DEPARTMENT OF STATISTICAL SCIENCES

HONOURS PROGRAMMES 2020

MODULE INFORMATION

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Advanced Probability Theory

Synopsis

The course begins by covering some probability theory topics that were not covered in STA3045F, before moving on to study advanced topics in martingale theory. The course then introduces continuous-time stochastic processes and general stochastic integration. Some applications involving Brownian motion are given and two important theorems (Feynman-Kac and Martingale Representation) are proved. The last part of course is dedicated to studying Levy processes.

Note: this module is a continuation of the Probability Theory section of STA3045F and knowledge of that material will be assumed. Students interested in the module are strongly advised to revise STA3045F and Real Analysis from MAM2000W.

Course Content and Lecturer Information

Lecturer: Mr Melusi Mavuso Room 5.64 Melusi.Mavuso@uct.ac.za

Topics:

1. Product spaces
2. Convergence of sequences of random variables
3. Martingale convergence and optional sampling theorems
4. Continuous-time σ-algebras: optional, previsible, and progressive.
5. The Doob-Meyer decomposition theorem and quadratic variation
6. Square integrable martingales
7. Stochastic integration
8. Local martingales, semimartingales
9. Feynmac-Kac and Martingale Representation
10. Levy processes

Relevant Texts:

1. *Probability* – A. N. Shiryaev
2. *Probability with Martingales* – D. Williams
3. *Brownian Motion and Stochastic Calculus* – I. Karatzas and S. Shreve
4. *Diffusions, Markov Processes and Martingales* vol 1 and 2 – L.C. Rogers and D. Williams
5. *Limit Theorems for Stochastic Processes* – J. Jacod and A. N. Shiryaev
6. *Theory of Martingales* – R. Lipster and A.N. Shiryaev
7. *Statistics of Random Processes* volume I: General Theory – R. Lipster and A.N. Shiryaev
8. *Levy Processes and Stochastic Calculus* - D. Applebaum

Assessment

- **Composition**: Assessment will consist of a single class test and exam.
- **Format**: Both the class test and exam will be open-book.
- **DP Requirement**: A minimum of 35% for the class test plus attendance of lectures.
- **Final Mark**: The final grade for the course will be based on:

Class Test:	30%.
Final Exam:	70%.

Applied Spatial Data Analysis

Synopsis

Applied Spatial Data Analysis is designed to introduce you to statistical techniques designed to analyse spatial data where location of observations is important. The course will cover handling spatial data in R, visualising spatial data, analysing three different types of spatial data, namely geostatistical, point pattern and lattice data. Applications will be drawn from a wide variety of fields in the natural, business and social sciences. Emphasis will also be placed on the interpretation of computer generated results using R.

Lecturer Information

Lecturer:	Dr. Sebnem Er	Room 5.55	sebnem.er@uct.ac.za
Lecturer:	Mr. Sulaiman Salau	Room 5.54	sulaiman.salau@uct.ac.za

Course Content

- Interpolation and Geostatistics
  - Estimating the spatial correlation: the variogram
  - Spatial prediction
  - Model diagnostics
  - Geostatistical simulation
  - Further methods for analysis of geostatistical data
- Point Patterns
  - Exploratory analysis of spatial point pattern data
  - Spatial randomness tests
  - Ripley's K-Function
  - Analysis of spatial random processes
  - Further methods for analysis of point patterns
- Lattice Data
  - Spatial neighbours and weights
  - Spatial autocorrelation
  - Modeling spatial lattice data
  - Further methods for analysis of lattice data

Assessment

- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. Page limits will be announced upon release of the assignments. Where prediction sets are required, these will be handed in electronically via Vula along with the assignment. Marks will be allocated for the quality of the write up.
- **Course Mark**: In calculating the course mark, each assignment counts 20% and 5% is the class presentation.
- **DP Requirement**: A minimum of 35% for the course mark and completion of all assignments by the due dates plus attendance of lectures.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	45%.
Final Exam:	55%.

Analytics

Synopsis

This course will cover computationally intensive statistical methods for analysing datasets of various sizes, with applications covering parallelisation of code and high performance computing. The methods covered include approaches to both regression and classification problems in a supervised learning context, as well as unsupervised learning methods. The course consists of three broad sections: Tree-based Methods, Artificial Neural Networks, and Unsupervised Learning. The first section covers regression and classification trees, bagging, random forests and boosting. The second section will introduce students to the basic principles of artificial neural networks, the concepts of stochastic gradient descent and backpropagation, and various network architectures and their uses. The last section will cover statistical methods for classifying observations into groups where the group memberships of the training data are not known in advance.

Course Content and Lecturer Information

- **HPC and Tree-Based Methods** (33%) (12 Lectures):

  Lecturer: Mr. Stefan Britz Room 5.46 stefan.britz@uct.ac.za

  Topics:

  1. High Performance Computing
  2. Regression and Classification Trees
  3. Bagging, Boosting, and Random Forrests.

  Prescribed Text: James, G., Witten, D., Hastie, T. and Tibshirani, R., 2013. *An introduction to statistical learning (Vol. 112).* New York: springer.

- **Neural Networks** (33%) (12 Lectures):

  Lecturer: Dr. Etienne Pienaar Room 5.43 etienne.pienaar@uct.ac.za

  Topics:

  1. Perceptrons and the Perceptron Learning Algorithm
  2. Neural Networks and Backpropagation
  3. Bias-Variance and Regularisation

  Prescribed Text: A complete set of course notes with relevant references will be posted on Vula. See also:

  Nielsen, M.A., 2015. *Neural networks and deep learning (Vol. 25).* USA: Determination press.

- **Unsupervised Learning** (33%) (12 Lectures):

Lecturer:	Dr. Sebnem Er Room 5.55	sebnem.er@uct.ac.za

Topics:

1. Clustering
2. Association Rule Mining
3. Self-Organising Maps

Prescribed Text: James, G., Witten, D., Hastie, T. and Tibshirani, R., 2013. *An introduction to statistical learning (Vol. 112).* New York: springer.

- **Course Administrator**: Dr. Etienne Pienaar – etienne.pienaar@uct.ac.za.

Assessment

- **Assignments** (Assignment topics may change):

Assignment 1	Tree-Based Methods	Hazard Score Prediction and Page Block Classification
Assignment 2	Neural Networks	Build a Neural Network and Pattern Recognition
Assignment 3	Supervised Learning	Clustering of Hand-Written Digits

- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. Page limits will be announced upon release of the assignments. Where prediction sets are required, these will be handed in electronically via Vula along with the assignment. Marks will be allocated for the quality of the write up.
- **Course Mark**: In calculating the course mark, each assignment counts one third of the **course mark**.
- **DP Requirement**: A minimum of 35% for the course mark and completion of all assignments by the due dates plus attendance of lectures.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	45%.
Final Exam:	55%.

Bayesian Analysis

Synopsis

The ideas underlying the Bayesian method dates back to the probability formulations by Thomas Bayes (1763) and Laplace (1812) but have only relatively recently (20-30 years ago) become popular in practical statistical research circles. Much of its popularity is due to the fact that many statistical analyses cannot easily be undertaken using the methods that are usually taught in undergraduate courses at universities but are relatively straight forward to undertake using Bayesian methods.

This module will cover a number of standard computational Bayesian techniques used in statistical analysis. This will include Acceptance-Rejection sampling, Gibbs sampling and Markov Chain Monte Carlo methods. The course is intended to be practical in nature with a large practical component (with a fair amount of rigorous derivations thrown in).

Potential application areas include: finance, ecology, differential equation modelling, biostatistics, spatial modelling, image analysis, state space modelling, variable selection.

Weekly tutorials will be set. These could involve some math and R programming.

Lecturer Information

Lecturer:	Mr Allan Clark	Room 5.51	allan.clark@uct.ac.za

Assessment

- Two assignments (each counts 20% of the final course mark).
- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. You will be required to formulate a problem, develop a Bayesian solution and thereafter use R (possibly Stan, JAGS or OpenBUGS) to analyze data. Page limits will be announced upon release of the assignments. Marks will be allocated for the quality of the write up.
- **DP Requirement**: A minimum of 35% for the course mark and completion of all assignments by the due dates plus attendance of lectures.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	40%.
Final Exam:	60%.

Biostatistics

Synopsis

This course is an introduction to the analysis of data from medical research. Students will be prepared for entry positions as biostatisticians and for postgraduate research degrees in medical statistics. The course could be called "Applied generalized mixed effect models" and though the applications taught in this course will refer to medical data, the methods have much wider application. The emphasis of the course will be on the application and interpretation of the different statistical methods.

Course Content and Lecturer Information

Lecturer:	A/Prof Francesca Little	Room 5.36	freedom.gumedze@uct.ac.za
	Dr Greg Distiller	Room 6.67	greg.distiller@uct.ac.za

Topics:

1. Introduction to programming in STATA/R for biostatistics
2. Measures of disease frequency and effect
3. GLMs, with specific emphasis on Logistic Regression
4. Analysis of Longitudinal Data, including GEE models and mixed effect models
5. Survival Analysis

Assessment

- **Composition**: Two assignments which make up the course mark and a final exam.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	50%.
Final Exam:	50%.

Decision Modelling

Synopsis

The aim of this module is to develop an understanding of human preferences and subjective judgements, for purposes of constructing models for decision support, within which we can apply quantitative tools studied elsewhere. The module thus provides a bridge between technical statistical and operational research tools on the one hand, and interaction with our clients on the other hand (especially in the context of decision support). We study both how to represent human preferences in mathematical models, and what cognitive models and errors may be exhibited by clients when we elicit subjective estimates of underlying parameters.

A substantial portion of the course relates to multiple criteria decision analysis (MCDA), in which we specifically aim to capture preferences and value tradeoffs between conflicting objectives and goals (e.g., social, environmental and economic goals).

In this course, we seek to develop an understanding of the following processes:

- How can we assist decision makers in defining and structuring decision problems in such a way that we are able to apply our quantitative analytical models to them?
- How should we model the preferences and value judgements which are expressed by decision makers or their advisors, in order to generate maximum insight into which courses of action best satisfy these preferences?
- How do people form and express subjective value judgements, for example regarding the relative importance of different goals or of the likelihood of certain events, which we may need to use in our models?

Decision Modelling is a multi-disciplinary field and in addressing the above questions, we touch on issues in psychology, economics, information systems, and operational research.

Course Content and Lecturer Information

- **Part I: Problem Structuring and Approaches to Decision Modelling** (12 lectures):

  Lecturer: Assoc Prof Leanne Scott Room 5.66 Leanne.Scott@uct.ac.za

  Topics: We look at how we can take a general decision problem and structure it in a way that is useful for later modelling. We introduce the three main schools of decision modelling, which offer different ways of modelling how people can and should make multi-criteria decisions. We then focus on one of these schools, value function modelling.

- **Part II: Further Topics in Decision Modelling** (12 lectures):

Lecturer:	Ms Georgina Rakotonirainy Room 5.51
Topics:	We extend the models of the first section into more advanced decision contexts: those involving uncertainty (where measurements cannot be made precisely), preferences over time, or groups of decision makers. As part of this section we also consider problems and biases that people commonly experience when they are asked to think about information or make a judgement.

Assessment

- **Assignments**:

Assignment 1:	Problem structuring of a public sector decision problem (35% of Course Mark)
Assignment 2:	Using a value function to structure, score, weight, aggregate and make an appropriate and defensible decision with regard to a given decision context. (65% of Course Mark)

- **DP Requirement**:A minimum of 35% for the course mark plus attendance of lectures.
- **Exam**: The final grade for the exam will be based on:

Part I:	30%,
Part II:	70%.

- **Final Mark**: The final grade for the course will be based on:

Course Mark:	30%,
Final Exam:	70%.

Introduction to Stochastic Processes

Synopsis

This module provides a basic overview of stochastic processes with both the state and parameter spaces discrete. Models involving discrete-time stochastic processes are studied and special attention given to stochastic processes known as Markov chains. Two models for the permissible 1-step transitions within the state space will be introduced.

Course Content and Lecturer Information

- **Discrete-valued time series and theory**:

Lecturer:	Mr Dominique Katshunga	Room 5.49	Dominique.Katshunga@uct.ac.za

Topics:

1. Chains and Markov chains
2. Transition probability matrix
3. Time homogeneity
4. Classification of states
5. Probability models for transitions
6. Stationarity and reversibility

Prescribed Text: Lecture notes and slides will be provided as needed.

Assessment

- **Assignments** (Assignment topics may change):

Assignment 1	Possibility & probability models for transition (coding in R will be required)
Assignment 2	Steady-state censuses

- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. Page limits will be announced upon release of the assignments. Marks will be allocated for the quality of the write up.
- **Course Mark**: Each assignment will count 50% toward the course mark.
- **DP Requirement**: A minimum of 35% for the course mark and completion of all assignments by the due dates plus attendance of lectures.
- **Final Mark**: The final exam and course marks will count toward the final mark as follows:

Course Mark:	25%.
Final Exam:	75%.

Likelihood

Synopsis

This module covers likelihood theory. The likelihood function plays an important role in Bayesian and in frequentist statistics. However, here we will treat likelihood as an approach to inference (point and interval estimates, hypothesis testing, model selection and comparison) in its own right.

In practice, most likelihood methods require substantial computation. Therefore the module will have a strong practical component, and will require the use of R for tutorial questions and the assignment.

Course Content and Lecturer Information

Lecturer:	Dr Birgit Erni	Room 6.64	birgit.erni@uct.ac.za

Topics:

1. likelihood for different problems, MLE, invariance property, likelihood intervals
2. asymptotic likelihood theory
3. likelihood with multiple parameters, profile likelihood, predictive likelihood, likelihood with random parameters

Prescribed Text: Course notes will be made available on Vula.

Assessment

Assignment:	25%
Final exam:	60%
Individual class work:	5%
Team-based class work:	10% weighted by peer-assessment and participation

Matrix Methods

Synopsis

This course covers basic matrix operations, an introduction to linear algebra, and some pertinent applications of matrix methods in statistics.

Course Content and Lecturer Information

The content covers the following topics:

- Nomenclature and revision of basics
- Determinants
- Inverses
- Matrix rank
- Generalized inverses and linear equations
- Eigenvalues and eigenvectors
- Spectral decomposition and singular value decomposition

Lecturer: Mr. Stefan Britz Room 5.46 stefan.britz@uct.ac.za

Assessment

Final Mark: A 2-hour exam comprises 100% of the final mark.

Multivariate Analysis

Synopsis

"Multivariate analysis is the area of statistics that deals with observations made on many variables. The main objective is to study how the variables are related to one another, and how they work in combination to distinguish between the cases on which the observations are made. The analysis of multivariate data permeates every research discipline: biology, medicine, environmental science, sociology, economics, education, linguistics, archaeology, anthropology, psychology and behavioural science, to name a few, and has even been applied in philosophy. All natural and physical processes are essentially multivariate in nature—the challenge is to understand the process in a multivariate way, where variables are connected and their relationships understood, as opposed to a bunch of univariate processes, i.e. single variables at a time, isolated from one another." Michael Greenacre, http://multivariatestatistics.org/index.html.

This honours module will introduce students to the underlying theory and the application of several multivariate techniques.The R programming languange will be used in the course.

Course Content and Lecturer Information

Lecturer: A/Prof Francesca Little Room 5.36 francesca.little@uct.ac.za

- **Theory and Inference**

  Topics:

  1. The Multivariate Normal Distribution
  2. Multivariate Maximum Likelihood Estimation
  3. Multivariate Inference
  4. MANOVA and Multivariate Regression Analysis

- **Applications of Multivariate Analysis**

  Topics:

  1. Principal Component Analysis and Factor Analysis
  2. Canonical Correlation Analysis
  3. Discriminant Analysis
  4. Correspondence Analysis

  Prescribed Text: RA Johnson & DW Wichern, "Applied Multivariate Statistical Analysis", 6th edition, Pearson International Edition, 2007.

- **Course Administrator**: Celene Jansen-Fielies – Celene.Jansen-Fielies@uct.ac.za.

Assessment

- **Assignments**:

Assignment 1	Theory and Inference
Assignment 2	Application

- **Format**: Assignments may involve derivation, calculation, computing and interpretation and will be submitted in the form of a report both electronically and in hard copy.
- **Course Mark**: In calculating the course mark, each assignment counts one half of the **course mark**.
- **DP Requirement**: 80% attendance of lectures and satisfactory perfomance in assignments
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	50%.
Final Exam:	50%.

A pass mark of 50% is required overall, with a 45% sub-minimum on each of the examination and semester mark.

Operations Research A

Synopsis

Operations Research (OR) is the study of scientific approaches to decision-making. Through mathematical modelling, OR seeks to design, improve and operate complex systems in the best possible way. OR has many applications in science, engineering, economics, and industry and thus the ability to formulate and solve OR problems is crucial for both researchers and practitioners. The mathematical tools used for the solution of such models are either deterministic or stochastic, depending on the nature of the system modelled. The goal of this course is to teach you to formulate, analyse, and solve mathematical models that represent real-world problems. The course will also introduce you to how to use Open Solver an open source add in to Excel for solving optimization problems expressed as spreadsheet models. Excel will also be used for simulation modelling.

Note: This module is intended for students who have not completed STA3036S

Course Content and Lecturer Information

Lecturer:	Dr Juwa Nyirenda	Room 6.68	Juwa.Nyirenda@uct.ac.za
	Dr Georgina Rakotonirainy	Room 5.51	zahgina@gmail.com

Topics:

1. Linear Programming formulation and Solution
2. Optimality Principles
3. Further Practicalities
4. Network and Project management models
5. Queuing Theory
6. Simulation

Prescribed Text: Complete notes for the course will be provided.

Assessment

- **Composition**: Two assignments and a final exam.
- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. Page limits will be announced upon release of the assignments. Where prediction sets are required, these will be handed in electronically via Vula along with the assignment. Marks will be allocated for the quality of the write up.
- **Course Mark**: In calculating the course mark, each assignment counts one third of the **course mark**.

- **DP Requirement**: A minimum of 35% for the course mark and completion of all assignments by the due dates plus attendance of lectures.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	33%.
Final Exam:	67%.

Operations Research B

Synopsis

Operations Research (OR) is the study of scientific approaches to decision-making. Through mathematical modelling, OR seeks to design, improve and operate complex systems in the best possible way. OR has many applications in science, engineering, economics, and industry and thus the ability to formulate and solve OR problems is crucial for both researchers and practitioners. The mathematical tools used for the solution of such models are either deterministic or stochastic, depending on the nature of the system modelled. The goal of this course is to teach you to formulate, analyse, and solve mathematical models that represent real-world problems. The course will also introduce you to how to use Open Solver an open source add in to Excel for solving optimization problems expressed as spreadsheet models. For simulation modelling a dedicated simulation package will be used.

Note: This module is intended for students who have completed STA3036S or Operations Research A.

Course Content and Lecturer Information

Lecturer:	Dr Juwa Nyirenda	Room 6.68	Juwa.Nyirenda@uct.ac.za
	Dr Georgina Rakotonirainy	Room 5.51	zahgina@gmail.com

Topics:

1. Multi-objective and Goal Programming
2. Duality
3. Data Envelopment Analysis
4. Integer Programming
5. Deterministic and Stochastic Dynamic programming
6. Simulation

Prescribed Text: Complete notes for the course will be provided.

Assessment

- **Composition**: Two assignments and a final exam.
- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. Page limits will be announced upon release of the assignments. Where prediction sets are required, these will be handed in electronically via Vula along with the assignment. Marks will be allocated for the quality of the write up.

- **Course Mark**: In calculating the course mark, each assignment counts one third of the **course mark**.
- **DP Requirement**: A minimum of 35% for the course mark and completion of all assignments by the due dates plus attendance of lectures.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	33%.
Final Exam:	67%.

Portfolio Theory

Synopsis

The course aims to familiarise the student with the foundations of portfolio theory, specifi cally as they related to the quadratic asset allocation problem driven by daily equity, bond and money market returns. The course will use R to model tactical and strategic assets via industry sector data sourced from INET. The course aims to motivate the use of equilibrium models in finance and use the link between asset pricing, financial equilibrium and mean-variance efficiency to make data informed portfolio selection decisions.
Note: This course forms the pre-requisite course for STA5091Z.

Course Content and Lecturer Information

Lecturer: A/Prof Tim Gebbie Room 5.39 tim.gebbie@uct.ac.za

Topics:

1. From Gold to Markets
2. Data Wrangling in R
3. Static Mean-Variance Theory
4. Tactical Asset Allocation
5. Black-Litterman Model
6. Fundamental Law of Active Management
7. Insights into Active Management
8. The Roll Criticism
9. Estimation Uncertainty
10. Performance Measures
11. Performance Attribution
12. Indexation

Prescribed reading: The Course is broadly based upon the below chapters, and aims to summarise key ideas in no more than 12, 2 hour sessions, at the level of the first year of graduate school (first year science postgraduate) :

1. Elton, E., Gruber, M., Brown, S., and Goetzmann, W.,(2014), Modern Portfolio Theory and Investment Analysis, 9-th edition, Wiley [Chapters 13, 17, 26, 28]
2. Ingersoll, J. E., (1987), Theory of Financial Decision Making, [Chapter 11, 13]
3. Lee, W., (2000), Theory and Methodology of Tactical Asset Allocation [Chapters 2, 3, 7]
4. Prigent, P-L., (2007), Portfolio Optimization and Performance analysis. Chapman & Hall [Chapters 1,3,4,5,7]
5. Rachev, S. T., Hsu, J. S. J., Bagasheva, B. S., Fabozzi, F. J., (2008), Bayesian Methods in Finance, [Chapters 8, 13, 14]
6. Ross, S., (2005), Neoclassical Finance, Princeton Press [Chapters 1]

Assessment

- **Composition:** Two assignments (theory and code) which make up the course mark and a final theory exam.
- **Format**: Assignments will consist of a formal write-up to be submitted in PDF format on Vula via the assignments tab. R markdown and Latex templates are available from the course Resources on the Vula site.
- **Course Mark**: In calculating the course mark, each assignment counts at least one third of the **course mark**. It is expected that there will be at least one presentation session where results for the assignments will be discussed, these presentations will be used to inform the class mark and will be student presentations given using beamer or equivalent in Latex prepared PDF documents..
- **DP Requirement**: The course has an exam subminimum of 45%, and expects the submission of all assignments by the due dates. In the event of a missed assignment a formal 2 hour theory test may be given. Lecture attendance is compulsory and active engagement with class discussions is expected.
- **Final Mark**: The final grade for the course will be based on:

Course Mark:	30%.
Final Exam:	70%.

Statistical Computing

Synopsis

Statistical Computing refers to the use of computers to do statistics. This definition includes data handling, visualization, statistical modelling, and writing software for statistical analyses. Statistical computing is also used to refer to computer intensive methods where the computer is used to solve problems that are analytically difficult (then also known as *Computational Statistics*). This latter category includes Monte Carlo methods and bootstrapping.

The R language for statistical computing will be used in this course. We start with the basics: R data structures such as vectors, matrices, and data frames. You will learn how to manipulate, summarize and organize data and data files, use R to create quality graphics, program and write your own functions, use simulations to solve statistical problems (Monte Carlo and bootstrap), optimize functions, and finally how to do parallel computing in R.

Course Content and Lecturer Information

Lecturer: Dr Birgit Erni Room 6.64 birgit.erni@uct.ac.za

Topics:

1. data structures
2. programming basics
3. data management (summarizing, transforming between formats, aggregating)
4. graphics
5. R Markdown for reproducible research
6. Monte Carlo methods
7. bootstrap
8. optimization
9. parallel computing

Prescribed Text: Course notes for the sections on Monte Carlo, bootstrap and optimization will be made available on Vula. A list with resources for learning R will be given.

Assessment

There will be no assignments. The final grade will be based on one final exam, which will be computer-based. Practical exercises during class and extra tutorial questions will help you to prepare for the exam.

Time Series

Synopsis

Many things that we measure or collect data on, change over time. Data points correlated in time are common in many fields: economics, environment, medicine, engineering. In recent years, new types of data recording devices and data sources have resulted in increased amounts of large time series data sets. Also, more powerful computers allow for more powerful statistical methods to be used. This course starts off with a brief revision of the Box-Jenkins approach to time series modelling. Then we will explore various methods in modern time series analysis, including spectral analysis, filtering, state-space models, Kalman filters.

Course Content and Lecturer Information

Lecturer:	Sulaiman Salau	Room 5.54	sulaiman.salau@uct.ac.za
	Birgit Erni	Room 6.64	birgit.erni@uct.ac.za

Topics:

1. introduction and revision
2. ARMA processes
3. linear prediction
4. non-stationary processes
5. estimation and model selection
6. spectral analysis and filtering
7. exponential smoothing
8. time series regression models
9. state-space models and Kalman filter
10. hidden Markov models

Prescribed Text: Robert H. Shumway & David S. Stoffer, 2016. *Time Series Analysis and its Applications. With R Examples.* 4th edition. Springer. `https://www.stat.pitt.edu/stoffer/tsa4/`

Assessment

There will be two assignments. Up to 20% of the course mark could be based on class participation. The final grade for the course will be calculated as:

Course Mark:	40%.
Final Exam:	60%.