Level 3 Mathematical Sciences Course

Semester 2, 2010

MATHS 3015 Communication Skills III

Lecturer: Dr Janice Gaffney

In the modern world skill at communicating mathematics is sometimes just as important as skill at doing mathematics. This course develops students' skills in both the written and verbal communication of mathematics. In addition the general communication skills which are fundamental to getting and keeping a job are taught. The course encourages student learning with a range of interesting teaching techniques including guest **Lecturer**s and workshops.

PURE MTH 3003 Number Theory III

Lecturer: Dr Alison Wolff

Number theory is one of the oldest branches of mathematics. It is concerned with the properties of numbers, especially the properties of the integers. Historically, it was valued as the purest form of mathematics, but in fact there are many modern applications to information technology and cryptography. Number theory is a fundamentally useful course for any mathematician, but it also attracts a general audience because of its intrinsic beauty and its emphasis on problem-solving.

APP MTH 3002 Fluid Mechanics III

Lecturer: Dr Ben Binder

Fluid flows are important in many scientific and technological problems including atmospheric and oceanic circulation, energy production by chemical or nuclear combustion in engines and stars, energy utilisation in vehicles, buildings and industrial processes, and biological processes such as the flow of blood.

Considerable progress has been made in the mathematical modelling of fluid flows and this has greatly improved our understanding of these problems, but there is still much to discover. This course introduces students to the mathematical description of fluid flows and the solution of some important flow problems.

APP MTH 3012 Financial Modelling: Tools and Techniques

Lecturer: Dr Janice Gaffney

The growth of the range of financial products that are traded on financial markets or are available at other financial institutions, is a notable feature of the finance industry. A major factor contributing to this growth has been the development of sophisticated methods to price these products. The significance to the finance industry of developing a method for pricing options (financial derivatives) was recognized by the awarding of the Nobel Prize in Economics to Myron Scholes and Robert Merton in 1997. The mathematics upon which their method is built is stochastic calculus in continuous time. Binomial lattice type models provide another approach for pricing options. These models are formulated in discrete time and the examination of their structure and application in various financial settings takes place in a mathematical context that is less technically demanding than when time is continuous. This course discusses the binomial framework, shows how discrete-time models currently used in the financial industry are formulated within this framework and uses the models to compute prices and construct hedges to manage financial risk. Spreadsheets are used to facilitate computations where appropriate.

APP MTH 3016 Telecommunications Systems Modelling III

Lecturer: Dr David Green

This course introduces students to the fundamental concepts of stochastic modelling with an emphasis on applications relating to telecommunication systems. Considerable emphasis is also placed on the development of skills, which are important in the workplace. Amongst these are presentation and communication skills, ability to present a solution in terms that the ``owner of a problem'' can understand, and ability to make decisions about which techniques might be useful to solve a problem. Application of the above skills to sophisticated models of telecommunications systems are developed by students through completing a series of mini-projects.

PURE MTH 3009 Integration and Analysis III

Lecturer: Dr Paul McCann

The Riemann integral works well for continuous functions on closed bounded intervals, but it has certain deficiencies that cause problems, for example, in Fourier analysis and in the theory of differential equations. To overcome such deficiencies, a "new and improved" version of the integral was developed around the beginning of the twentieth century, and it is this theory with which this course is concerned. The underlying basis of the theory, measure theory, has important applications not just in analysis but also in the modern theory of probability.

PURE MTH 3012 Fields and Geometry III

Lecturer: Dr Sue Barwick

This first part of this course generalizes the real numbers to a mathematical structure called a field. Finite fields have many applications, particularly in Information Security where the understanding of finite fields is fundamental to many codes and cryptosystems. Properties and constructions of fields will be investigated in detail. The second part of the course considers projective geometries. Projective geometry is one of the important modern geometries introduced in the 19th century. Projective geometry is more general than our usual Euclidean geometry, and it has useful applications in Information Security, Statistics, Computer Graphics and Computer Vision. The focus of this course will be primarily on projective planes.

PURE MTH 3018 Coding and Cryptology III

Lecturer: Dr Thomas Leistner

The fundamental objective of cryptology is to enable communication over an insecure channel in such a way that an eavesdropper cannot understand what is being said. Classical cryptosystems required participants to share a common key. The new public key systems removed the need to share a private key. Coding theory is concerned with finding efficient schemes by which digital information can be coded for reliable transmission through a noisy channel. Error correcting codes are widely used in applications such as transmission of pictures from deep space, storage of data on CDs and design of identification numbers.

STATS 3005 Time Series III

Lecturer: Associate Professor Zudi Lu

Time series consist of values of a variable recorded over a long period of time. Such data arise in just about every area of science and the humanities, including econometrics and finance, engineering, medicine, genetics, sociology, environmental science. What makes time series data special is the presence of dependence between observations in a series, and the fact that usually only one observation is made at any given point in time. This

means that standard statistical methods are not appropriate, and special methods for statistical analysis are needed. This course provides an introduction to time series analysis using current methodology and software.

APP MTH 3010 Variational Methods and Optimal Control III

Lecturer: Associate Professor Matt Roughan

Many problems of optimisation and control in the sciences and engineering seek to find the shape of a curve or surface satisfying certain conditions so as to maximise or minimise some quantity. For example, shape a yacht hull so as to minimise fluid drag. Variational methods involve an extension of calculus techniques to handle such problems. This course develops an appropriate methodology, illustrated by a variety of physical and engineering problems.

STATS 3008 Biostatistics III

Lecturer: Professor Patty Solomon

Biostatistics is the branch of statistics developed for applications within the biomedical, pharmaceutical and health sciences. These methods are fundamental to contemporary medical research. They play a key role in evaluating treatments for diseases such as cancer and heart disease, in predicting the spread and incidence of epidemics and in evaluating the risk associated with factors such as obesity or exposure to electromagnetic radiation. This course provides an introduction to the design and analysis of clinical trials and epidemiological studies, and methods for the analysis of biostatistical data.

APP MTH 3004 Mathematical Biology III

Lecturer: Dr Yvonne Stokes

The application of mathematics to problems arising in the life sciences is a rapidly growing area yielding quantitative understanding of questions about such things as the spread of infectious diseases, population growth and interaction, organ (e.g. heart) function, cell signalling, nutrient supply, and more. This course will introduce students to the fascinating world of modelling biological systems. A variety of biological problems will be considered, in the context of which students will be exposed to a variety of mathematical techniques. No previous exposure to biology is necessary.

STATS 3003 Sampling Theory and Practice III

Lecturer: Associate Professor Andrew Metcalfe

Sample surveys are an important source of statistical data. A great many published statistics on demographic, economic, political and health related characteristics are based on survey data. Simple random sampling is a well known method of sampling but, for reasons of efficiency and practical constraints, methods such as stratified sampling and cluster sampling are typically used by statistical authorities such as the Australian Bureau of Statistics and by market research organisations. This course is concerned with the design of sample surveys and the statistical analysis of data collected from such surveys.