

POSTGRADUATE INSTITUTE OF SCIENCE

UNIVERSITY OF PERADENIYA



M.Sc. in GIS and Remote Sensing

2009/2010

1. INTRODUCTION

The Postgraduate M.Sc. programme in GIS and Remote Sensing offered by the Postgraduate Institute of Science of the University of Peradeniya, seeks to provide a sound theoretical and practical knowledge and comprehensive training in the Geographic Information systems (GIS) and Remote Sensing (RS). The goal of this M.Sc. course is to provide opportunity for the participants, a critical understanding and competence in developing systems and tools for the acquisition, processing, transformation, analysis, storage, presentation and use of geo-spatial information. In addition, skills are developed to enable the participants to design and undertake research and development projects in various fields and also to actively engage in multidisciplinary research and development projects.

GIS and RS are rapidly evolving towards becoming standard tools, influencing everyday decision-making particularly among professionals. Eventhough this has been described as “Geoinformatics” by some of the professionals, the Postgraduate Institute of Science decided to name it as “GIS and Remote Sensing” due to its popularity. As a multi-disciplinary programme, it includes courses in Geographical Information System, Remote sensing, numerical methods and algorithms in RS and GIS, Digital photogrammetry, GPS and its applications, digital image processing. In addition, there are courses in application of GIS in various disciplines such as Earth Sciences, Landuse planning, Disaster Management, Natural resources Management, Agriculture, Forestry, Wild life, Transportation and supply net work, Transmission and Telecommunication network will be included. The programme is designed for the students to use computers throughout the programme, enabling them to use the latest software available in the fields of GIS and Remote Sensing.

The programme includes a dissertation component and the students are required to select a suitable research topic in any of the fields mentioned above and submit a research report in the form of a dissertation. In this connection, the students are free to select an institution of their choice to conduct the research study. The Postgraduate Institute of Science would also help the students to find suitable institutions and topics for their research.

2. AIMS AND OBJECTIVES

This programme aims at developing human resources in the fields of GIS and Remote Sensing. The objectives of the programme are;

1. To train personnel in the fields of remote Sensing and Geographic Information Systems and the related aspects at postgraduate level.
2. To Provide an opportunity to improve existing skills in GIS and Remote Sensing.
3. To provide a necessary background knowledge for research in Remote Sensing and GIS applications.
4. To provide necessary skills for use of GIS and Remote Sensing in management of natural resources.

3. PROGRAMME ELIGIBILITY

This programme is designed to suit professionals and young graduates who do not have any previous experience in the use of GIS or Remote Sensing. Candidates should have a strong background in at least one of the following subject areas: Computer science, Physical and Biological Sciences, Earth and Natural Sciences, Geography, Agriculture, Engineering, Medicine or any other discipline that will be endorsed by the Board of Study in Earth Sciences of the PGIS.

The candidates who are employed and eligible for admission need to produce evidence of leave granted to follow the programme and a letter of release from the relevant Head of the Department/Institution.

4. PROGRAMME FEE

(N.B. The Programme fees given below may be revised.)

Country of Origin	M.Sc. Programme Fee
Sri Lanka	Rs. 100,000
SAARC Countries	US \$ 3,300
Other Countries	US \$ 6,600

Programme fees shall be paid in two instalments (50% *at the registration and the balance 50% within six months from registration*). Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS.

5. THE PROGRAMME STRUCTURE AND DURATION

This is a full-time programme consisting of course work and a research project. Course work will be conducted over a period of two semesters of 15 – weeks each. The taught courses will be conducted on Fridays, Saturdays and/or Sundays covering a total of 12 - 15 hours per week. The entire programme duration will be about 15 – 18 months inclusive of 3 - 6 months for the individual research project. Satisfactory completion of a minimum of 24 credits of course work (with a Grade Point Average - GPA of not less than 3.00) is required for the programme in addition to the six credits allocated for the full-time research project (*If the student obtains a GPA in the range of 2.75 to 2.99, then he/she is eligible only for the award of the Diploma in GIS and Remote Sensing*). Continuous attendance is compulsory during the period of research work. After successful completion of the research project, the student is eligible for the award of the M.Sc. Degree. Based on the performance by students in the taught courses and thesis, PGIS may upgrade the registration of such students to M.Phil. or Ph.D. programmes.

Each candidate will be assigned an academic advisor, whose advice should be sought when planning the M.Sc. Programme. The approval of the programme coordinator is necessary prior to the commencement of the programme. English will be the medium of instruction.

Programme Summary

Course Code	Course Description	Lecture hrs.	Practical hrs.	No. of Credits
ESR 501	Fundamentals of Geographic Information Systems (GIS)	30	30	3
ESR 502	Remote Sensing and Aerial Photography	30	30	3
ESR 503	Database Management Systems	10	10	1

ESR 504	GPS and its Applications	10	10	1
ESR 505	Fundamentals of Space Technology*	30	-	2
ESR 506	Advanced Technologies in GIS	30	30	3
ESR 507	Advanced Mapping Technology*	15	30	2
ESR 508	Digital Photogrammetry*	15	30	2
ESR 509	Spatial analysis and Modeling	15	30	2
ESR 510	Applications and Development of GIS and Remote Sensing	30	30	3
ESR 511	Digital Image Processing in Remote Sensing*	15	30	2
ESR 512	Geostatistics in GIS*	15	30	2
ESR 513	Application and Development of Web GIS*	10	10	1
ESR 514	Numerical Methods and Algorithms in RS and GIS*	20	20	2
ESR 597	Seminar on Applications of GIS and Remote Sensing	-	-	1
ESR 599	Research Project on RS and/or GIS Applications	6 months		6

* *Optional Courses. Students are required to obtain 7 credits from optional courses.*

6. PROGRAMME CONTENTS

ESR 501: Fundamentals of Geographic Information Systems (GIS) (3 Credits)

Course Outline

Introduction to GIS, Definition, Overview, History and Concepts of GIS, Scope and Application areas, Purpose and Benefits of GIS, Functional elements of GIS, Required hardware and software for GIS, Required functions of GIS software, Installation of GIS, Mapping Concept – Map Elements, Map scales and representations, Map Projection, Geometric rectification, Data Structure – raster and Vector Data Structures, Input of geospatial data, Sources of data and input devices, Spatial database – concept of spatial database, Data Acquisition and Management Techniques, Data Manipulation and Analysis, Map Output Generation.

Laboratory Sessions

Spatial database development, Data input, Linking non-spatial and spatial database, database editing and updating, GPS data integration in GIS, Data manipulation and preprocessing, Spatial analysis, Map generation, Charting and tabular representation. Mini-project for GIS application.

ESR 502: Remote Sensing and Aerial Photography (3 Credits)

Course Outline

Overview and concepts of Remote Sensing technology, basics of photogrammetry, practical uses of aerial photographs/satellite photographs in various disciplines, fundamental characteristics of electromagnetic radiation, interaction of radiation with matter refraction, absorption, diffusion, emission with radiometric terms and units, concepts of spectral resolution and detection, Remote Sensing platforms, Satellite System and sensors, active and passive sensing systems, visual-digital interpretation, overview of RS Applications, Introduction to RS image processing. Image enhancement. geometric correction. RS Image classification,

Laboratory Sessions

Visual interpretation of aerial photographs for land use, land pattern analysis, geological and structural analysis as well as manipulation and analysis of remote sensing images,

Text Books and References:

ESR 503: Database Management Systems (1 Credit)

Course Outline

Introduction to databases, database management systems, hierarchical model, relational database, principles and technologies of object-oriented programming, object oriented database, Concept of spatial database, design of spatial database.

ESR 504: GPS and its Applications (2 Credits)

Course Outline

The earth, Spherical Earth & Mathematical Model, Rotations of the Axis of the Earth, True North, Absolute and Relative coordinate systems for Positioning on the Earth, Ellipsoidal model of the Earth and Mathematical model, Mean Sea Level, Equipotential surfaces & Geoid, Geoid undulations. Positioning, Introduction to GPS, Map Projections and Coordinate Transformations, GPS Basic Concepts, Kinematic and Post Processed Differential GPS, GPS Accuracy and Precision, Database Management and Data Dictionaries, Navigation with GPS, Map production and update, GPS/GIS Applications.

Laboratory Sessions

Hands on sessions with GPS equipments, Real-life case studies, location of a ground point with different coordinate systems, navigation, GPS survey, Electronic data downloading, conversion of GPS data to GIS.

ESR 505: Fundamentals of Space Technology (2 Credits)

Course Outline

Elements and Tools for Aerospace Systems and their applications. Status of the World Space Projects. Management of Space Projects. Principle of Space Flight Mechanism. Application Satellites. On-board Space Subsystems. Operation and Utilization of Aerospace Systems and Low Cost Space Projects. Principle of Flight Mechanics, Flight Dynamics; Ultralight to Rocket, Orbital Mechanics, Navigation, Guidance and Control, Application Satellites Earth Observation Satellites, Meteorological Satellites, Communication, Broadcast, and IT Satellites, Optical and Microwave Sensors and, Other Mission Equipments

ESR 506: Advanced Technologies in GIS (3 Credits)

Course Outline

State of the Art of GIS Technologies, Developments in GIS Technology, Various applications of GIS, Accuracy of Geo-spatial Databases. DEM Generation 3D map display, TIN Algorithms. 3D-GIS Models, Acquisition of 3D Geo-spatial Data, Generation of 3D Geo-spatial Databases, Visualization and Virtual Reality, Examples for 3D GIS Modeling, Analysis of Discrete Entities in Space, Spatial Analysis using Continuous Fields, Map Algebra and Cartographic Modeling, Point Operations, Spatial Analysis Using Convolution, Deriving Surface Topology and Drainage Networks, Spatial Regression Analysis and Modeling Customization and Automation in GIS, Customization to End User Needs, Introduction to Programming in GIS, Automation in GIS Functionality, Introduction to Web GIS.

Laboratory sessions

Database import and export using SQL, Statistical analysis, Regression analysis of spatial data, Advance data analysis, 3D modeling in GIS, Map algebra and cartographic modeling, Hotlinking, Automation and customization, Programming in GIS, Internet GIS.

ESR 507: Advanced Mapping Technology (2 Credits)

Course Outline

Advanced methodology of mapping technology. Concepts of Automated Cartography Automated map recognition. Morphological Filtering Binary Image Feature Extraction, Topological Properties, Map scanning and processing. Geometric correction. Map feature extraction. Raster-vector conversion.

Recognition of contour maps. Cadastral Map Recognition Map Line Feature Extraction, polygon Generation, Multi-relations based Checking,, Generation of Triangulated Irregular Network (TIN)

Laboratory Sessions

Introduction of Auto-2D System and Testing MM Operators, Pre-processing for Scanning Maps, Example of Contour Map and Cadastral Map Recognition

ESR 508: Digital Photogrammetry (2 Credits)

Course Outline

Introduction to digital photogrammetry, overview and history, concepts of digital photogrammetry. Fundamentals of Digital Photogrammetry, Analog, Analytical and Digital Photogrammetry, Photo Scanning and Geometric Correction, Image Filtering, image Segmentation, Image Feature Extraction, Acquisition of digital images, direct digital recording, scanning of analog images, basic operations of digital images, statistical characteristics of digital images, Geometric transformation, Image classification, Image feature extraction, Image matching, DEM generation, Orthophoto generation, Topographic and thematic mapping. Applications.

ESR 509: Spatial Analysis and Modeling (2 Credits)

Course Outline

Use of GIS in attribute and spatial queries, single and multilayer operations, geometric modeling, point pattern analysis, reclassification and coverage building, surface analysis, raster grid analysis, various types of overlay operations and spatial operations in GIS, Buffer analysis, fuzzy spatial analysis, Basic geostatistical components for spatial analysis, proximity analysis, connectivity analysis, diffusion modeling, establishment of objectives and criteria for analysis, data preparation for spatial operations, evaluation and interpretation of results.

ESR 510: Application and Development of GIS and Remote Sensing (3 Credits)

Course Outline

Application of GIS in Cartography and map making, geological mapping, Natural resources exploration and management, Environmental planning and management, Disaster management, environmental impact assessment, Geological and Hydrological modeling, coastal zone management, Irrigation system management, Agricultural planning and development, Forestry management, fishery and marine applications, Coastal zone management, Epidemics and Disaster Management and mitigation, Archeology, Planning and management of Transport networks, Telecommunication tower networks, Water supply and distribution networks, Electrical distribution networks, Navigation system development, GIS for business planning and managements etc.

Students are requested to compile a mini project report on the application of GIS in any selected discipline.

ESR 511: Digital Image Processing in Remote Sensing (2 credits)

Course Outline

Image Data Handling in computer system. Image Model in Computer Memory, File format, Image Processing Algorithm and Implementation. Image statistics and contrast enhancement, Spatial enhancement, spectral enhancement, radiometric enhancement, Color Composite, Manipulation and data fusion, Texture Analysis, Segmentation, Image Classification, Image matching, Image Compression - JPEG file handling, RS data and DEM for 3D Visualization and Mapping, Digital Elevation Model, Coordinate System, Shading Model, Z-Buffer Model, Topographic feature extraction, Real-time RS mapping techniques.

Laboratory Sessions

Modifying / making computer programs in C for image analysis. Programming for image file I/O, creating/reading images in popular image formats, statistical analysis, contrast enhancement, filtering.

ESR 512: Geostatistics in GIS (3 credits)

Course Outline

Methods of statistical learning theory, spatial statistics, and modeling, mapping distances, allocation, shortest path, accumulation surfaces, interpolating to Raster, terrain analysis, spatial prediction and risk analysis, spatial sampling and monitoring network design etc., Interfaces between geo-statistics and GIS, integration of geostatistics and GIS, mutual benefits, statistical problems of error propagation and uncertainty in GIS, etc., Application of geostatistical methods in the Earth and Environmental Sciences, in Agriculture and Forestry, Epidemiology and Health Sciences, Econometrics and Telecommunications, Interfaces between (geo-) statistical software systems, spatial database management systems and visualization and mapping software systems.

ESR 513: Application and Development of Web GIS (1 Credit)

Course Outline

Implementing Web-GIS Solutions using Open Source Software (OSS). Meta-data Management and Clearing House concepts, Interoperability and Standardization Issues Related to Spatial Data, Installing and using OSS tools such as GRASS GIS and Minnesota MapServer.

Laboratory Sessions

The Laboratory session will provide hands on experience on using OSS for developing, managing and serving spatial and geo-referenced multimedia contents on the Web.

ESR 514: Numerical Methods and Algorithms in RS and GIS (2 Credits)

Course Outline

Fourier transform and Image Filtering, Overview of Numerical Methods in Digital Image Processing and GIS, GIS and RS systems design and development: fundamentals. Principles in software development: data structures, methods, algorithms. Language description and software development : VC++, VC# .Net, Data structure for GIS and RS: vector description and storage, raster structures. Basic computational geometry, Basic algorithms in GIS and RS: resolution of some common geometric problems: positions, tessellation, vectorization, interpolation, buffering, line following, classifications (adjacency, proximity), Image processing and algorithms for RS: mathematical morphology, filters, textures, sampling, cartography, vector codification, graphic languages and image codification. 3D representation and perspective.

ESR 597: Seminar on Applications of GIS and Remote Sensing (1 Credit)

This seminar class is designed to provide graduate students with the opportunity to search information on current topics related to their project/thesis. All graduate students pursuing MSc degrees will be required to take this class and offer their findings, orally in a 30-minute presentation to the faculty members of the Postgraduate Institute of Science and students, six months prior to the completion of their program. This presentation will be followed by a question and answer session. Graduate students will also submit a written version of their presentations (or a hard-copy of their presentation slides) to the Course Coordinator.

ESR 599: Research Project on RS and/or GIS Applications (6 months duration - 6 Credits)

Each student is required to carry out an independent research project on a selected topic related to the development or applications of GIS and/or Remote Sensing, under the guidance of a supervisor and prepare a Project report. Report has to be compiled based on the guidelines stipulated by the Postgraduate Institute of Science.

7. PROGRAMME EVALUATION

Programme evaluation will be as stipulated in the PGIS Handbook 2002.

8. TEACHING PANEL

- Dr. P.K. Champatiray, Senior Scientist, Indian Institute of Remote Sensing
M.Tech, PhD (ITC)
- Mr. S.D.P.J. Dampegama, Institute of Surveying and Mapping, Diyatalawa
B.Sc.(Kelaniya), MSc (USA).
- Dr. H.A. Dharmagunawardena, Department of Geology, University of Peradeniya
B.Sc. (Perad.), M.Sc. (Perad.), PhD (Denmark)
- Dr. (Ms.) NDK Dayawansa, Department of Agricultural Engineering, University of Peradeniya
B.Sc. (Perad.), M.Sc. (AIT), PhD (New Castle)
- Dr. Jayalath Edirisinghe, Department of Civil Engineering, University of Peradeniya
B.Sc. (Perad.), M.Sc. (Ehime), PhD (Ehime)
- Dr. Jagath Gunatilake, Department of Geology, University of Peradeniya
B.Sc. (Perad.), M.Sc. (AIT), PhD (Saga)
- Dr. K Jacobsen, Institute of Geoinformatics and Photogrammetry, University of Hannover,
Germany *B.Sc., PhD*
- Dr. S.W. Nawaratna, Department of Geology, University of Peradeniya
B.Sc. (Perad.), M.Sc. (Canada), PG Dip (Austria), PhD (Austria)
- Dr. Ranjith Premalal, Department of Agricultural Engineering, University of Peradeniya
B.Sc. (Perad.), M.Sc. (AIT), PG. Cert. (Italy), PhD (Cranfield)
- Dr. Uditha Ratnayake, Department of Civil Engineering, University of Peradeniya
B.Sc. (Perad.), M.Sc. (AIT), PhD (AIT)
- Dr. Lal Samarakoon, Director, GIS Application Center, AIT, Bangkok, Thailand
B.Sc (Kelaniya), M.Sc. (Saga), PhD (Ehime)
- Dr. Amara Satarasinghe, Director, Dept. of Census and Statistics, Colombo
BSc., MSc., PhD (Perad.)
- Dr. Nitin K. Tripathi, Asian Institute of Technology, Bangkok
B.Tech (IIT), M.Tech (IIT), PhD (IIT)
- Prof. P. Wickramagamage, Department of Geography, University of Peradeniya
B.A. (Perad.), PhD (UK)
- Dr. R.L. Wijewardena, Department of Physics, University of Peradeniya
B.Sc. (Perad.), M.Sc. PhD

PRINCIPAL COORDINATOR

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