Subject Code: SPA115
Subject Title: Principles of Geographic Information Systems
Point Value: 8

Abstract: This subject introduces students to, and provides a foundation in the use of, geographic information systems (GIS). Students develop the basic theoretical, technical and analytical skills necessary to apply GIS to simple spatial problems. The subject contains a significant element of practical work in which students are encouraged to directly apply their theoretical knowledge. Attention is focussed on the operations of GIS and the application of GIS to simple spatial analysis. This subject forms a basis for further study in other modules.

Enrolment Restrictions: Nil
Prerequisite(s): Nil
Corequisite(s): Nil

Objectives: Upon completing this subject students will be able to:

- Discuss and evaluate the various definitions of a GIS;
- Have a good working knowledge of the principle GIS components;
- Understand the fundamental cartographic principles underlying GIS operation;
- Discuss the nature and characteristics of spatial data and objects;
- Identify and state differences between GIS data structures;
- Identify and understand basic database structures and understand the role of the database management system (DBMS) in a GIS;
- Undertake basic spatial analysis within a GIS;
- Understand problems associated with GIS analysis, such as data accuracy and data transfer;
- Identify a GIS as a decision support system.

Curriculum: This subject will cover the following topics:

- Concepts, principles and components of a GIS;
- Cartographic principles in GIS operation;
- GIS data types and structures;
- Data acquisition and preprocessing;
- The DBMS and its management;
- GIS analysis and applications;
- The future of GIS.
Subject Code: SPA105
Subject Title: Remote Sensing
Points: 8
Abstract: The subject covers the remote sensing discipline: electromagnetic spectrum; spectral response of targets; sensor design (image and non-image formats); platforms; and ground truth collection. Although it concentrates upon the applications and limitations of aerial photography there is substantial coverage of satellite-based sensors, platforms and imagery.
Enrolment Restrictions: Nil
Prerequisite(s): Nil
Corequisite(s): Nil
Objectives: Upon completing this subject students will be able to:

- Have a thorough grounding in the range and character of the remote sensing discipline;
- Understand the interrelationships between the target, the sensor and atmospheric interference;
  - now the capabilities and limitations of aerial photography;
- Use the principal forms of aerial photography both in the laboratory and the field;
- Be familiar with the main satellite-based remote sensing systems: their orbit, platform, sensor design and imagery types;
- Be introduced to the use of computer systems to display and interpret digital imagery;
- Use aerial photography and satellite imagery to produce a land cover map of a selected study area.
Curriculum: This subject will cover the following topics:

- The electromagnetic spectrum
  Remote sensing systems: scanners, platforms, interactions of EMR with atmosphere and target; storage of data; display, enhancement and classification of digital data; and use of radiometer for collection of spectral response data.

- Satellite-based remote sensing systems
  Air photography: scale, parallax, geometry, interpretation, (panchromatic, true colour and false colour).

  Applications of remote sensing to environment sciences - agriculture, soils, geology, hydrology, vegetation mapping and urban analysis.
Subject Code: SPA 406
Subject Title: GIS Applications
Points Value: 8
Abstract: This subject extends the study of geographic information systems (GIS). It considers a wide range of analytical techniques available for modelling and analysis of spatial data, emphasising those with direct environmental application.
Enrolment Restrictions: Nil
Prerequisite(s): SPA115 Principles of Geographic Information Systems
Corequisite(s): Nil
Objectives: Upon completing this subject students will be able to:
- Understand the concepts of geographic information science;
- Demonstrate an array of spatial analytical capabilities;
- Be familiar with data modelling techniques;
- Be able to analyse and model spatial problems using a GIS.
Curriculum: This subject will cover the following topics:
- Geographic information science;
- GIS analytical functionality;
- Modelling techniques;
  Related issues and conclusion.
Subject Code: SPA402
Subject Title: Spatial Statistics
Point Value: 8

Abstract: Provides an introduction to and overview of the application of statistical techniques in spatial data analysis. The fundamental approach used will be to highlight the practical value of using modern techniques instead of previous compromises. To this end, case studies from several discipline areas will be used together with a brief historical perspective. A feature of this subject will be the practical component involving data analysis and interpretation for various problems using computer packages and algorithms.

Enrolment Restrictions: Nil

Prerequisite(s): STA201 or equivalent
Corequisite(s): Nil

Objectives: Upon completion of this subject, students will be able to:
- describe the use of smoothing and interpolation in producing maps and in estimation problems;
- sample spatial features, test their patterns and estimate their densities;
- interpret the results of an analysis of a mapped point pattern;
- demonstrate an understanding of the different techniques that are required across a range of applications such as geostatistics, field experiments, ecology and landscape; and
- develop the required skills to use computer facilities in execution of spatial analysis and interpretation.

Curriculum: An overview of
- history of the subject and areas of application via case studies
- sampling methods for 2D data
- smoothing techniques and their role in other analyses
- graphical methods for interpretation
- packages and computer skills

An indepth coverage of
- spatial patterns
- sampling methods in 2D
- smoothing and interpolation
- use of the variogram and autocorrelation
- 'kriging' and 'cokriging'
- case studies in ecology, geostatistics and field experiments
Subject Code: SPA403
Subject Title: Algorithms in GIS and Modelling
Point Value: 8

Abstract: This subject aims to cover the required skills to analyse and develop mathematical algorithms for GIS.

Enrolment Restrictions: Nil

Prerequisite(s): MTH101 or SPA409 or equivalent and a GIS subject OR approval by Course Coordinator

Corequisite(s): Nil

Objectives: Upon completion of this subject, students will be able to:
- understand the mathematical concepts required for the development of GIS and CAD related algorithms;
- have gained a good understand of applications of computational geometry concepts to GIS and modelling;
- be able to analyse, modify and design various GIS algorithms that employ geometrical concepts.

Curriculum: The subject will cover the following topics:
- Concept of space and geographical data.
- Introduction to geometrical concepts used in GIS and modelling.
- Curves (including interpolation and splines concepts widely used in GIS).
- Relational properties: distance between two points; distance between a point and a curve; distance between two curves.
- Intersections: line, plane and curve intersections.
- Coordinate systems and map projections for GIS
  - Terrestrial systems
  - Plane systems
  - Projections (transformations)
  - Choice of a suitable projection
- Transformations used in GIS
  - Translation, rotation, scaling
  - Homogeneous transformations
  - Nonlinear transformations
- Fundamental graphical procedures used in GIS
  - vector techniques
  - raster techniques
- Projections on computer graphics
  - The Display Environment
  - Projections
  - Scene transformations
  - Hidden surfaces
- Computer systems and low and high level data structures for GIS
  - Classification of systems
  - Software development strategy
  - Spatial Data models and structures
  - Three dimensional GIS
Subject Code: SPA404

Subject Title: Remote Sensing Algorithms

Point Value: 8

Abstract: This subject aims to give students an understanding of the important mathematical concepts and algorithms commonly used in processing, multispectral, remote sensed, imagery.

Enrolment Restrictions: Nil

Prerequisite(s): MTH102 & STA201 or equivalent subjects, OR approval by course coordinator.

Corequisite(s): Nil

Objectives: Upon completion of this subject, students will:
- have an understanding of the sources and characteristics of remote sensed data.
- have an awareness of the radiometric and geometric corrections that are required to correct remote sensed imagery for atmospheric and view geometry distortions.
- Have an understanding of the mathematical and statistical formulation of image processing techniques commonly used in remote sensing.
- Be able select and use appropriate image processing techniques to enhance and classify land cover classes using multispectral image data.

Curriculum: The subject will cover the following topics:
- Sources and characteristics of remote sensed data.
- Geometric and radiometric correction imagery.
- Radiometric enhancement techniques including; look up tables, linear contrast enhancement, histogram equalisation, histogram matching, density slicing and pseudocolour techniques.
- Geometric enhancement techniques including; smoothing, edge detection and enhancement, spatial derivatives and general convolution filtering.
- Multispectral transformations of image data including; principal component analysis, band ratios, vegetation indicies, tasseled cap and Taylor transformations.
- Spatial filtering using Fourier transformation techniques.
- Supervised classification of multispectral imagery including; maximum likelihood, box, Euclidean distance and Mahalanobis classifiers.
- Advanced classification techniques including; contextual, neural network and expert system classifiers.
- Unsupervised classification techniques.
- Feature reduction and land cover discrimination using canonical variate analysis techniques.
- Analysis of multispectral remote sensed image data - case studies.
Subject Code: SPA 405

Subject Title: Image Analysis

Point Value: 8

Abstract: The subject covers the theoretical background of remote sensing; treats in detail the acquisition of digital data by imaging/non-imaging systems; and examines the commonly used procedures for enhancing and classifying multi-spectral data.

Enrolment Restrictions: Nil

Prerequisite(s): SPA101 Introduction to Geographic Information Systems

Corequisite(s): Nil

Objectives: Upon completing this subject students will be able to:

- Understand the characteristics and format of digital data;
- Understand the main components of image processing systems;
- Display and manipulate digital data;
- Apply standard image analysis techniques to digital imagery;
- Be familiar with the methodology of computer-based classifications of imagery.

Curriculum: This subject will cover the following topics:

- Basic principles of computer display and processing digital imagery;
- Brief introduction to Remote Sensing Platforms and Sensors;
- Preprocessing of Remotely Sensed Data from satellite and airborne scanners;
- Enhancement techniques;
- Image transforms;
- Filtering techniques;
- Classification methodology;
- Applications;
- Integration with GIS.
Subject Code: SPA409

Subject Title: Introductory Mathematics for Spatial Analysis

Point Value: 8

Abstract: This subject provides an introduction to the basic mathematical and statistical techniques required for spatial analysis applications in GIS, Image Analysis and Remote Sensing.

Enrolment Restrictions: Nil

Prerequisite(s): Nil

Corequisite(s): Nil

Objectives: Upon completion of this subject, students will be able to:

• understand the mathematical and statistical concepts that underpin many procedures used in the fields of GIS, Image Processing and Remote Sensing; and

• apply mathematical and statistical techniques to assist in the solution of a range of problems in Spatial Analysis.

Curriculum: The subject will cover the following topics:

• Introduction to differential calculus: historical background, functions, limits, slope of a tangent, derivative, stationary points, applications of differentiation;

• Introduction to integral calculus: indefinite integrals, approximate areas, definite integrals, applications of integration;

• Introduction to vectors and matrices: elementary matrix operations, determinant, inverse, solutions of systems of linear equations;

• Introduction to linear algebra: linear maps, eigenvectors, eigenvalues, diagonalization of a matrix;

• Parametric representation of curves;

• Simple probability concepts: complement, addition rule, product rule.

• Representation of data - histogram, stem-and-leaf plot, boxplot, scatterplot;

• Descriptive statistics: mean, standard deviation, variance covariance, correlation and standardised values;

• Simple distributions: binomial and poisson, normal; sampling distributions: t, chi square, F distributions;

• Introduction to hypothesis testing: testing a population mean;

• Introduction to regression: simple linear regression.
Subject Code: SPA 412
Subject Title: Integrated GIS/Remote Sensing
Point Value: 8

Abstract: This subject focuses on the integration of geographic information systems (GIS) and remote sensing technologies. Students will examine the use of these combined technologies as they apply to natural resource management problems. A major emphasis will be placed on students completing a case study incorporating the use of remote sensing and GIS.

Enrolment Restrictions: Nil

Prerequisite(s): SPA 101 Introduction to GIS OR SPA 406 GIS Applications and SPA 405 Image Analysis.

Corequisite(s): Nil

Objectives: Upon completing this subject students will be able to:

- Identify a broad range of real world uses of integrated remote sensing/GIS projects;
- Process raster data for merging with GIS data;
- Extract information from raster based data using computer-based classification;
- Integrate raster data into a GIS for data analysis;
- Develop and present a project outline which requires the integration of remote sensing and GIS technologies.

Curriculum: This subject will cover the following topics:

- Models of data integration;
- Raster image rectification;
- Raster image classification;
- Data stratification;
- Thematic data accuracy assessment;
- Data error sources;
- GIS analytical techniques;
- Map design and production.