management and insurance, social statistics and survey research, amongst others. A master's degree or PhD is very helpful and often required or recommended for higher level positions in industry.

Statistics Industry HUB in our Department

The HUB brings master's students and industry partners together through exciting study opportunities. Join a vibrant HUB community and experience statistics used to compile life insurance products; statistics used to recommend fashion items online; statistics used to detect fraudulent credit card transactions; and many more. Select one of many research topics, and start building your statistics career while you're a student.

The Department of Statistics at the University of Pretoria offers an extensive and flexible range of postgraduate programmes.

The following postgraduate programmes and disciplines are presented (in collaboration with other departments at UP and other institutions) from 2018:

Faculty of Natural and Agricultural Sciences	Faculty of Economic and Management Sciences	
Mathematical Statistics	Mathematical Statistics	Statistics
BSc (Hons) MSc; MSc (eScience)[1] PhD	BCom (Hons) Mcom; MSc (eScience)[1] PhD	

[1] See the MSc section.

Honours Programmes

General

The honours degree is presented in Mathematical Statistics and in Statistics. Apart from the modules presented by the Department of Statistics, it is also possible to include postgraduate modules from other departments e.g. Mathematics, Economics, etc. Regarding the number of credits from other departments the following is applicable:

a. The department must be a "related" department.
b. The student must hand in a proposal to the head of the department for approval at his/her own discretion.
c. At most one of the six modules (required for the degree) can be replaced with the understanding that compulsory modules cannot be replaced and thus only elective modules are replaceable.

Normally a module is only offered once a year in any one semester, see program composition for presentation period. A candidate must compile his/her programme in consultation with the head of the department or the department's postgraduate committee.

Admission requirements

a. A relevant Bachelor's degree with Mathematical Statistics or Statistics on the 300 level is required (Economics on the 300 level is also required for BCom(Hons) in Statistics specialising in Economic Statistics).
b. For BSc(Hons) and BCom(Hons) in Mathematical Statistics, an average mark of 65% or more for Mathematical Statistics modules on the 300 level.
c. For BCom(Hons) in Statistics an average mark of at least 65% in Statistics 310, 320 and 353 is required.
d. Please see the additional requirements for external students as well as international students at the end of this document. Student numbers are limited to a maximum of 40, collectively over all Honours Programs in the Department of Statistics.
e. Historical performance during prior studies will also be considered in selecting students. Specific attention will also be given to modules repeated and duration of study.
f. Any additional entrance requirements as specified by the head of the department in consultation with the departmental postgraduate selection committee. Students with gaps in between studies may be required to write an entrance evaluation.
g. A student may only commence studies in this department at the beginning of an academic year.

Duration of programme

The minimum duration is one year of full-time study or two years of part-time study. A student must complete his or her study for an honours degree, in the case of full-time students, within two years from the first examination to the final examination and in the case of part-time students, within three years from the first examination to the final examination. Under special circumstances, the Dean, on the recommendation of the head of department, may give approval for a limited extension of this period.

Promotion

The progress of all honours candidates is monitored biannually by the department's postgraduate committee and head of department. Subject to exceptions approved by the dean, on recommendation of the head of the department, a student may not enter for the honours' examination in the same subject more than twice and a candidate's study may be terminated if the progress is subsequently deemed unsatisfactory or if the candidate is unable to finish his/her studies during the prescribed minimum period. If a candidate has failed more than three (3) different subjects, he/she will be dismissed from the degree. In addition the research report may only be registered for once – unsuccessful completion will result in dismissal from the degree.

Programme composition

The available programs with their compositions are given below.

- **BSc(Hons) in Mathematical Statistics and BCom(Hons) in Mathematical Statistics** (135 credits):

First Semester	Second Semester
Compulsory modules (60 credits)	
LMO710 Linear Models (15)	
MVA710 Multivariate Analysis (15)	
WST795 Research Report: Mathematical Statistics (30)	
STK796: Research Orientation (0)	
Elective modules (choose 5) (75 credits)	
SFT720 Sampling Techniques (15)	LMO720 Linear Models (15)
VMT710 Distribution-free Methods (15)	MVA720 Multivariate Analysis (15)
SPC780 Statistical Process Control (15)	PNP720 Parametric Stochastic Processes (15)
	EKT720 Introduction to Statistical Learning (15)
The student must complete the compulsory modules LMO710 and MVA710 in the first semester and the compulsory essay over the whole duration of a year. It is suggested the student weight the five elective modules either 2:3 or 1:3 in order to allow sufficient time to complete the essay in the first semester (the essay work is weighted two thirds and one third over the two semesters respectively).	

In the case of students from other universities TRA 720 (Time series Analysis 720) with credits (15) may be taken as optional module in the second semester for **BSc(Hons) in Mathematical Statistics** or

BCom(Hons) in Mathematical Statistics students subject to the approval by the head of the department.

- **BCom(Hons) in Statistics** (120 credits):

First Semester	Second Semester
Compulsory modules (90 credits)	
RAL780 Regression Analysis (15)	EKT720 Introduction to Statistical Learning (15)
	TRA720 Time Series Analysis (15)
	MET720 Multivariate Techniques (15)
STK795 Research Report: Statistics (30)	
STK796: Research Orientation (0)	
Elective modules (choose 2) (30 credits)	
SFT720 Sampling Techniques (15)	
MIE780 Microeconomics (15)	
SPC780 Statistical Process Control (15)	
MEK780 Macroeconomics (15)	
The student must complete the compulsory essay over the whole duration of a year.	

Notes

a. Some of the second semester modules have first semester modules as prerequisites, as explicated in the section "Particulars regarding the contents of modules."

b. Tests and assignments may be taken into account in the determination of the final mark in each module. Exam entrance may be enforced in each module on discretion of the lecturer.

c. Regulation G.17 applies with regard to examination registration.

d. Examinations in a module will take place during one of the official university examination time periods. In order to pass the programme, a final mark of at least 50% in each of the prescribed modules must be obtained. The honours examination can be divided into at most four sections which must each be written in a time period of at most three weeks and over at most four semesters.

e. Note that the Department of Statistics does not provide supplementary nor sick exams for any postgraduate modules.

f. It is compulsory for all the postgraduate students to attend the seminar series as indicated in STK796.

g. Study financing remains the responsibility of the student. The department is not responsible for the funding or obtaining funding for a student. A student must thus plan his/her finances personally. The department will assist in directing students towards bursary opportunities.

In the case of a dispute with the allocated study leader(s) of research report, the department will proceed as follows:

- The student must raise his/her valid concerns in an open professional manner, without fear of retribution.
- The supervisor(s) has to find constructive solutions to the problem and obtain agreement from the student for the way forward.
- The above- mentioned process assumes that the student did not commit an act which involves disciplinary actions, such cases should be referred to the legal department.
- If the conflict/dispute cannot be solved amicably between student and supervisor then either party can request a change in supervisor. If the current promotor agrees **and** a suitable 'new' supervisor can be found then the student may continue with his/her existing studies. Allocation of a new supervisor is subject to capacity constraints of the department and the current research topic cannot be guaranteed. All existing financial commitments shall be honoured.
- Finally in absence of the above mentioned agreement the student must terminate his/her current studies.

Research Report: WST 795 and STK 795

a. The total time spent on the essay must be at least double that of any module. The submission date of the essay is the middle of November. The dates for the essay poster presentations will be set mid-year. All students must present on these dates. No exceptions.

b. Refer to the document: **Honours Research Report Course Information** available on the web in 2018 (**www.up.ac.za/statistics)** under Postgraduate Studies. Registration and allocation of topic (and by implication a study leader) will be dealt with by the Head of the Department and research report coordinators during the last week of January/ first week of February 2018; details will be conveyed by email in 2018 and a number of topics will be provided on the web page of the department.

c. There is a preparation course during the last week of January comprising part of the compulsory module STK796. *This course will take place during working hours so students should organise leave in advance.* These classes are compulsory. Details in the document mentioned above.

d. This module may only be done once. If a student fails WST 795/STK 795 the student will be excluded from the honours program.

e. Part-time students are advised to do the module WST 795/STK 795 during their second year of study and complete most modules during the first year of study. STK796 has be completed in both years of study.

f. The research report must be handed in together with an acceptable TurnItIn report.

Particulars regarding the contents of modules

- **Distribution-free Methods 710 (VMT 710)**

  Prescribed book:
  - ➢ Randles, R.H. and Wolfe, D.A.: *Introduction to the Theory of Nonparametric Statistics* (John Wiley, 1979)

  Curriculum:

  A selection of: Nonparametric stochastic processes. Power and asymptotic power of distribution-free procedures. Theory and simulation. Asymptotic relative efficiency. Linear rank tests: Definition, properties and applications. Equal in distribution technique. Counting and ranking statistics. Introduction to one and two sample *U*-statistics. Permutation and distribution-free rank-like statistics. Multi-sample distribution-free tests, rank correlation and regression. Some nonparametric bootstrap and smoothing methods.

  Prerequisite: [WST 311, 312, 321 and 322]

- **Introduction to Statistical Learning 720 (EKT 720)**

  Prescribed book:
  - ➢ Gujarati, D.N.: *Basic Econometrics* (Second edition) (McGraw-Hill, 1988)
  - ➢ Intriligator, M.D.; Bodkin7 G.C. and Hsiao, C.: *Econometric Models, Techniques & Applications* (Prentice Hall, Inc.,1996)
  - ➢ Hastie, T; Tibshirani, R and Friedman, J: *The elements of Statistical learning* (Second edition) (Springer 2009)

  Recommended books:
  - ➢ Pindyck, R. S. and Rubinfield, D.L.: *Econometric Models and Economic Forecasts* (Fourth edition) (McGraw-Hill, 1991)
  - ➢ Draper, N and Smith, H: *Applied Regression analysis* (John Wiley, 1998)

  Curriculum:

  The emphasis is on the theoretical understanding and practical application of advanced statistical modelling. The following topics are covered.

  Single equation models: Nonparametric regression. Bootstrap procedures within regression analysis, k-nearest neighbour classification. Modelling categorical dependent variables - Logit / Probit models. Multiple outputs. Linear regression of an indicator matrix. Ridge regression. Non-linear regression modelling. Factor analysis regression. Some new developments in regression and classification.

  Simultaneous equation models: Specification, identification and estimation of simultaneous equation models.

  Prerequisites: [BCom(Hons) Statistics: RAL 780]

- **Linear Models 710 (LMO 710)**

  Recommended book:
  - ➢ Searle, S.R.: *Linear Models* (John Wiley, 1971)

  Curriculum:

  Projection matrices and sums of squares of linear sets. Estimation and the Gauss-Markov theorem. Generalized *t* and *F* tests.

  Prerequisite: [WST 311, 312, 321 and 322]

- **Linear Models 720 (LMO 720)**
  Recommended book:
  > Searle, S.R.: *Linear Models* (John Wiley, 1971)

  Curriculum:
  The singular normal distribution. Distributions of quadratic forms. The general linear model. Multiple comparison. Analysis of covariance. Generalized linear models. Analysis of categorical data.
  Prerequisite: [LMO 710]

- **Macroeconomics (MEK 780)**
  Refer to the Department of Economics for details.

- **Microeconomics (MIE 780)**
  Refer to the Department of Economics for details.

- **Multivariate Analysis 710 (MVA 710)**
  Prescribed book:
  > Johnson, R.A. and Wichern, D.W.: *Applied Multivariate Statistical Analysis* (Sixth edition) (Prentice Hall)

  Recommended books:
  > Morrison, Donald, F.: *Multivariate Statistical Methods*. (Fourth edition)(Thomson)

  Curriculum:
  Matrix algebra. Some multivariate measures. Visualizing multivariate data. Multivariate distributions. Samples from multivariate normal populations. The Wishart distribution. Hotelling's T^2 statistic. Inferences about mean vectors.
  Prerequisites: [WST 311, 312, 321 and 322]

- **Multivariate Analysis 720 (MVA 720)**
  Prescribed book:
  > Johnson, R.A. and Wichern, D.W.: *Applied Multivariate Statistical Analysis* (Sixth edition) (Prentice Hall).

  Recommended books:
  > Everitt, B. and Torsten Hothorn, T. *An introduction to applied multivariate analysis with R*

  Curriculum:
  The matrix normal distribution, correlation structures and inference of covariance matrices. Discriminant analysis. Principal component analysis. The biplot. Multidimensional scaling. Exploratory factor analysis. Confirmatory Factor analysis and structural equation models.
  Prerequisite: [MVA 710]

- **Multivariate Techniques 720 (MET 720)**
  Prescribed book:
  > Bain, L.J. and Engelhardt, M.: *Introduction to Probability and Mathematical Statistics* (Second Edition) (PWS-Kent Publishing Company, 1992)

  Curriculum

Estimation: methods of moments and maximum likelihood. Cramer-Rao inequality, mean squared error, loss and risk functions, Bayes estimators. Sufficient statistics, completeness, the exponential class. Tests of statistical hypothesis: power function, critical region and Neyman-Pearson lemma.
Prerequisites: [STK 310, 320]

- **Parametric Stochastic Processes 720 (PNP 720)**
Recommended book:
  ➢ Baht, U.N: *An Introduction to Queueing Theory: Modelling and Analysis in Applications (*Birkhäuser, 2008).
Curriculum:
Introduction to statistical measure theory. Queueing processes: M/M/1; M/M/S; M/G/1 queues and variants; limiting distribution of the queue length and waiting times. Queueing networks. Some stochastic inventory and storage processes.
Prerequisite: [WST 312]

- **Regression Analysis 780 (RAL 780)**
Prescribed book:
  ➢ Kutner, Nachtsheim and Neter (2004). *Applied Linear Regression Models*, 4th edition, Mc Graw Hill
Recommended books:
  ➢ Freund, J.F., Wilson, J.W. and Ping, S. (2006). *Regression Analysis: Statistical Modeling of a Response Variable*, 2nd edition, Elsevier.
  ➢ Freund, J.F. and Ramon, C.L. *SAS System for Regression*, 3rd edition, Cary, N.C. : SAS Institute.
  ➢ Mendenhall, W. and Sincich, T.: *A second module in business statistics: Regression Analysis* 6th edition, Macmillan
  ➢ Montgomery, D.C. and Peck, E.A.: *Introduction to Linear Regression Analysis*, 2nd edition, John Wiley.
Curriculum:
Matrix methods in statistics. Simple and multiple regression models. Sums of squares of linear sets. Generalized t- and F-tests. Residual analysis. Diagnostics for leverage, influence and multicolinearity. Indicator variables. Regression approach to analysis of variance. Weighted least squares. Ridge regression. Theory is combined with practical work.
Prerequisites: [STK 310, 320]

- **Sampling Techniques 720 (SFT 720)**
Prescribed book:
  ➢ Lohr, S.L.: *Sampling: Design and Analysis* (2nd edition) (Brooks/Cole, Cengage Learning, 2010)
Curriculum:
Simple random sampling. Estimation of proportions and sample sizes. Stratified random sampling. Ratio and regression estimators. Systematic and cluster sampling. Complex survey methodology. Handling of nonresponse.
Prerequisites: [BSc(Hons) and BCom(Hons) Mathematical Statistics: WST 311, 312, 321 and 322] [BCom(Hons) Statistics: STK 310, 320]

- **Statistical Process Control 780 (SPC 780)**
  Prescribed book:
  - ➢ Montgomery, D.C.: *Statistical Quality Control: A Modern Introduction* (Sixth Edition - International Student Version) (John Wiley, 2009)

  Curriculum:
  Quality control and improvement. Shewhart, cumulative sum (CUSUM), exponentially weighted moving average (EWMA) and Q control charts. Determining process and measurement systems capability. Parametric and nonparametric (distribution-free) control charts. Constructing control charts using Microsoft Excel and/or SAS. Obtaining run-length characteristics via simulations, the integral equation approach, other approximate methods and the Markov-chain approach.
  Prerequisites: [BSc(Hons) and BCom(Hons) Mathematical Statistics: WST 311, 312, 321 and 322] [BCom(Hons) Statistics: STK 310, 320]

- **Time Series Analysis 720 (TRA 720)**
  Recommended book:
  - ➢ Cryer, J.D. & Chan, K. S.: *Time Series Analysis: With Applications in R* (Second edition) (Springer; 2008)

  Curriculum:
  In this module certain basic topics relating to discrete, equally spaced stationary and non-stationary time series are introduced as well as the identification, estimation and testing of time series models and forecasting. Theoretical results are compared to corresponding results obtained from computer simulated time series.
  Prerequisites: [STK 310, 320] Students having completed WST321 are ineligible for TRA720.

- **Research Orientation 796 (STK 796)**
  Curriculum:
  A compulsory bootcamp must be attended as part of this module – usually presented during the last week of January each year (details are made available by the department). The bootcamp will cover the basics of research to prepare students for the research component of their degree. The bootcamp should be done in the same year as registration for STK 795/WST 795. Each year of registration for the honours degree will also require the attendance of three departmental seminars. Students should ensure that their attendance is recorded by the postgraduate co-ordinator present at the seminars. The department approves the seminars attended. In addition, students are required to present their STK 795/WST 795 research in the department during the year of registration for these modules.

Master's Programmes

General

The Master's degree is presented in the following directions: Mathematical Statistics and Statistics, eScience.

Students must consult their relevant faculty to ascertain themselves with the applicable submission dates for the dissertation, essay or thesis. Students must frequent themselves with the regulations regarding the submission of dissertations, essays and theses in order to comply with the requirements of their host faculty.

The following degrees are offered:

- **MSc in Mathematical Statistics**
- **MCom in Mathematical Statistics and MCom in Statistics**
- **MSc in eScience**

Admission Requirements

a. A relevant honours degree as indicated is required:

Programme:	Prerequisite:
MSc in Mathematical Statistics	BSc(Hons) in Mathematical Statistics
MCom in Mathematical Statistics	BCom(Hons) in Mathematical Statistics
MCom in Statistics	BCom(Hons) in Statistics
MSc in eScience	An honours degree in either statistics, mathematics, computer science, physics, or related fields; AND demonstrable knowledge of basic principles of probability and statistics, computing, calculus and linear algebra; OR Passing an entrance evaluation designed by the academic advisory committee of the programme

a. For MSc (Mathematical Statistics) an average mark of at least 65% or more in BSc(Hons) Mathematical Statistics module, with a minimum of 65% for the research component.
b. For MCom (Mathematical Statistics) and MCom (Statistics) an average mark of at least 65% or more for the modules in the respective BCom(Hons), with a minimum of 65% for the research component.
c. For MSc eScience an average of 65% at honours level is the minimum for consideration, although admission will be competitive and an honours average of at least 70% is highly recommended. Student numbers are limited to 6 at UP. Admission is additionally dependent on availability of supervisor/s and/or projects within the participating departments.
d. Please see the additional requirements for external students as well as international students at the end of this document. Student numbers are limited to a maximum of 26 collectively over all Master's Programs in the Department of Statistics.
e. Historical performance during prior studies will also be considered in selecting students. Specific attention will also be given to modules repeated and duration of study.

f. Admission to MSc (Mathematical Statistics), MCom (Mathematical Statistics) and MCom (Statistics) is also subject to the availability of supervisory capacity in the field of specialisations available in the department.

g. The research proposal of applicants should be in line with the research focus of the department or participating departments in the case of MSc eScience.

h. Any further additional entrance requirements as specified by the head of the department in consultation with the department's postgraduate selection committee. Students with gaps in between studies may be required to write an entrance evaluation.

i. The head of department, in consultation with the departmental postgraduate selection committee and participating departments (in the case of MSc eScience) reserves the right to prescribe additional modules.

j. A student may only commence studies in this department at the beginning of an academic year.

Duration

As long as progress is satisfactory, renewal of registration of a master's student will be accepted for a second year of study in the case of a full-time student. Renewal of registration for a third and subsequent years for a full-time student will only take place when Student Administration of the Faculty receives a written motivation (including a time line (Gantt chart) indicating potential completion date) that is supported by the Head of Department and Postgraduate Committee.

Promotion

The progress of all master's candidates is monitored biannually by the supervisor and the department's postgraduate committee. A candidate's study will be terminated if the progress is unsatisfactory or if the candidate is unable to finish his/her studies during the prescribed period. Subject to exceptions approved by the dean, on recommendation of the head of the department, a student may not enter for the master's examination in the same subject more than twice. As soon as a student has failed two (2) different modules, the student will be dismissed from the postgraduate program.

Notes

a. Attendance of the preparation course during the last week of January for the honours research component, if not completed during the honours programme, at the start of the Master's program is compulsory. This is part of the module STK 899 Research Orientation.

b. **The completion of the module work is a prerequisite for commencing with the dissertation**. The student must identify a possible supervisor and topic (see focus area list) near the end of coursework (2 subjects completed with satisfactory performance) and consult with the Head of Department Prof Andriette Bekker (andriette.bekker@up.ac.za) before approaching the supervisor and must be approved by the Postgraduate Committee.

c. It is compulsory for all the postgraduate students to attend the seminar series as indicated in STK 899.

d. Study financing remains the responsibility of the student. The department is not responsible for the funding or obtaining funding for a student. A student must thus plan his/her finances personally. The department will assist in directing students towards bursary opportunities.

e. In the case of a dispute with the allocated supervisor(s), the department will proceed as follows:

- The student must raise his/her valid concerns in an open professional manner, without fear of retribution.
- The supervisor(s) has to find constructive solutions to the problem and obtain agreement from the student for the way forward.
- The above- mentioned process assumes that the student did not commit an act which involves disciplinary actions, such cases should be referred to the legal department.
- If the conflict/dispute cannot be solved amicably between student and supervisor then either party can request a change in supervisor. If the current promotor agrees **and** a suitable 'new' supervisor can be found then the student may continue with his/her existing studies. Allocation of a new supervisor is subject to capacity constraints of the department and the current research topic cannot be guaranteed. All existing financial commitments shall be honoured.
- Finally in absence of the above mentioned agreement the student must terminate his/her current studies.

f. The MEMORANDUM OF UNDERSTANDING (obtainable from the faculty/Dr Fabris-Rotelli) must be signed by both the candidate, the supervisor(s) and the department's postgraduate committee and be submitted to the office of the Head of Student Administration within two months after the date of registration for the research component of the programme. This document must first go through the departments' postgraduate committee. The committee will also sign the document (in collaboration with the HOD) and enters into the agreement with the student as well. The Department of Statistics requires the following additional procedures for this document:

   (i) Title: **Department of Statistics Postgraduate MoU between the student, supervisor and the Department of Statistics**
   (ii) Under supervisor's expectations the following additional requirements should be added:
   - The regular scheduled meetings must occur a minimum of every 2 months (not the 3 months indicated in the document). More frequent meetings are highly recommended to ensure throughput.
   - The candidate is required to present at least 2 seminars a year to the department and its students on the progress of the work.
   - The student must ensure sufficient progress is made so that the supervisor can report positively to the postgraduate committee biannually.
   (iii) Under candidate's expectations the following additional requirements should be added:
   - The supervisor must submit reports to the postgraduate committee on the student's progress biannually to ensure visibility of the student's progress.

g. On completion of the research component of the Master's degree a student must present a final departmental seminar before submission of the dissertation.

h. Tests and assignments may be taken into account in the determination of the final mark in each of the lectured modules. Exam entrance may be enforced in these modules on discretion of the lecturer.

i. Note that the Department of Statistics does not provide supplementary nor sick exams for any postgraduate modules.

j. Examinations in modules take place during one of the official university examination time periods.
k. The research component must be handed in together with an acceptable TurnItIn report.

Programme composition (Total credits required: 180)

A candidate must compile his/her curriculum in consultation with the department's postgraduate committee. The Master's degree is awarded on the grounds of a dissertation and additional prescribed module work. A pass mark must be obtained in the dissertation as well as in the additional module work.

For:

- **MSc in Mathematical Statistics**
  WST895 Mini-dissertation: Mathematical statistics (100)
  STK899 Research orientation (0)
  And choose four of the following modules:
  WST805 Cyber Analytics (20)
  MVA880 Statistical learning (20)
  STK880 Capita selecta: Statistics (20)
  TRA880 Analysis of time series (20)
  TRG880 Data analytics and visualisation (20)

- **MCom in Mathematical Statistics**

  Dissertation
  WST890 Dissertation (180)***
  STK899 Research orientation (0)

    or

  Coursework
  WST895 Mini-dissertation: Mathematical Statistics (100)
  STK899 Research orientation (0)
  And choose four of the following modules:
  WST805 Cyber Analytics (20)
  MVA880 Statistical learning (20)
  STK880 Capita selecta: Statistics (20)
  TRA880 Analysis of time series (20)
  TRG880 Data analytics and visualisation (20)

- **MCom in Statistics**

  Dissertation
  STK890 Dissertation (180)***
  STK899 Research orientation (0)

    or

  Coursework
  STK895 Mini-dissertation (100)
  STK899 Research orientation (0)

And choose four of the following modules:
WST805 Cyber Analytics (20)
MVA880 Statistical Learning (20)
STK880 Capita selecta: Statistics (20)
TRA880 Analysis of time series (20)
TRG880 Data analytics and visualisation (20)

- **MSc eScience**
  Curriculum: Year 1
  Minimum Credits: 90
  <u>Core modules</u>

  NEP 801 Research methods and capstone project in data science 801 (15)
  NEP 802 Data privacy and ethics 802 (15)

  <u>Elective modules</u>
  Select four of the following modules:
  NEP 803 Adaptive computation and machine learning 803 (15)
  NEP 804 Data visualisation and exploration 804 (15)
  NEP 805 Large-scale computing systems and scientific programming 805 (15)
  NEP 806 Mathematical foundations of data science 806 (15)
  NEP 807 Special topics in data science 807 (15)
  NEP 808 Statistical foundations of data science 808 (15)
  NEP 809 Large-scale optimisation for data science 809 (15)

  Curriculum: Year 2
  Minimum Credits: 90
  Research
  NEP 800 Mini-dissertation: eScience 800 (90)

***Note that we do not admit registration for the Masters by dissertation unless under exceptional circumstances and with approval by the head of department in consultation with postgraduate committee of the department. The Masters by coursework is geared to train a professional statistician for industry and academia and is the preferred direction.

Particulars regarding the contents of modules (MCom and MSc)

- **Data analytics and visualisation (TRG 880)**
  <u>Prescribed book:</u>
  > Kutner, MH; Neter, J and Nachtsheim, WL: *Applied Linear Statistical Models* (Fifth edition) (McGraw-Hill Education, 2004)
  <u>Curriculum:</u>
  Regression introduction: Simple and multiple regression. Multicollinearity, Heteroscedasticity, Ridge regression. Logistic regression: Estimation, inference and applications. Non Linear regression: Estimation, inference and applications. Text mining: Topic modeling with applications. Survival regression: Survival models applied in regression. Regression extensions: CART, MARS and Conjoint analysis.

- **Statistical Learning (MVA 880)**

Prescribed book:

> Paolo Giudici : *Applied Data Mining* (John Wiley ,2003)
> Hastie, T; Tibshirani, R and Friedman, J: *The elements of Statistical learning* (Second edition) (Springer, 2009)

Curriculum:

Supervised and unsupervised methods, including computational methods, within the broader context of Data mining.

Supervised learning: Linear methods for regression, classification and prediction. Basis Expansions, Regularization, Smoothing, Additive models and Support Vector Machines.

Unsupervised learning: Clustering, principal components, dimensional reduction.

Data methods: Organisation of data and exploratory data analysis.

- **Capita Selecta : Statistics (STK 880)**

Recommended book:

> Montgomery, D.C.: *Statistical Quality Control: A Modern Introduction* (5th or later edition - International Student Version) (John Wiley, 2009). It is not compulsory to buy the textbook.

Curriculum:

The module is primarily article based and covers the most recent literature that discusses the developments and research in, for example, Shewhart charts, Exponentially Weighted Moving Average (EWMA) charts, Cumulative Sum (CUSUM) charts, Q-charts, Parametric and Nonparametric charts, Univariate and Multivariate charts, Phase I and Phase II control charts, Profile monitoring .Other research topics, that will be determined annually.

- **Time Series Analysis (TRA 880)**

Prescribed book:

> Hamilton, J.D. : *Time Series Analysis* (First edition) (Princeton University Press, 1994)

Recommended books:

> Box, G.E.P., Jenkins, G.M. & Reinsel, G.C.: *Time Series Analysis: Forecasting and Control* (Fourth edition) (John Wiley, 2008)
> Cryer, J.D. & Chan, K.-S.:*Time Series Analysis: With Applications in R* (Second edition) (Springer, 2008)
> Gilgen, H. : *Univariate Time Series in Geosciences: Theory and Examples* (First edition) (Springer, 2005)
> Lütkepohl, H.: *New Introduction to Multiple Time Series Analysis* (Springer, 2007)
> Palma, W. : *Long-Memory Time Series: Theory and Methods* (First edition) (John Wiley-Interscience, 2007)
> Wei, W.W.S.: *Time Series Analysis: Univariate and Multivariate Methods* (Second edition) (Addison Wesley, 2005)

Curriculum:

Difference equations. Lag operators. Stationary ARMA processes. Maximum likelihood estimation. Spectral analysis. Vector processes. Non-stationary time series. Long-memory processes.

Prerequisite: [WST 321 or TRA 720]

- **Cyber Analytics (WST 805)**

Curriculum:

Reviewing, from a statistical perspective, the cyberinfrastructure ecosystem including distributed computing, multi node and distributed file eco systems. Structured and unstructured data sources, including social media data and image data. Setting up of large data structures for analysis. Algorithms and techniques for computing statistics and statistical models on distributed data. Software to be used include, Hadoop, Map reduce, SAS, SAS Data loader for Hadoop.

- **Research orientation 899 (STK 899)**

Curriculum:

A compulsory bootcamp must be attended as part of this module, usually presented the last week of January each year. Details each year are available from the department. The bootcamp will cover the basics of research to prepare the student for the research component of their degree. A student can be exempt from the bootcamp if it was already attended in a previous year or degree. Each year of registration for the Masters degree will also require the attendance of three departmental seminars. The student is responsible to ensure attendance is taken by the postgraduate co-ordinator present at the seminar. The department approves the seminars attended. The student is also required to present their mini-dissertation research within the department or at a conference.

Mini-dissertation: eScience 800 (NEP 800)
Curriculum:
This is the research component of the MSc (eScience) degree and comprises a mini-dissertation which develops the research skills and bridges the gap between theory and practice.
Prerequisite: Completion of the coursework for the programme

Research methods and capstone project in data science 801 (NEP 801)
Curriculum:
Scientific writing styles; layouts for assignments, projects, theses or publications; research methodologies; scientific assignments; integration of all the aforementioned content items for a capstone project in data science.
Period of presentation Semester 1 or 2

Data privacy and ethics 802 (NEP 802)
Curriculum:
Technical processes of data collection, storage, exchange and access; Ethical aspects of data management; Legal and regulatory frameworks in South Africa and in relevant jurisdictions; Data policies; Data privacy; Data ownership; Legal liabilities of analytical decisions and discrimination; and the Technical and algorithmic approaches to enhance data privacy, and relevant case studies.
Period of presentation Semester 1 or 2

Adaptive computation and machine learning 803 (NEP 803)
Curriculum:
Introduction: Basic concepts. Supervised learning setup: Least means squares, logistic regression, perceptron, exponential family, generative learning algorithms, Gaussian discriminant analysis, naïve Bayes, support vector machines, model selection and feature selection. Learning theory: bias/variance tradeoff, union and Chernoff/Hoeffding bounds, VC dimension, worst case (online) learning. Unsupervised learning: clustering, k-means, expectation maximization, mixture of Gaussians, factor analysis, principal components analysis, independent components analysis. Reinforcement learning and control: Markov decision processes, Bellman equations, value iteration and policy iteration, Q-learning, value function approximation, policy search, reinforce, partially observable Markov decision problems.
Period of presentation Semester 1 or 2

Data visualisation and exploration 804 (NEP 804)
Curriculum:
Data and image models; visualisation attributes (colour) and design (layout); exploratory data analysis; interactive data visualisation; multidimensional data; graphical perception; visualisation software (Python & R); and types of visualisation (animation, networks and text).
Period of presentation Semester 1 or 2

Large-scale computing systems and scientific computing 805 (NEP 805)
Curriculum:
Introduction to scientific computing architectures in Python, introduction to distributed systems, introduction to distributed databases, introduction to parallelism, large-data computation and storage models, introduction to well-known distributed systems architectures, and programming large-data applications on open-source infrastructures for data processing and storage systems.
Period of presentation Semester 1 or 2

Mathematical foundations of data science 806 (NEP 806)
Curriculum:
High-dimensional space, best-fit subspaces and singular value decomposition, random walks and Markov chains, statistical machine learning, clustering, random graphs, topic models, matrix factorisation, hidden Markov models, graphical models, wavelets, and sparse representations.
Period of presentation Semester 1 or 2

Special topics in data science 807 (NEP 807)
Curriculum:
Specialised and applied concepts and trends in data science.
Prerequisites Completion of the coursework of the programme.
Period of presentation Semester 1 or 2

Statistical foundations of data science 808 (NEP808)
Curriculum:

An understanding of multivariate statistics, hypothesis testing and confidence intervals. The ability to model data using well-known statistical distributions as well as the ability to handle data that is both continuous and categorical. The ability to perform statistical modelling including multivariate linear regression and adjust for multiple hypotheses. Forecasting, extrapolation, prediction and modelling using statistical methods. Bayesian statistics, an understanding of bootstrapping and Monte Carlo simulation.

Period of presentation Semester 1 or 2

Large-scale optimisation for data science 809 (NEP 809)
Curriculum:
Introduction to convex optimisation, subgradient methods, decomposition and distributed optimisation, proximal and operator splitting methods, conjugate gradients, and nonconvex problems.

Period of presentation Semester 1 or 2

Doctoral Programme

General

The Doctoral degree is presented in the following disciplines: Mathematical Statistics and Statistics. The study is performed under the supervision of a promoter. The topic is determined and the promoter is appointed in consultation with and subject to the approval of the head of the department and the department's postgraduate committee. The topic of the thesis to be submitted must be approved by the Dean on recommendation of the head of the department. The Mathematical Statistics option involves research on theoretically identified aspects with applied demonstrations and examples of the concepts. The applied option involves research into theoretical aspects identified through specific application needs and requirements. The applied option doesn't allow only for standard application of known statistical techniques on data sets. The applied statistics option involves more application based research with some theoretical work, that is, new statistical techniques for a specific application. The most appropriate option for the dissertation must be discussed with the head of the department.

Admission Requirements

a. A relevant Master's degree in Mathematical Statistics is required.
b. Applicant's obtained Masters degree has include a research dissertation and a full set of course work that consist of core topics that underpin further study in the discipline.
c. For PhD (Mathematical Statistics) an average mark of at least 65% or more in the modules of the MSc Mathematical Statistics, with a minimum of 65% for the dissertation.
d. For PhD (Mathematical Statistics) and PhD (Statistics) an average mark of at least 65% or more in the modules of the MCom Mathematical Statistics or MCom Statistics, with a minimum of 65% for the dissertation.
e. Before admission to the program and after being shortlisted a prospective student is required to submit (1) a detailed research proposal, (2) present a seminar to the postgraduate committee of the department; and (3) submit a letter of intent. The latter should address the following:

> *Why the applicant wishes to enroll for a PhD?*
> *What field of study in statistics the applicant has been exposed to (time series / distribution theory etc.)?*
> *Which publications/proceedings (if any) you already have?*
> *What field has the applicant identified, and what reading (general and academic journals) has been done to convince the student to enroll for a PhD?*
> *Possibility of identified supervisor?*
> *Interdisciplinary topics, or work with other academic departments or universities that is envisaged for the degree?*
> *Current work situation: full time student, or part time student and full time employee elsewhere?*
> *Declaration of understanding that the PhD degree weighs a total (minimum) of 360 credits and understanding of how much work this entails (time wise and volume-wise). Understanding the faculty regulations of one paper accepted (NAS)/submitted (EMS) from PhD research before graduation can occur.*

Admission to the program will based on the outcome of (1) – (3). A Skype session for the seminar can be organized if required.

f. Please see the additional requirements for external students as well as international students at the end of this document. Student numbers are limited to a maximum of 10, collectively over all Doctoral Programs in the Department of Statistics.

g. Historical performance during prior studies will also be considered in selecting students. Specific attention will be given to modules repeated and duration of study.

h. Admission is also subject to the availability of supervisory capacity in the field of specialisations available in the Department.

i. Additional entrance requirements as specified by the head of the department. Students with gaps in between studies may be required to write an entrance evaluation.

j. A student may only commence studies in this department at the beginning of an academic year.

Duration

As long as progress is satisfactory, renewal of registration of a doctoral student will be accepted for a second year and third year of study in the case of a full-time student. Renewal of registration for a fourth and subsequent years for a full-time student will only take place when Student Administration of the Faculty receives a written motivation (including a time line (Gannt chart) indicating potential completion date) that is supported by the head of department and department's postgraduate committee.

Promotion

The progress of all doctoral candidates is monitored biannually by the supervisor and the postgraduate committee. A candidate's study may be terminated if the progress is unsatisfactory or if the candidate is unable to finish his/her studies during the prescribed period. The regulations of the university with regard to doctoral degree studies apply.

Programme composition

A candidate must complete a thesis in one of several fields in Mathematical Statistics or Statistics in which research is actively being done within the Department. The thesis must be handed in together with an acceptable TurnItIn report.

In addition the module STK 911 has to be completed (0 credits).
STK911 description: A compulsory bootcamp must be attended as part of this module, usually presented the last week of January each year. Details each year are available from the department. The bootcamp will cover the basics of research to prepare the student for the research component of their degree. A student can be exempt from the bootcamp if it was already attended in a previous year or degree. Each year of registration for the Doctoral degree will also require the attendance of three departmental seminars. The student is responsible to ensure attendance is taken by the postgraduate co-ordinator present at the seminar. The department approves the seminars attended. The student is also required to present their mini-dissertation research within the department or at a conference.

Notes

Attendance of the preparation course during the last week of January for the honours research component, if not completed during the honours or Masters programme, at the start of the Doctoral program is compulsory. This forms part of STK 911.

Study financing remains the responsibility of the student. The department is not responsible for the funding or obtaining funding for a student. A student must thus plan his/her finances personally. The department will assist in directing students towards bursary opportunities.

It is compulsory for all the postgraduate students to attend the seminar series as indicated in STK 911.

In the case of a dispute with the allocated supervisor(s), the department will proceed as follows:
- The student must raise his/her valid concerns in an open professional manner, without fear of retribution.
- The supervisor(s) has to find constructive solutions to the problem and obtain agreement from the student for the way forward.
- The above- mentioned process assumes that the student did not commit an act which involves disciplinary actions, such cases should be referred to the legal department.
- If the conflict/dispute cannot be solved amicably between student and supervisor then either party can request a change in supervisor. If the current promotor agrees **and** a suitable 'new' supervisor can be found then the student may continue with his/her existing studies. Allocation of a new supervisor is subject to capacity constraints of the department and the current research topic cannot be guaranteed. All existing financial commitments shall be honoured.
- Finally in absence of the above mentioned agreement the student must terminate his/her current studies.

The MEMORANDUM OF UNDERSTANDING (obtainable from the faculty/ Dr Fabris-Rotelli) must be signed by both the candidate, the supervisor(s) and the postgraduate committee and be submitted to the office of the Head of Student Administration within two months after the date of registration for the research component of the programme. This document must first go through the departments' Postgraduate Committee. The Postgraduate committee will also sign the document (in collaboration with the HOD) and enters into the agreement with the student as well. The Department of Statistics requires the following additional procedures for this document:

(i) Title: **Department of Statistics Postgraduate MoU between the student, supervisor and the Department of Statistics**
(ii) Under supervisor's expectations the following additional requirements should be added:
    a. The regular scheduled meetings must occur a minimum of every 2 months (not the 3 months indicated in the document). More frequent meetings are highly recommended to ensure throughput.
    b. The candidate is required to present at least 2 seminars a year to the department and its students on the progress of the work.
(iii) The student must ensure sufficient progress is made so that the supervisor can report positively to the postgraduate committee biannually.
(iv) Under candidate's expectations the following additional requirements should be added:
    a. The supervisor must submit reports to the postgraduate committee on the student's progress biannually to ensure visibility of the student's progress.

Masters and Doctoral degree research studies focus areas:

Only research topics within the department's research fields can be accommodated.

Advanced Dynamic Statistical Analysis

Statistical learning
Statistical image processing and Spatial Statistics
Bayesian network modelling
Topic modelling for short text

Statistics Education

Identifying and Evaluating Threshold Concepts in First Year Statistics modules at the University of Pretoria
The effect of interdisciplinary collaboration: Statistics and Academic Literacy
Scaffolding learning in an extended learning programme for foundation mathematical statistics
Investigating different initiatives to address the throughput rate of a large first level Statistics module

Statistical Process Control

Generalized linear modeling and experimental design

Optimal designs for microarrays
Estimation procedures when the usual assumptions are violated
Statistical analysis of grouped data
Bayesian inference in econometric modelling
STONK
Sigmoidal modelling

Distribution Theory

Quantile-based distribution theory
Distribution theory – Impact and reach

Stochastic Processes

Parameter estimation for stochastic processes
Lévy processes in option pricing

Bayesian Nonlinear Models

Robust nonlinear mixed effects regression models in Tuberculosis research
Statistical inference for Ectoparasiticide efficacy in animal trials

Additional requirements for students entering UP from externally (including international students)

1. A compulsory language proficiency test must be completed at UP. The postgraduate committee of the department will help with the facilitation of the test through the universities

language unit. It may be required, based on the outcome, that a student does additional language courses.

2. Applications to study at UP must include full academic transcripts from undergraduate to current level, include SAQA accreditation (for international students only but may be required for South African students on request). The previous degree should have compatible content with the degree applied for at the University of Pretoria.
3. An entrance evaluation will be required of all external applicants.
4. A research proposal and/or previous research work must be submitted with the application, together with a self-evaluation (1/2 page).

Further information

There are excellent opportunities for postgraduate bursaries. For postgraduate bursaries or any other information contact the Department of Statistics. See also departmental website. Bursaries are on based on academic merit, academic performance, academic progress in the programme and availability of funds, however funding support remains the responsibility of the student.

The Main Campus library provides excellent postgraduate study facilities.

All postgraduate programme inquiries please contact Dr I Fabris-Rotelli:
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Website: Department of Statistics at http://www.up.ac.za/statistics

Young alumni have their say

"I build statistical models to help banks make sound decisions about who they grant loans to and whether a customer can actually afford the credit they are applying for. Statistics is a thrilling field with so many applications in every industry. Statistics helps to answer questions. Statistics is a rare skill that is highly sought after in the workplace."

Buwang Mokuele (Decision Analyst)

"People across the globe need statistical skills. Statistics is everywhere and relates to everyday life in countless ways. News, information exchanges, interactions and events involve statistics. I am grateful to be a statistician!"

Seite Makgai (Lecturer in the Department of Statistics at UP)