CURRICULUM OF

REMOTE SENSING &

GEOGRAPHICAL INFORMATION SYSTEM

BS
MS

(Revised 2005)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum one can judge the state of intellectual development and the state of progress of the nation. The world has turned into a global village; new ideas and information are pouring in like a stream. It is, therefore, imperative to update our curricula regularly by introducing the recent developments in the relevant fields of knowledge.

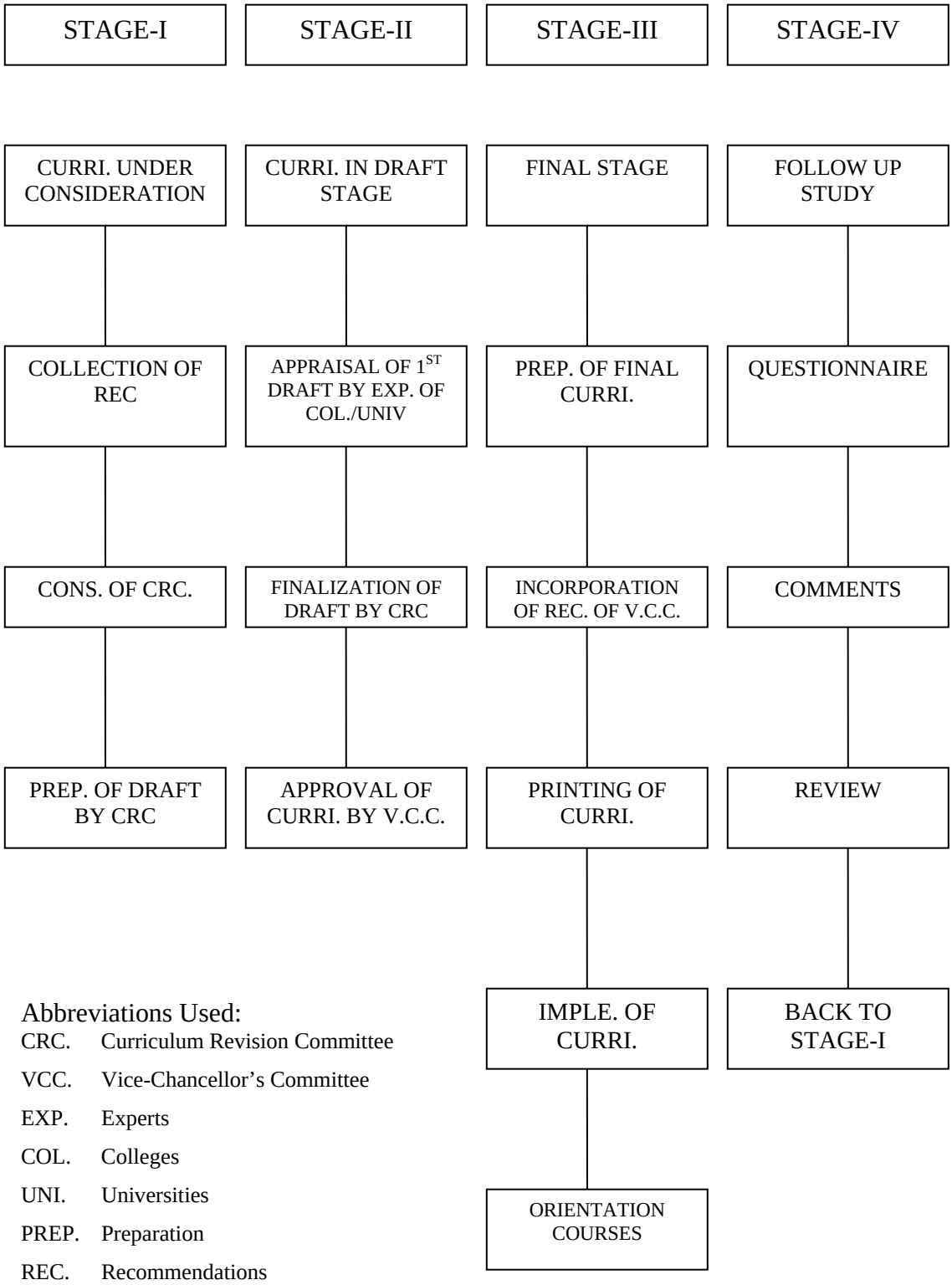
In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification no. D773/76-JEA (Cur.), dated December 4, 1976, appointed University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various committees are constituted at the national level comprising senior teachers nominated by universities. Teachers from colleges and experts from user organizations, where required, are also included in these committees. The National Curriculum Revision Committee for Remote Sensing & GIS in its meeting held in May 2005 at the HEC Regional Centre, Lahore revised the curriculum after due consideration of the comments and suggestions received from universities and colleges where the subject under consideration is taught. The final draft prepared by the National Curriculum Revision Committee duly approved by the Competent Authority is being circulated for implementation by architectural institutions.

(PROF. DR. ALTAF ALI G. SHAIKH)
Adviser (Acad/R&D)

August 2005

CURRICULUM DEVELOPMENT



Abbreviations Used:

CRC.	Curriculum Revision Committee
VCC.	Vice-Chancellor's Committee
EXP.	Experts
COL.	Colleges
UNI.	Universities
PREP.	Preparation
REC.	Recommendations

INTRODUCTION

Two meetings of the National Curriculum Revision Committee (NCRC) for Remote Sensing (RS) & Geographical Information System (GIS) were held at HEC Regional center in Karachi (14-16th March 2005) and Lahore (16-18th May 2005). Realizing the importance of RS&GIS in the developed world arena as well as in developing countries such as India, these meetings were organized by the Higher Education Commission of Pakistan. Focus was given to develop an international standard curricula and launch 4 years BS and 2 years MS degree programs for both public and private sector degree awarding institutions and universities of Pakistan. Various Remote Sensing, GIS, Information Technology professionals, Geographers and educationists from all over Pakistan attended these meetings.

List of Participants

1	Prof. Dr. Waqar Ahmad HEC Foreign Faculty Hiring Programme, GIS Center, University of the Punjab, Lahore.	**Convener**
2	Dr. S. Jamil H. Kazmi Associate Professor Department of Geography, University of Karachi, Karachi.	**Secretary**
3	Dr. M. Ejaz Sandhu Director Research, Superior College, 31 Tipu Block, New Garden Town, Lahore	Member
4	Prof. Dr. Amir Khan Chairman, Department of Geography, University of Peshawar, Peshawar	Member
5	Prof. Dr. Imdad Ali Ismaili Institute of Information Technology & Telecommunication Technology University of Sindh, Jamshoro	Member
6	Prof. Dr Aftab Ahmad Memon Co-chairman, Department of Electronic, Telecom & Biomedical Engineering. Mehran University of Engg. & Technology, Jamshoro.	Member
7	Dr. Allah Bakhsh Associate Professor, Department of Irrigation Drainage, University of Agriculture Faisalabad	Member

8	Dr. Mudassar Hassan Arsalan Assistant Professor, Institute of GIS, National University of Science & Technology, 112, St 37, F-10/1, Islamabad.	Member
9	Mrs Farha Sattar Lecturer GIS Centre University of the Punjab, Lahore	Member
10	Dr. Fazlur-Rahman Assistant Professor Department of Geography, University of Peshawar, Peshawar	Member
11	Mr. Ajab Khan Director I.T. Department of Computer Science, University of Malakand,Chakdara	Member
12	Mr. Muhammad Rafique Dhanani Associate Professor/Chairman Department of Geography, University of Sindh, Jamshoro	Member
13	Mr. Muhammad Taleem Badashah Assistant Professor, Department of Geography, University of the Balochistan, Quetta	Member
14	Mr. Muhammad Nawaz Assistant Professor, Department of Geography, University of the Punjab, Lahore	Member
15	Mr. Mubashar Hussain Assistant Professor, Institute of GIS, National University of Science &Technology, 112,St.37F-10/1, Islamabad	Member
16	Mr. Ghazanfar Ali Khattak Research Associate, National Centre of Excellence in Geology, University of Peshawar	Member
17	Mr. Ahsan Abdullah Associate Professor & Head Centre for Agro Informatics Research (CAIR), National University of Computer and Emerging Sciences, Fast House, Rohtas Road, G-9/4, Islamabad	Member

18	Mr. Ijaz Ahmad Manager, Satellite Ground Station, (SGS) SGS Complex, SUPARCO, P.O Box No.1271, Near Toll Plaza, Islamabad Highway, Islamabad.	Member
19	Mr. Muhammad Nawaz Deputy Director, Survey of Pakistan, Central Street #22, DHA Phase-II, PNHL lines, Karachi	Member
20	Mr. Muhammad Ikram, Deputy Director, Soil Survey of Pakistan, P.O. Awan Town, Lahore	Member
21	Malik Rahim Buskh Senior Research Officer, Soil Survey of Pakistan, Lahore	Member
22	Mr. Javed Sami Department of Space Science University of the Punjab, Lahore-Pakistan	Member
23	Syed Amer Mahmood Department of Space Science University of the Punjab, Lahore-Pakistan	Member

Minutes of the Meetings

The first meeting of the committee was held in Karachi regional HEC center. The meeting commenced with the recitation from the Holy Qur`an. **Dr. Altaf Ali G. Sheikh, Member/Advisor (HRD) HEC, Islamabad,** welcomed the participants. In his inaugural address he expressed his pleasure over the worthy participation of academia and R&D organizations from around the country, representing both the public and private sector institutions. He pointed out the need to develop state of the art curricula for Remote Sensing and GIS, though some of the institutes are already offering RS & GIS courses at a rudimentary level. Dr Altaf acknowledged that **Professor Dr Imdad Ali Ismaili** proposed him and stressed the need to introduce Remote Sensing and GIS programs at BS and MS at national level and mentioned its significance for the scientific management of Pakistan's natural and environmental resources in particular and globally in general. He also emphasized the need of standardized curricula for all HEC recognized Universities/Institutes for quality education and uniformity at all levels.

Dr. Altaf requested the participants to select a *Convener* for the NCRC meeting to chair and lead the effort of RS&GIS curriculum development.

The name of **Professor Dr. Waqar Ahmad** who has 25 years of teaching and research experience in Remote Sensing and GIS at various international universities and has published almost hundred research papers at international journals was proposed and agreed upon to act as Convener. In the initial meeting **Dr. M. Ejaz Sandhu** was requested to act as a Secretary for this meeting.

The second meeting in Lahore started with the recitation of verses from Holy Quran. **Mr. Muhammad Tahir Ali Shah, Assistant Director (Curriculum), HEC** welcomed all the participants of the meeting and requested the new participants to kindly introduce themselves before the proceedings of the second meeting. In his welcome address he appreciated the efforts by the committee members for their excellent output of the first meeting. He informed the committee that the draft RS & GIS curriculum was circulated internationally to get feedback on the proposed curriculum. Meeting was then handed over to Dr. Waqar Ahmad, convener of the NCRC.

Dr. Waqar welcomed all the participants and appreciated the coordination and cooperation by Mr Tahir Ali Shah in holding and organizing NCRC meetings in due time. He also thanked all members for their cohesive and productive contribution made to the first meeting. Dr Waqar Ahmad, in his meeting opening remarks, formally withdrew his name as Convener and opened forum for reselection of Convener and Secretary. Dr. Jamil Kazmi appreciated the strong contribution of Dr. Waqar Ahmad and proposed his name again for the Convener of the NCRC. It was resolved and agreed upon unanimously. Mr. Muhammad Nawaz proposed the name of Dr. Jamil Kazmi as Secretary and seconded by Dr. Amir Khan.

In these meetings, Dr. Waqar Ahmad requested the participants to provide their views on the structure of Remote Sensing & GIS curricula. He stressed the need of time and showed his delight over the decision to introduce RS & GIS courses in Pakistan. He pointed out that in India at the moment there are more than 1800 Departments that are offering Remote Sensing and GIS courses at postgraduate levels. Indians also has a plan to introduce these technologies at school level. He thanked HEC leadership especially the visionary approach of **HEC Chairman Dr Atta-ur-Rehman** to prioritize emerging technologies curriculum developments and their introduction in the Pakistani universities. These technologies have brought revolution in the management of natural and environmental resources especially in our neighboring country. He stressed that it's a unique moment for all of us, to contribute for introducing new programs and come up with a quality product that could bring our academic institutions at par with the developed world. He informed that over the last two decades he has taken a key role in developing RS& GIS curriculum for the Australian universities.

Aims and Objectives:

Each of these meetings spanned over three days and NCRC members had intensive debate on multidimensional aspects of the required curriculum. The main challenges and the task confronting to this group were:

1. To develop international standard Remote Sensing and GIS curriculum for undergraduate and postgraduate degree programs that could uniformly be adopted by the public and private sector institutions.
2. To impart cutting edge knowledge and practical based skills among our graduates through rigorous theory, practical work and field exercises centered around key and applied aspects of these space age technologies.
3. To craft short, medium and long term training programs for Pakistani academics and resource managers who lack training in Remote Sensing and GIS.
4. To craft a mechanism to procure the required technological components for the smooth implementation of teaching and research programs at higher education institutes of Pakistan..

As a starting point, Bachelor of Science (RS&GIS) four years degree program was taken up for the discussion on its nomenclature, duration, eligibility criteria, and course streams to be offered. Dr. Waqar Ahmad who is currently the head of Remote Sensing and GIS program at Charles Darwin University, Australia made a presentation about the key issues that are critical in the development of undergraduate and postgraduate programs in RS & GIS. After prolonged discussions, in the first meeting of NCRC, the abstract draft on degree nomenclature, duration, eligibility criteria, program structure and core courses for BS (RS&GIS) degree program was finalized.

At the onset of this preliminary meeting, it was agreed to prepare an overall skeleton of the core and elective courses that could easily be adopted by various public and private sector institutions. It was unanimously agreed that the RS & GIS BSc degree would have major streams: Remote Sensing, Geographical Information Systems, Geography, Information Technology, Surveying and Field studies. Mathematics and Applied Sciences, English, Social Sciences and General Education as Knowledge Areas

Process and the Working Mechanism

Considering the area of specialization along with teaching and research experience, all participants of the NCRC were divided into 4 major groups to finalize the contents of the courses for the streams and others. Dr. Waqar Ahmad briefed about the expected outcome from the individual groups. He stressed the need that individual group coordinator should engage in an

intensive debate and discuss the core and elective course, its learning outcome, weekly theoretical and practical components and the recommendation of key text books. He advised that after the consultative process, each group coordinator will be responsible for giving the presentation on their group behalf in a joint session of all participating groups. These groups represented the following four streams:

1. Remote Sensing (RS)
2. Geographical Information System (GIS)
3. Geography and Earth Sciences (GE)
4. Information Technology (IT)

Stream1: Remote Sensing

1. **Dr. Waqar Ahmad** **Coordinator**
2. Dr. Jamil Kazmi
3. Mr. Mubashar Hussain
4. Dr. Allah Bakhsh
5. Mr. Javed Sami
6. Mr Syed Amir

Stream 2: Geographical Information Systems

1. **Mr. Muhammad Nawaz** **Coordinator**
2. Mr. Ijaz Ahmad
3. Dr. Mudassar H. Arsalan
4. Muhammad Ikram
5. Ms. Farha Sattar
6. Malik Rahim Bakhsh

Stream 3: Geography & Earth Sciences

1. **Prof. Dr. Amir Khan** **Coordinator**
2. Prof. M. R. Dhanani
3. Mr. Taleem Badshah
4. Dr. Fazlur-Rahman
5. Mr Ghazanfar Ali Khattak

Stream 4: Information Technology

1. **Prof. Dr. Imdad Ali Ismaili** **Coordinator**
2. Mr. Ajab Khan
3. Mr. Ahsan Abdullah
4. Dr. M. Ejaz Sandhu

All members of the above mentioned groups took a keen role and actively participated in the development of the Remote Sensing and GIS curriculum. Convener of the meeting Dr. Waqar Ahmad presented his vision and the approached that various groups should adopt to tackle the above mentioned challenges. He discussed in length the pros and cons of various alternatives at hand. After useful discussions, the house unanimously approved that the RS & GIS curricula development focus should be on the application of the Remote Sensing and GIS technologies for the management of Pakistan's natural and environmental resources. If someone is interested in the development of the underlying Remote Sensing and GIS software, that can be followed up under the elective courses stream.
In joint sessions of the two meetings, each coordinator of the corresponding group explained the details and the justification of each of the course of their stream to all members of the mentioned groups. In their presentation, a clear guideline was given requesting them to discuss the weekly topics (theory and practical) that need to be taught at undergraduate and postgraduate level. In this joint session, all participants had an opportunity to view the overall course offerings and render their advices in the finalization of the RS&GIS.

The final meeting also concentrated on the resources requirement (ensuring cross institutional uniformity), maintenance of RS & GIS curriculum quality by setting up a national body i.e. **Pakistan Council of Remote Sensing and Geographic Information System (PCRGIS)** and a game plan to tackle trained staff in RS&GIS.

Details of the 4 years BS (RS&GIS) program that includes semester-wise sample scheme of study and detailed outlines of various core and elective courses is given as under. **The details of weekly theory and practical components of all of the core courses are given in Appendix 1.**

Bachelor of Science (BS)
in
Remote Sensing (RS)
&
Geographical Information System (GIS)
BS (RS&GIS)

Eligibility:

1. Intermediate with Science or Equivalent with Mathematics at that level.
2. All those students who have not taken mathematics course at Intermediate level will have to take **"prescribed mathematics"** as non- credit course.

Duration:

- Four years program spread over 8 semesters (two Semesters per Year)
- 127+ credit hours courses including final project.

Degree Requirement:

Minimum 127+ Credits are required to complete Bachelor of Science (RS&GIS) Minimum Cumulative Grade Point Average (CGPA) required is 2.0 out of maximum of 4.0 CGPA.

Evaluation:

For the uniformity in the evaluation system, NCRC recommends that the minimum CGPA required to pass a semester is 2.0 out of 4.0 at undergraduate level.

Table 1.0

Following table provides full details of core courses centered around key streams of 4 years BS (RS & GIS) Program.

Structure of 4 years BS (RS&GIS)

Core Remote Sensing (RS) Courses				15/127
#	Course Code	Pre-Req	Course Title	Credit hours
1		Nil	Introduction to RS	3
2		Nil	Cartography	3
3		1	Digital Image Processing	3
4		3	Microwave & Hyper Spectral RS	3
5		Nil	Introduction to Photogrammetry	3
Core Geographical Information System Courses				**24/127**
1		Nil	Introduction to GIS	3
2		1	Data Base Systems	3
3		1	Global Positioning System	3
4		1 & 2	Spatial Data Visualization	3
5		1 & 2	Spatial Decision Support System	3
6		IT3	GIS Programming	3
7		1 & 2	Spatial Data Analysis	3
8		1	Project Management	3
Core Geography, Humanity and Earth Sciences Courses				**19/127**
1		Nil	Pakistan Studies	2
2		Nil	Islamic Studies / Ethics	2
3		Nil	Physical Geography	3
4		3	Human Geography	3
5		Nil	Fundamentals of Geology	3
6		Nil	Fundamentals of Ecology	3
7		Nil	Surveying	3
Core Information Technology Courses				**15/127**
1		Nil	Introduction to Computer Programming	3
2		1	Object Oriented Programming	3
3		1	Data Structures & Algorithms	3
4		2	Computer Graphics	3
5		Nil	Computer Aided Drawing/Drafting	3
Core Mathematics & Applied Sciences Courses				**15/127**
#	Code	Pre-req	Course Title	Credit Hours
1		Nil	Calculus & Analytical Geometry	3
2		Nil	Linear Algebra Applications	3
3		1	Discrete Mathematics	3
4		Nil	Statistic & Probability	3
5		4	Geo-Statistic	3

Core English and Communication Courses				**12/127**
#	Course code	Pre-req	Course Title	
1		Nil	Functional English	3
2		Nil	Oral Communication	3
3		2	Communication Skills and Report Writing	3
4		Nil	Research Methods	3
	Electives (Specialization areas)			**21/127**
	Final Project (Remote Sensing or GIS)			**06/127**
	Total Credit Hours for 4 years BS (RS & GIS)			**127**

Semester-wise scheme of study for 4 years BS (RS & GIS) Program.

Semester Wise 4-Year Plan

Semester 1	Cr. Hrs.
Pakistan Studies	2
Computer Aided Drawing/Drafting	3
Calculus and Analytical Geometry	3
Physical Geography	3
Functional English	3
Introduction to Computer Programming	3
	17

Semester 2	Cr. Hrs.
Islamic Studies/Ethics	2
Object Oriented Programming	3
Introduction to RS	3
Oral Communication	3
Surveying	3
Linear Algebra and Applications	3
	17

Semester 3	Cr. Hrs.
Discrete Mathematics	3
Introduction to GIS	3
Fundamentals of Geology	3
Cartography	3
Introduction to Photogrammetry	3
Data Structure & Algorithms	3
	18

Semester 4	Cr. Hrs.
Human Geography	3
Digital Image Processing	3
Communication Skills and Report Writing	3
Statistics & Probability	3
Global Positioning Systems	3
Database Systems	3
	18

Semester 5	Cr. Hrs.
GIS Programming	3
Spatial Decision Support Systems	3
Geo-Statistics	3
Computer Graphics	3
Spatial Data Visualization	3
	15

Semester 6	Cr. Hrs.
Spatial Data Analysis	3
Research Methods	3
Project Management	3
Microwave & Hyper Spectral RS	3
Ecology	3
	15

Semester 7	Cr. Hrs.
Final Project I	3
Spatial Data Management	3
Elective I	3
Elective II	3
Elective III	3
	15

Semester 8	Cr. Hrs.
Final Project II	3
Elective IV	3
Elective V	3
Elective VI	3
	12

Stream 1: Remote Sensing (RS) Courses

Core Remote Sensing (RS) Courses				15/127
#	Course Code*	Pre-Req	Course Title	Credit hours
1		Nil	Introduction to Remote Sensing	3
2		Nil	Cartography	3
3		Nil	Introduction to Photogrammetry	3
4		1	Digital Image Processing	3
5		3	Microwave & Hyperspectral Remote Sensing	3

***: Course Code**: Individual institutions to devise their own codes.

1: Introduction to Remote Sensing	
Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3
Prerequisites: Nil	
Objectives: This course introduces students to find out how pictures of the earth's surface are recorded from aircraft and satellites and different ways these images can be analyzed. Students gain an understanding of "common" Remote Sensing products such as earth resources, satellite images, aerial photographs as well as more sophisticated research tools such as RADAR and multispectral scanner systems. In this course via field trips opportunity is provided to assess the usefulness of different types and scales of remotely sensed data via on the ground comparisons. Basic map reading skills required for Remote Sensing projects are also covered.	
Course Outline: Definition and History, Physical Basis (EM Spectrum, Energy Interaction, Spectral Reflectance Curves, Image Characteristics) Introduction to Aerial Photograph, Sensor Systems (Space and airborne, MSS, TM, ETM, HRV, LISS, IKONOS-2, Quick bird-2, AVHRR and others), Platforms (Types and Orbital Characteristics),Thermal Infrared (Characteristics, TIR Band Properties, TIR Image Interpretation, Intro to Microwave (Importance and applications), Digital Image Processing (Over view of computer based image processing), Applications (agriculture, urban, natural resources etc.)	
Lab Outline: Introduction to labs, Single band image interpretation, False color predictions, False color composite Images Interpretation, Visual Interpretation of aerial photographs, Various sensors data comparison, Thermal Infrared Image interpretation, Intro to ERDAS Imagine, display, Geo-linking, Zooming, Identification of targets, FIELD TRIP	
Reference Material:	

1. Lillesand, T. M. and Kiefer, R. W. (2004). Remote Sensing and Image Interpretation, 5th edition. (John Wiley and Sons), ISBN 0-471-15227-7
2. Mather, P M (2004). Computer Processing of Remotely Sensed Images, 3rd Ed. (John Wiley and Sons), ISBN 0-470-84919-3
3. Campbell, James B. (2002. Introduction to Remote Sensing, 3rd Ed., (The Guilford Press) ISBN # 0-7484-0663-8 (pbk).
4. Gibson, P.J (2000). Introductory Remote Sensing: Principles and Concepts (Routledge), ISBN 0-415-19646-9
5. Jensen, J. (2000) Remote Sensing of the Environment: An Earth Resources Perspective, Amazon Publishers, ISBN #
6. Sabins, F.F (1996). Remote Sensing: Principles and Interpretation, 3rd ed, (W H Freeman & Co), ISBN # 0-7167-2442-1

Journals / Periodicals:

1. International Journal of Remote Sensing
2. Remote Sensing of Environment Journal
3. Photogrammetric Engineering & Remote Sensing Journal
4. Geo Carto International Journal
5. Asian Pacific Remote Sensing Journal
6. Canadian Journal of Remote Sensing

Computer Aided Learning:

The computer aided learning (CAL) packages "Introduction to Remote Sensing" and "Advanced Image Processing" are available in the Remote Sensing / GIS lab. The packages provide a useful revision of the basic principles of remote sensing.

World Wide Web: Explore this…sky is the limit here.

2: Introduction to Cartography

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3
Prerequisites: Nil	
Objectives: Subject provides the basic knowledge of portraying spatial features from reality by using cartographic techniques. Subject incorporates the fundamentals of map reading, map making, coordinate and projection systems, map symbolization and generalization, Map production and map classification techniques.	
Course Outline: Introduction to Cartography, Nature of Cartography, Map Types.	

History of Cartography, Map Symbols, Lettering, Scale and direction, Coordinate systems, Map Projections Graphical and datum, Map Projections Mathematical.
Perspective, non-perspective, conventional, Generalization, Thematic Maps, Descriptive Statistics, Class Intervals, Choropleth Maps, Proportional Symbol Maps, Dot Maps, Isarithmic Maps, Cartograms, Flow Maps, Graduate Colour Maps, Map Compilation, Map Design, Cartography and Ethics, Map Production.

Lab Outline: Map reading, Assignment on Types of Maps, Understanding of survey of Pakistan symbology and Development of Symbol Charts, Development of Graphical Map Projections, Large to small scale map conversion, Data classification and Thematic Mapping, Map composite development, Assignment on misleading cartography, Visit to SOP

Reference Material

1. Slocum, Robert McMaster, Fritz Kessler, Hugh Howard (2004) Thematic Cartography and Geographic Visualization, 2nd Edition, Terry. ISBN, 0130351237.
2. Robert G. Cromley (2003) “Digital Cartography”. Prentice Hall Inc.
3. M.J. Kraak & F.J. Ormeling, (1996) “Cartography- Visualization of Spatial Data.” Addison Wesley Longman Limited.
4. Robinson, A.H., Morrison,J.L., Muhrcke, A.J.,Kimerling and Guptil,S.C. (1995) “Elements of Cartography” 6th edition, John Wiley & Sons, New York.
5. Cartography, Visualization of Spatial Data (2002) 2nd Edition, Menno-Jan Kraak, Ferjan Ormeling, ISBN 0130888907.
6. AMAZON (1988), Cartography with ArcView GIS and Map Projection, 5th Edition.
7. AMAZON (1988), Cartography: Thematic Map Design, 5th Edition.
8. AMAZON (1999) Multimedia Cartography, 1st Edition.

3: Introduction to Photogrammetry

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Nil

Objectives: This course attempts to provide basic knowledge about the key elements of photogrammetry such as cameras, aerial photographs, techniques of measuring 2 D and 3 D objects, stereophotogrammetry and its applications.

Course Outline: Introduction, history and Overview, Analog, analytical, and digital photogrammetry, Photogrammetric cameras, Review of data acquisition and single photograph properties, Spatial measurement and scale calculation, Problems with aerial photograph and rectification of a single aerial photograph, Aerial Photograph Interpretation, Types of Aerial

Photograph and mosaics, Stereoscopic Analysis DEM generation, Orthophotography/Orthoimage, applications.

Lab Outline: Introduction, Comparison of formats**,** Sensor, films and filters, Data acquisition methods, Area and scale measurement, Parallax and radial displacement, Visual interpretation of aerial photographs, vertical airphotos, Mirror stereoscopic interpretation, Ortho-rectification, case studies.

Reference Material:

1. Sabins S.F (2000). Remote Sensing: Principles and Interpretation, Third Edition. Freeman and Company, New York. ISBN: 0 – 7167-2442-1.
2. Lo, C.P (1986). Applied Remote Sensing (Longman).
3. Philipson, W.R (1997) Manual of Photographic Interpretation (2nd edition) (American Society for Photogrammetry and Remote Sensing).
4. Colwell, R.N (ed.) (1983) *Manual of Remote Sensing Second Edition* in 2 volumes (American Society of Photogrammetry)

4: Digital Image Processing

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Introduction to Remote Sensing

Objectives: This course builds on the introductory Remote Sensing unit and provides practical application of digital image processing of remotely sensed data for analysis of earth resources. This unit focuses on various aspects of digital image processing of remotely sensed data sets originating from a number of satellites. Various aspects of digital image processing (image pre processing, image classification, accuracy assessment etc.) to extract useful information such as land cover maps from the remotely sensed digital data are focused in this subject via working on a real life project.

Course Outline: Data Sources and Procurement, Data Formats (BSQ, BIL, BIP, etc.) Image Subsetting & Enhancement, Image Cleaning, Atmosphere Path Correction,, Image Mosiacing and Color Balancing, Image Rectification, Registration and Re-sampling, Band Ratios, Vegetation Indices, Image Filtering, Difference Images, Principal Component Analysis, Classification Schemes, Types, Algorithms, Field data collection, Qualitative and quantitative techniques, sampling techniques, Error matrices, Ground-Verification (Field Verification). Project (from third week students will be advised to commence their project work in a teamwork environment. Project work will be based on real life data sets obtained from resource monitoring agencies such as SUPARCO, SOP).

Lab Outline: Intro to lab and software, Image Management (Import/Export & Display), Enhancement Techniques, Spectral and spatial digitizing

(image masking), Mosaicing and color balancing, Rectification and Registration and Re-sampling, Band Ratio, Vegetation Indices, Difference images, Image filters, Signature selection, Supervised, Unsupervised and Hybrid classification, ISODATA, MDM, MLC, and Baysian classification, Error Matrix Generation, Classification validation, field work

Reference Material:

1. Mather, P (1999, 2004). Computer processing of remotely sensed images. Third Edition, J Wiley. ISBN 0-470-849193
2. Gibson, P.J and Power, C.H (2000). Introductory Remote Sensing: Digital Image Processing and Applications. Routledge. ISBN 0-415-18962-4
3. Sonka, M; Hlavac, V and Boyle, R (1999). Image Processing, Analysis and Machine Vision (2nd Edition) International Thompson Publishing (ITP) Company. ISBN 0-534-95393-X
4. Schowengerdt, R A (1997) Remote Sensing, Models and Methods for Image Processing (Academic Press) ISBN 0-12-628981-6.
5. Jensen, J. R. (2002) , Digital Image Processing: A Remote Sensing Perspective, Prentice Hall, New York.

5: Microwave and Hyperspectral Remote Sensing

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Digital Image Processing

Objectives: This course introduces students about the new and advanced developments that are taking place especially in microwave and hyper spectral remote sensing. This unit focuses on the basic concepts, data acquisition, working mechanism, Spectral and spatial characteristics of microwave and hyper spectral data sets. Data compression and construction techniques, Radar and hyper spectral image processing techniques, Active and passive remotely sensed devices data fusion techniques, Applications of Radar and hyper spectral data sets.

Course Outline: Types, History, Advantages and Disadvantages of Active Remote sensing, Sensor and Platform Types (RADAR, SAR, AIRSAR, SLAR etc.), Working Mechanism, Spectral Characteristics of Microwave Images, Key Concepts, RADAR Image Geometry and interferometry, Data Compression and Reconstruction, RADAR Image Pre-processing and Classification, Field Verification, Data Fusion Techniques, Microwave Applications, Hyperspectral Remote Sensing Channels and Spectral Libraries Sensors (AIS, AIVIS etc.), Application of Hyperspectral data.

Lab Outline: Introduction to Microwave Image Processing Module, Microwave Image Comparisons, Visual Interpretation of Radar Images, Radar Image pre-processing (Total Power Image, Like and Unlike

Polarization, Ground Resolution, Rectification and Registration, Optical and RADAR data fusion case studies, Student Projects: Application Areas such as Mining, Environmental Monitoring, Vegetation Changes, Cropping Pattern, Salinity/Sodicity and Water Logging etc.

Reference Material:

1. Henderson, F.M and Lewis, A.J (1998). Principles and Applications of Imaging Radar. Manual of Remote Sensing, Third Edition Volume 2. John Wiley and Sons. ISBN 0-471029406-3.
2. Campbell, James B. (2002*. Introduction to Remote Sensing*, 3rd Ed., (The Guilford Press) ISBN # 0-7484-0663-8 (pbk).
3. Henderson, F.M. and Lewis, A. J (1998) Principles & Application Imaging Radar / Manual of Remote Sensing / Third Edition, Volume 2, Published in Cooperation with the American Society for Photogrammetry and Remote Sensing, John Wiley & Sons, New York.
4. Peebles, P.Z (1998), Radar Principles, Wiley Inter science, New York.
5. Elachi, C. (1988): Spaceborne Radar Remote Sensing: Applications and Techniques, IEEE Press, New York.

Stream 2: Geographical Information Systems Courses

Core Geographical Information System (GIS) Courses					**24/127**
#		**Course Code**	**Pre-Req**	**Course Title**	**Credit hours**
1			Nil	**Introduction to GIS**	3
2			1	**Data Base Systems**	3
3			1	**Global Positioning System**	3
4			1&2	**Spatial Data Visualization**	3
5			1&2	**Spatial Decision Support System**	3
6			I&3	**GIS Programming**	3
7			1&2	**Spatial Data Analysis**	3
8			1	**Project Management**	3

1: Introduction to GIS

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisite: Nil

Objectives: The course aims at providing an understanding of GIS, its evolution, applications, spatial data models and data structures, design aspects of GIS; spatial data acquisition, sources and standards; spatial data manipulation, spatial analysis and visualization of data. This course also covers the understanding of GIS software environment. This subject provides basic training in understanding GIS data capture, storage, retrieval, analysis and display. It also helps to learn functionality of GIS software and to gain basic skills.

Course Outline: Introduction, Definitions, Key components, Functional Subsystem, Raster Data Model, Vector Data Model, Attribute Data Model, **Data Acquisition Techniques,** Data sources, Data capturing techniques and procedures, **Data Transformation, Visualization of spatial data,** Layers and Projections, **Map Design:** Symbols to Portray Points , Lines and Volumes , Graphic Variables , Visual Hierarchy,
Data Classification Graphic Approach , Mathematical Approach, **Spatial Analysis:** Overlay Analysis ,Spatial analysis, Neighborhood functions, Network and overlay analysis, buffering, **Spatial data Quality:** Components of Data Quality , Micro Level Components , Macro Level Components , Usage Components Sources Of Error , Accuracy, Project work.

Lab Outline: Introduction to GIS Lab (hardware / software), Raster/Vector/Attribute Data Display, Scanning, Digitization, Coordinate based point mapping, Raster / Vector Conversion, Data layer integration and display of different projections, Map layout, Data Classification and Thematic Mapping, Handling with Topological Errors, Overlay and network analysis.

Reference Material:

1. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth Edition. ISBN - 0912804008
2. Clarke, K. (2004) “Getting started with Geographic Information System”, Prentice Hall , New York, Second Edition. ISBN - 1879102897
3. Heywood, I., Cornelius, S. and Carver, S. (2003) “ An introduction to Geographic Information System”, Addison Wesley Longman, New York, Second Edition. ISBN - 0130611980
4. Burrough, P.(2002) “Principles of Geographic Information Systems for Land Resources Management”, Oxford University Press, Oxford, Second Edition. ISBN - 0198233655

5. McDonald, R. and Burrough, P. (2001) “Principles of Geographic Information Systems”, Oxford University Press, Oxford, Second Edition ISBN - 0198233855
6. Foresman, T. (1997) “The history of Geographic Information System”, Prentice Hall, New York. ISBN – 0138621454

2: Database Systems

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours: 3**

Prerequisites: Data Structures

Objectives: The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts.

Course Outline: Basic database concepts; Entity Relationship modeling, Relational data model and algebra, Structured Query language; RDBMS; Database design, functional dependencies and normal forms; Transaction processing and optimization concepts; concurrency control and recovery techniques; Database recovery techniques; Database security and authorization. Small Group Project implementing a database.

Lab outline: Structured Query language commands, PL/SQL Commands, Creating & populating tables, Design of simple database: Conceptual, logical and physical level, Database normalization process techniques, Query optimization (Relational Algebra), Indexing concepts, Performance of concurrency protocols, Partial & full recovery techniques, Concepts of database securities, Development of a GUI interface (optional). Design and implementation of a simple MIS system

Reference Material:

1. Date, C.J. (2004) Database Systems, Addison Wesley Pub. Co. ISBN - 0201385902
2. Connolly R. and P.Begg (2003) *Database Systems: A Practical Approach to Design, Implementation and Management,* Addison-Wesley Pub. Co ISBN – 0321210255
3. Elmasri, R. and Navathe, S.B (2004) “*Fundamentals of Database Systems”* Addison-Wesley Pub. Co ISBN – 0-201760355
4. Rigaux, P. Scholl, M. and Voisard, A.(2001) “Spatial Databases: With Application to GIS” Morgan Kaufmann; 2nd edition ISBN - 01017386802

3: Global Positioning Systems

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Introduction to GIS

Objectives: This course attempts to provide training on the fundamental aspects of GPS, and then it will lead towards various GPS measurements, their corresponding accuracies and its uses in the identification of targets and assessing satellite based imageries is also discussed.

Course Outline: Introduction to GPS**,** U. S. Department of Defense Satellite Navigation System, Space Segment, Control Segment, User Segment, GPS Positioning Services Specified In the Federal Radio Navigation Plan, Precise Positioning Service, Standard Positioning Service, GPS Data, Position and Time from GPS, Code Phase and Pseudo-Range Navigation, Receiver Position, Velocity, and Time, Carrier Phase Tracking (Surveying), GPS Satellite Signals, GPS Error Sources, Differential GPS Techniques
Differential Code-Phase Navigation, Differential Carrier-Phase Surveying, Common-Mode Time Transfer, GPS Techniques and Project Costs, Exploration of Advance System as Differential GPS.

Lab Outline: GPS value reading, Easting Northing & elevation, Map Projections and Datum Settings, GPS based surveys, tracking and data processing, Planimetric & vertical errors calculations, GPS Project

Reference Material:

1. Michael Kennedy (2002), "The Global Positioning System and GIS: An Introduction" 2nd Edition, Taylor & Francis, New York. ISBN: 0 – 415-28608-5
2. Paul Zarchan (1996), "Global Positioning System: Theory and Application, Volume I, American Institute of Aeronautics and Austronautics, Inc., Washington DC. ISBN: 1563471078
3. Heywood, I., Cornelius, S. and Carver, S. (1999) " An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition. ISBN: 0 –81-7808 – 982 -3
4. Aronoff, S**. (**1995) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Canada, Forth edition. ISBN: 0 - 921804008
5. GPSCO (1992). Getting started with GPS Surveying .GPSCO Land Information centre, NSW, Australia.

4: Spatial Data Visualization

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Introduction to GIS & Database System

Objectives: Spatial data visualization deals with the data classification and interactive displays. This course aims at provide training on how to make suitable cartographic visualizations of the spatial data (on screen displays and on papers), principles of scientific visualization, graphic design and cartographic symbolization, thematic mapping of statistical data over space and time, basic training in construction of thematic layers to visualize spatial & attribute data, web mapping, animations and simulations.

Course Outline: Quantitative Revolution and Digital Cartography, Introduction to Visualization, Visualization Process, Visualization Strategies, Statistical and Visual Foundation, Principles of Symbolization, Principles of Colour, Tri-Simulate(chromatic Model, Intensity, Hue and Saturation, Map Design Process, Mapping Techniques, Cognitive, Social and Ethical Issues in Cartography and spatial data visualisation, Internet Mapping, 3D Modeling, Map Animation, Virtual Reality, Electronic Atlases and Multimedia.

Lab Outline: Exploration of visualization tools in digital environment, Thematic Mapping, Designing of point, line and polygon symbols, Exercise: Color formation and Conversion (RGB, CMYK, IHS), Assignment: Cartographic Design and Reproduction (Example: Topographic Mapping), Mono, Bivariate and multivariate thematic Mapping, Assignment: War and Propaganda Maps, Map Server Application, Perspective Viewing, Multi-layer Draping and Fly Through, assignment.

Reference Material:

1. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth edition. ISBN: 0921804008
2. Kraak, M.J & Ormeling, F. (2004), " Cartography: Visualization of Spatial Data". Addison Wesley Longman. Second Edition. ISBN: 0-13-0888980-7
3. Chang, Krang-tsung, (2002) "Introduction to Geographic Information Systems"McGraw Hill. ISBN: 0-07-049552-1
4. Ed Madej **(**2001) "Cartographic Design Using Arc View GIS"**,** One Word Press, USA. ISBN: 1566901871
5. ITC (2000) "Principles of Geographic Information Systems" ITC Educational Textbook Series, Enschede, The Netherlands. ISBN: 90-6461-226-4

5: Spatial Decision Support Systems

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Database Systems, Data Structures & Algorithms

Objectives: The overall aim of this course is to provide the students with an understanding of decision support system and with the development of decision support systems.

Course Outline: Decision Making Processes: Introduction, Major decision-making Paradigms, Models of decision-making, Different types of problem, Hierarchy of decisions

Spatial Decision-Making: Introduction, A systematic approach for solving spatial problems, Methods and techniques to support spatial decisions, Performance modeling and types of criteria, Measurement Scales, Uncertainty in decision making process

Decision Support Systems: Introduction, Origin, Definition and components, Fundamental Phases, Characteristics and Capabilities of DSS, GIS and Decision Support Systems, Spatial Decision Support Systems, Integration of GIS and DSS

Multicriteria Evaluation: Criteria properties, Criteria weighting, Pair wise comparison, Ranking techniques, Rating techniques, Sensitivity analysis, Redistribution criteria weight, Option Ranking methods, Weighted summation, Ideal point, Rank order

Methods and Tools for Collaborative Decision- Making: Introduction, Task Analysis as a Needs Assessment, System Requirement Analysis, Software Capabilities, Collaboration Personnel, Example Configurations for Same Place – Same Time Collaboration, Architectures for Implementing Collaborative Decision Support Systems, Hardware Architecture for Same-Place, Same-Time Collaboration Support, Software Architecture for Same-Place, Different-Time Collaboration Support, Hardware Architecture for Different-Place, Same-Time Collaboration Support, Software Architecture for Different-Place, Different-Time Collaboration Support, Existing DSS-Supported Collaborative Decision -Making Software Packages, INDEX®, Smart Places Series E, Active Response GIS, Geo Choice Perspective™, Consensus Evaluation, Conflict Analysis, Identification of Stakeholders, Identification of Options, Identification of Interest (criteria), Mediation and Negotiation Approaches, Facilitation, Consensus Evaluation

Lab Outline: Populating a data warehouse using different loading facilities, running different queries for extraction of results. Populating and using an OLAP tool.

Reference Material:

1. A . E. Turban and J. Aronson (1998), Decision Support Systems and Intelligent Systems, 5th edition, Prentice Hall. ISBN: 0-13-781674-8
2. B .Sauter, V. (1997) “Decision Support Systems ”, John Wiley & sons,

Inc. ISBN: 0-471-31134-0

6: GIS Programming

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Data Structures and Algorithms

Objectives: This course attempts to provide a foundation for application development using VBA and ArcObjects. This course produces the skills to create usable ArcObjects code for typical GIS programming tasks. Students work with VBA development tools and the ArcGIS Customize dialog box and learn how to access online help resources.

Course Outline: Intro to course; fundamentals of geo-processing; fundamentals of Python; using variables; naming conventions and reserved words; testing and printing variable values, Looping and control structures, Debugging, optional and required parameters, Objects, properties and methods; the OO paradigm; Object Model Diagrams,
The geo-processor object, introduction, Functions and parameters, passing and returning values, Multiple inputs and complex parameter passing, Selections and sets, SQL basics, Writing results to disk, various formats and switches, Advanced topics and further directions; Num.py for numerical modeling (instead of Matlab?); other useful modules…, Presentations

Lab outline: Introduction to Lab, Looping statements, Getting and setting object parameters, Exploring the geo-processor object, Glacier clipping exercise, Glacier raster statistics exercise, projects

Reference Material:

1. Ralston, B. A. (2002), Developing GIS Solutions with MapObjects and Visual Basic, Onword Press, New York. ISBN: 0766854388
2. Kropla, B. (2005) “MapServer: Open Source GIS Development” Apress, Co. ISBN: 1590594908
3. Rigaux, P. Scholl, M. and Voisard, A.(2001) “Spatial Databases: With Application to GIS” Morgan Kaufmann; 2nd edition.ISBN: 1558605886.
4. Bugg, K.E (2003)“GIS Programming: Prepare for the Gathering Storm” GEO.

7: Spatial Data Analysis

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Spatial data visualization

Objectives: This course attempts to develop spatial analysis skills, reveals how basic understanding to spatial analysis concepts are implemented

within geographic information systems. Techniques are not limited but will include the application of GIS analysis to the environment, urban planning and natural resource management issues. Beginning with an overview of the main functional components of GIS, the course moves into hands on experiences with data input, data management and spatial analysis components and provides basic training in point pattern analysis, Line pattern and network analysis, area objects and autocorrelation and Geo-computation.

Course Outline: Introduction to spatial data type, Potentials of spatial data, Spatial Analysis, Point pattern analysis, Lines and networks, Area objects and spatial autocorrelation, types of area objects, Geometric properties of areas, Boundary Analysis, Buffering and neighbourhood function, Proximity Analysis, Neighbourhood Function/Analysis, Modelling and storing field data, Spatial interpolation, type, Methods / algorithms, Derived measures on surfaces, Map overlay, Vector and raster overlay operations, Problems in simple Boolean polygon overlay, Multivariate data, multidimensional space**,** Multivariate data and multidimensional space, Distance, difference and similarity, Cluster analysis, PCA, New approaches to spatial analysis, Interpolation techniques, surface modelling, DTM/DEM, Multi-criteria and Multi-attribute Modelling, Uncertainties in spatial modelling.

Lab Outline: Assignment on Spatial Analysis for various applications, Geo-coding and Point analysis exercise, Network analysis exercise, Areal analysis exercise, Buffer analysis exercise, Multivariate analysis, Assignment on advanced spatial analysis, Interpolation of elevation data and surface modeling, Suitability analysis, Risk Modeling, Assignment on uncertainties in spatial modeling

Reference Material:

1. David O' Sullivan and David J. Unwin (2003) "Geographic Information Analysis", John Wiley & Sons, Inc., Canada. ISBN: 0-471-2117-1
2. Chang, Krang-tsung (2002) "Introduction to Geographic Information Systems" McGraw Hill. ISBN: 0-07-049552-1
3. David L. Verbyla (2002) "Practical GIS Analysis", , Taylor & Francis, London
4. Donald P. Albert & Wilbert M. Gesler (2000) "Spatial Analysis, GIS and Remote Sensing Application in Health Sciences" Ann Arbor Press, Michigan, USA.1-57504-101-4
5. John Stillwell & Graham Clarke (2004) "Applied GIS and Spatial Analysis", John Wiley & Sons, UK. ISBN: 1-57504-101-4
6. Peter M. Atkinson and Nicholas J. Tate (1999) "Advances in Remote Sensing and GIS Analysis" John Wiley & Sons, UK. ISBN:0-471-985070-5
7. Heywood, I., Cornelius, S. and Carver, S.(1999) "An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition. ISBN: 81-7808-982-3

8. Paul, L., Michael, G., David, M. & David, R.(1999) “Geographic Information Systems: Principles, Techniques, Applications and Management”. John Wiley & sons. ISBN: 0-471-73545-0
9. Nicholas, C. (1997) “Exploring Geographic Information System”. John Wiley & sons, UK. ISBN: 0471321826
10. Robert, L., Derek, T. (1992) “Fundamentals of Spatial Information Systems”. Academic Press. ISBN:0124383807

8: Project Management

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3

Prerequisites: Introduction to GIS

Objectives: This course attempts to cover important aspects of different types of project including development and business projects. The course covers various topics starting from basic concepts and problems relating to projects, project management, and project managers.

Course Outline: Overview, project management**,** project organization, projection selection models and techniques, Cost Benefit analysis, Project planning, project scheduling, project monitoring, reporting and controlling, and project termination.

Reference Material:

1. Merideth, J.R., Sammuel, J. Manbel. (1989) Project Management, New York, John Wiley. ISBN: 0471-85319-4
2. Choudhry, S. Taha, (2000) Project Management, India, McGraw Hill.ISBN: 0-13-032374-8
3. LittleI.M.D., Mirrlees, J.M. (1982) Project Appraisal and Planning for Developing Countries, India, Oxford and IBH. ISBN: 0-435-84501-2

Stream 3: Geography, Humanity and Earth Sciences Courses

Core Geography, Humanity and Earth Sciences Courses				19/127
#	Course Code	Pre-Req	Course Title	Credit hours
1		Nil	Pakistan Studies	2
2		Nil	Islamic Studies / Ethics	2
3		Nil	Physical Geography	3
4		3	Human Geography	3
5		Nil	Fundamentals of Geology	3
6		Nil	Surveying	3
7		Nil	Fundamentals of Ecology	3

1. Pakistan Studies

Course Structure: Lectures: 2 / Labs: 0	**Credit Hours:** 2

Prerequisites: None

Objectives: To take an analytical view in the history and development of Muslim society and culture in the sub-continent, emergence of Pakistan and its constitutional development. To develop an appreciation of the issues and challenges currently being faced in Pakistan. The strengths of its people and strategies to deal with the impediments to progress. International relations of Pakistan

Course Outline: Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, The downfall of Islamic society, The establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmad Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Creation of Pakistan and transfer of power. Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Reference Material:

The Emergence of Pakistan, by Chaudary M. Ali

The Making of Pakistan, by K.K. Aziz

2. Islamic Studies

Course Structure: Lectures: 2 / Labs: 0	**Credit Hours:** 2

Prerequisites: None

Objectives: To impart an understanding of the fundamental principles and teachings of Islam through study of selected verses of the Quran and Prophetic Sayings. Important facets of the Prophet's life and salient, features of Islamic Civilization. To provide appreciation of other prominent religions, systems of ethics and cultures to prepare students to survive in international and multicultural work place.

Course Outline: Fundamentals of Islam. (Aqaid, Ibadat, Islamic Dawah etc.); Ethical values of Islam; Ser-ah of the Holy Prophet (PBUH); Islamic Civilization and its affects on humanity. Study of other prominent world religions and ethical systems in comparison with Islamic viewpoint. Multicultural societies.

Reference Material:

1. Islam in the Light of a First Testament and Traditions by Shaukat Umari
2. What Everyone Knows About Islam by Zunaire Hanif
3. Introduction to Islam by Hamidullah

3: Physical Geography

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Nil

Objectives: This course attempts to impart the knowledge of physical geography including lithosphere, atmosphere and hydrosphere

Course Outline: Scope and status of physical Geography, The basic concept and theories in physical Geography including theory of continental drift, plate tectonics and pen plain concept, Factors of Landform Development, Weathering and Mass Wasting, Fluvial morphology, Desert Landforms, Glaciers and their topographic effects, Karsts topography, Soil Development, Factors and elements of weather and climate, Composition and structure of atmosphere, Horizontal and vertical distribution of temperature, The distribution of pressure and seasonal variations, Wind Circulation, Humidity and forms of condensation, Classification of Climate, Origin of oceans and seas, Floor of oceans - Characteristic features of the ocean basins, Temperature, salinity distribution, cause and effects, Ocean circulation: Waves, currents and tides, their nature, causes and effects and impact on man and environment.

Lab Outline: Identification of rocks and minerals, Study and identification

of landforms using air photos and General topographic sheet, soil and water analysis. Use and making of various models showing various types of landforms, Recording and observation of weather data from a mini weather station, Identification of cloud types, Drawing of World map showing the origin of continents and oceans.

Field visits:

Ground truthing of types of rocks, fluvial, glacial and desert landform identify the various type of soil, identification of limestone topography landforms.
Visit to the coastal area to observe and appreciate the characteristic of coastal features.
Visit to Soil Survey of Pakistan, Geological survey of Pakistan, Meteorological station/observatory and National Institute of Oceanography and SUPARCO
Air journey/Visit to and appreciate the landforms from air and study of clouds.

Reference Material:

1. Strahler, A.N. (2004) “Modern Physical Geography” New York: John Wiley.
2. Gabler, R.E, Sager, R.J and Wise, D.L (1997). Essentials of Physical Geography, Fourth Edition. Saunders College Publishing, New York. ISBN 0-03-098237-5.
3. Scott, R.C (1996) Introduction to physical geography, West Publishing Co, New york. ISBN: 0-314-06260-2.
4. Miller, G.T (1996) Living in the Environment, Principles, connections and solutions, Ninth Edition, Wadsworth, ISBN0 534 23898 x.
5. Thurman, H.V. & Mexrill (1996) “Essentials of Oceanography” Menson, London.
6. Diwan A.P. & D.K. Arora (1995) “Origin of the Ocean” Anmol Publisher, Delhi.
7. Mcuveen (1992) “Fundamentals of Weather and climate” Prentice Hall New Jersey.
8. Kendrew (1961): Climates of the continents. Longman London/New York.
9. Thornbury, W.D. (1969) “Principles of Geomorphology” John Willy & Sons. New York.

4: Human Geography

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3
Prerequisites: Physical Geography	
Objectives: This course attempts to impart knowledge about the relationship between man and environment including the distribution of	

population, human settlement, resources and related human activities.

Course Outline: Scope and Status of human Geography, Basic concepts and theories including Environmental determinism, Possibilism, Probabilism and cognitive behaviorism, Population: Population distribution, density and growth. Population change including migration, Population composition and Structure, Human Activities: Primary, secondary and Tertiary (agriculture, mining, forestry animal husbandry, poultry, light and heavy industries, transport and trade and tourism) and their impacts on environment, Natural resources, distribution and utilization: Renewable and non-renewable resources e.g., Air, land, water, fauna and flora fossil fuel metallic and non-metallic minerals, Energy generation and consumption, Human Settlements: Evolution and housing types, Urban and Rural contrast, Land Use/land cover Pattern e.g. Commercial, Industrial and Residential, Open and Green Spaces, Transport, Theories of urban structure e.g., Concentric Zone Theory, Multiple Nuclei Theory, Sector Theory, Rural Settlements, Dispersed, Nucleated and Ribbon Settlements, City-Size, Distribution, Rank-Size Rule, Primate Cities.

Lab Outline: Survey and data collection from rural and urban settlements, regarding land use/ land cover, population and demographic and housing characteristics, services and utilities. Slums and Social Area Analysis, Analysis of Settlements from Topographic Sheets, Analysis of Settlements as Central Places, Analysis of Settlements as Population Foci, Analysis of Urban Areas, Cartographic Techniques to analyze and present field data

Field Visits: To identify the use of natural resources, to study land use and land cover, to study the urban structure, mining area, national parks, industrial areas and various rural and urban settlement.

Reference Material:

1. Rowntree, L. et .al (2004) “Globalization and Diversity: Geography of a Changing World” Prentice Hall, New York
2. Neuwirth, R. (2004) “Shadow Cities: A Billion Squatters, A New Urban World” Routledge, London.
3. Harper, H.L. (2003) “Environment and Society: Human Perspectives on Environmental Issues” Prentice Hall; (3 Edition)
4. Knox, P.L. & S.A. Marston (2003) “Places and Regions in Global Context: Human Geography” Prentice Hall. (3rd Edition)
5. Becker, A. & Secker (2002) “Human Geography: Culture, Society, and Space” John Wiley and Sons. (7th Edition)
6. Blij, H.J.D. (2002) “Human Geography: Culture, Society, and Space” John Wiley and Sons (7th Edition)
7. Lewis, C.P. Mitchel-Fox & C. Dyer (2001) “Village, Hamlet and Field: Changing Medieval Settlements in Central England” Windgather Press.
8. Hagget, P. (1997): “Geography: A Modern Synthesis” Harper International, London.

5. Fundamentals of Geology

Course Structure: Lectures: 2 / Labs: 1B	**Credit Hours:** 3

Prerequisites: Physical Geography

Objectives: This course attempts to familiarize students with Science of Geology, to discuss in detail the theory of Plate Tectonics and mountain building. To discuss in brief the economic potential of different rock units with special reference to Geology of Pakistan

Course Outline: Overview of Earth, Geological Framework of Earth, Structure and Composition of Earth; Deformation and Mountain Building Processes, Rock Cycle
Volcanoes, Geological Hazards; Earthquakes, Tsunamis, Floods, Landslides, Mass-movements, Geological Time Scale; Cenozoic, Mesozoic, Paleozoic, Fossils and Evolution, Global Change in the Earth System, Economic Geology; Exploration and Exploitation of Natural Resources, Petroleum Basins of Pakistan.

Lab Outline: Identification of rocks and minerals in hand specimen, Identification of different rock units and geological structures in field, Preparation of Geological maps, Petrographic studies of rocks and minerals and Field visit to different Mining areas

Reference Material:

1. McGeary, D., Plummer, C.C. & Carlson, D.H., (2004) Physical Geology: Earth revealed. McGraw Hill, Boston.
2. Murphy, B and Nance D (1999). Earth Science Today. ITP, Brooks Cole Publishing, NYC. ISBN 0-534-52182-7.
3. Dutch, S.I; Monroe, J.S and Moran, J.M (1998). Earth Science, Wadsworth, ISBN: 0 314 20111 4.
4. Allen, P.A. 1997. Earth Surface Processes, Blackwell Science Ltd.
5. Skinner, B.J and Porter, S.C (1992). The dynamic Earth: an introduction to physical geology, John Wiley & Sons New York, ISBN:0 471 55224 0.
6. Duff, P.M.D (1993). Holmes Priniples of Physical Geology, Chapman and Hall, ISBN 0 412 40320 x.
7. Clarke, I.F and Cook, B.J (1992). Perspectives of the Earth (geological Science, Australian Academy of Science, Canberra. ISBN 0 85847 105 1.

6. Surveying

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: None

Objectives: The purpose of this course is to present the material to familiarize the students with introductory surveying. Time will be spent on acquisition of theory and practical field skills reinforcement. Principles and applications are designed for use by civil engineers as well as those in civil technology.

Course Outline: Overview of surveying, objects and classifications of surveying, scales, survey tasks, survey principles and methods, accuracy and precision, measurement and errors, coordinate systems and computation, direct distance measurements, errors in measurement of distance and corrections, height measures, leveling and its types, bench marks, leveling staff, sources of errors in leveling and accuracies, angular measurements, reading systems of optical theodolites, measuring angles and adjustments, indirect distance measurements, contouring plans by level and staff, section and cross-sections, precise and reciprocal leveling, traverse survey, triangulation and trilateration, GPS survey.

Lab Outline: : Instrumental surveys will be included for measuring the distance, angles and heights. Major emphasis will be towards theodolite and leveling surveys.

Reference Material:

1. Anderson, J. M., Mikhail E. M., (1998), Surveying Theory and Practice, 7th Ed., MCB/McGraw-Hill, US, ISBN 0-07-015914-9
2. Wolf P R., Ghilani C, 2005, Elementary Surveying : An Introduction to Geomatics ,11th Edition, Prentice Hall, USA, ISBN 0131481894
3. Wirshing R., Wirshing R. J., (1985), Schaum's Outline of Introductory Surveying, McGraw-Hill, UK, ISBN 0070711240
4. McCormac J. C., McCourmac J. C., Anderson W., (1999), Surveying, 4th Edition, Wiley, UK, ISBN 0471366579

7. Fundamentals of Ecology

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: None

Objectives**:** An introduction to ecology at the population, community and ecosystems levels**.** This course is designed to present an introduction to current theories and practices in ecology. It covers fundamental ecological principles with special reference to levels of organization, population and community properties, structural adaptation, functional adjustments, and other factors affecting the distribution of organisms.

Course Outline: Topics covered include: factors governing species distribution, population growth and regulation; species interactions, community description and classification; factors determining community structure and diversity, emergent properties of communities, succession and ecosystem energetics; island biogeographic theory; community stability, Community Types, Community Metrics, Diversity and Stability, Succession and Biogeography, Trophic Strucure, Energy and Nutrient Flow

Lab Outline: Lab Introduction, Spreadsheets, Demography, Population Size Estimation, Forest Ecosystem - Spatial Patterns, Predation and Functional Response

Reference Material: Provide ISBN Numbers as well

1. ***Ecology: Theories and Applications,* 4th ed.**, Stilling, P. D. 2001; Prentice-Hall
2. Smith, Robert Leo and Thomas M. Smith. 2001, Ecology and Field Biology, 6th. ed. Benjamin Cummings Publ. Co., Inc. San Francisco.
3. Molles, MC. Ecology. Concepts and Applications**.** 3rd Edition. WCB-McGraw Hill 2004

Stream 4: Information Technology Courses

Information Technology Courses				**15/127**
	Code	Pre-req	**Course Title**	**Credit Hours**
1		Nil	Introduction to Computer Programming	3
2		1	Object Oriented Programming	3
3		1	Data Structures & Algorithms	3
4		2	Computer Graphics	3
5		Nil	Computer Aided Drawing/Drafting	3

1. Introduction to Computer Programming

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours: 3**

Prerequisites: None

Objectives: The course is designed to familiarize students with the basic structured programming skills. It emphasizes upon problem analysis, algorithm designing, and program development and testing.

Course Outline: Fundamental programming constructs, translation of solution (algorithms) to programs, data types, control structures, functions, arrays, pointers, Graphical programming link lists, filing (sequential, Random) and testing of programs. Programme development with basic algorithms of searching & sorting, debugging of programming code.

Lab Outline: coding, executing and debugging of simple programs, Implementation of Constructs: if, then, switch, etc., Implementation of loops: for, while, Implementations of simple functions and overloading functions, Implementations of Arrays (1D, 2D), pointers (dynamic memory allocation), link lists, sequential & random filing, data sorting, binary tree structures (bottom-up & top-down)

Reference Material:

1. Bailey and Lundgaard, (1988) *Program Design with Pseudo-code*, Brooks/Cole Publishing.
2. Lesley Anne Robertson, *Simple Program Design: A step-by-step approach*, 4/e, ISBN: 0-619-16046-2 © 2004

2: Object Oriented Programming

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Introduction to Computer System, Introduction to Computer Programming

Objectives: The course aims to focus on object-oriented concepts, analysis and software development.

Course Outline: Evolution of OO, OO concepts and principles, problem solving in OO paradigm, OO program design process, classes, methods, objects and encapsulation; constructors and destructors, overloading operator and function overloading, derived classes, inheritance and polymorphism, I/O and file processing, exception handling

Lab coverage: Introduction Object Oriented Programming Environment, Implementation of OO simple programming: Classes, methods, objects instantation, abstract Class and Inheritance, class composition, class aggregation, Operator overloading, Implementation of I/O filing and implementation of polymorphism, Constructors, Distracters, abstract data

types, file processing using OOPs.

Reference Material:

1. Budd, *Understanding Object Oriented Programming*, Addison Wesley
2. Deitel and Deitel, *Java: How to Program*, 5th edition, Prentice Hall, ISBN 0131016210/0131202367 International Edition.
3. Deitel and Deitel, *C++: How to Program*, 4th edition, Pearson
4. Deitel and Deitel, *Java: How to Program*, 4th edition, Pearson
5. Bruce Eckel, *Thinking in C++*, 2nd Edition, Prentice Hall

3: Data Structures and Algorithms

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours: 3**

Prerequisites: Object Oriented Programming

Objectives: The course is designed to teach students structures and schemes, which allow them to write programs to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity and analysis of sorting and searching programs. Exposure to theory of NP-Completeness.

Course Outline: Introduction to data structures and Algorithms and their inter linkage; Efficient storage of ADTs (Abstract Data Types) and memory intensive problems. Advantages and disadvantages of different data structures using Arrays, Stacks, Queues, Priority Queues and Linked Lists. Recursion, sorting and searching algorithms, Hashing, Binary tree algorithim, Storage and retrieval performance of different techniques using various data structures. Introduction to theory of NP-Completeness and problem transformation.

Lab outline: Implementing ADTs using arrays, dynamic memory, Implementation of stacks, Queues & priority Queues, linked lists (single, double, circular), tree searching algorithms, hash algorithms, performance of different data structure techniques, bubble sort and insertion sort for random and ordered data sets. Implementation and comparison of linear search and binary search.

Reference Material:

1. Frank M. Carrano, Paul Helman, Robert Veroff, Data Abstraction and Problem Solving with C++, 2nd ed, Addison-Wesley, 1998
2. Lafore, Data Structures and Algorithms (SAMS teach yourself), Sams Publishing, 1999
3. Horowitz, Sahni, and Mehta *Fundamentals of Data Structures in C++*, Computer Science Press, 1995
4. Standish, Data Structures in JAVA, Addison Wesley, 2000.
5. Deitel and Deitel, Data Structures in JAVA, 4th edition, Pearson.
6. Aho, Hopcroft and Ullman, Design & Analysis of Algorithms.

4: Computer Graphics

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Object Oriented Programming, Linear Algebra, Data Structures & Algorithms

Objectives: Study of various algorithms in computer graphics and their implementation in any programming language.

Course Outline: Graphics hardware. Fundamental algorithms. Applications of graphics. Interactive graphics programming - graph plotting, windows and clipping, segmentation. Programming raster display systems, panning and zooming. Raster algorithms and software - Scan-Converting lines, characters and circles. Region filling and clipping. Two and three-dimensional imaging geometry and transformations. Curve and surface design, rendering, shading, color and animation.

Lab outline: Introduction to graphic hardware, Implementation of differential line drawing algorithms, Implementing 2nd order curve algorithms, polygons, window and Clipping, Panning & Zooming, Region filling, 2D & 3D imaging geometry & transformation, curve and surface design, rendering, shading and animation

Reference Material:

1. J. D. Foley, A. van Dam, S. K. Feiner and J. F. Hughes. Computer Graphics, Principles and Practice, Addison-Wesley ISBN 0-201-12110-7
2. F.S. Hill, *Computer Graphics,* Maxwell MacMillan, ISBN 0-02-354860-6

5. Computer Aided Drafting

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites: Computer Graphics

Objectives:
Study of various tools of computer drafting and their applications in GIS and Remote Sensing.

Course Outline: Introduction to engineering drawing/map, concept of lines, polgons, orthographic projection, projection of points, projection of lines, solids of revolution, introduction to Auto CAD map, drawing of 2D figure, drawing views of 3D Solids, Topology and Errors,.

Lab Outline: Introduction to CAD Environment, Concept of reference systems, unit systems, points, reference plane, Drawing Lines, poly lines, 2nd order curves, polygons, mirroring, Scaling, Stretching, Translation, Rotation, perspective projection, Orthographic projection, assembly drawing, cross-sectional areas, solid of revolution, shading, textures,

rendering, etc.

Reference Material:

1. Sham Tickoo, AutoCAD 2004: A Problem Solving Approach
2. David Frey, AutoCAD 2005 and AutoCAD LT 2005: No Experience Required
3. Kunwoo Lee, Principles of CAD/CAM/CAE
4. Frederick E. Giesecke, Technical Drawing (12th Edition)
5. Frederick E. Giesecke, Principles of Engineering Graphics (2nd Edition)

Stream 5: Mathematics and Applied Science Courses

Core Mathematics and Applied Sciences Courses				15/127
#	Course Code	Pre-Req	Course Title	Credit hours
1		Nil	Calculus & Analytical Geometry	3
2		Nil	Linear Algebra Applications	3
3		1	Discrete Mathematics	3
4		Nil	Statistic & Probability	3
5		4	Geo-Statistic	3

1. Calculus and Analytic Geometry

Course Structure: Lectures: 3 / Labs: 0 | **Credit Hours:** 3

Prerequisites: None

Course Outline: Complex Numbers, DeMoivre's Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence. Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution. Reference Frames, Coordinate systems

Reference Material:

1. Ron Larson (202) Calculus With Analytic Geometry, Seventh Edition**.**
2. Ron Larson, Robert P. Hostetler, Bruce H. Edwards, Houghton Mifflin, 2004 Calculus with Analytic Geometry, Seventh Edition.
3. George B., Jr Thomas, Ross L. Finney; (2004). Calculus and Analytic Geometry (9th Edition), Amazon.

4. George Brinton Thomas, et al; Amazon,(2004) ,Thomas' Calculus (10th Edition).
5. Swokowski, Olinick and Pence (2004) Calculus and Analytical Geometry.
6. Sherman K Stein, Anthony, Amazon, (2002). Calculus and Analytic Geometry

2: Linear Algebra and Applications

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3

Prerequisites: None

Course Outline: Vectors, Vector Spaces, Matrices & Determinants, Linear Transformations, Operations on matrices, Inner products, Eigenvalues & Eigenvectors. Applications to Systems of Equations and to Geometry.

Reference Material:

Linear Algebra by David C Lay, 3ed, Amazon, 2002
Linear Algebra: A Modern Introduction -- by David Poole, Amazon, 2003
Introduction to Linear Algebra, Third Edition**,** by Gilbert Strang, 2003, Amazon
Schaum's Easy Outline of Linear Algebra by Seymour Lipschutz, Marc Lipson, 2002
Linear Algebra, Fifth Edition**,** by Gareth Williams, 2004, Amazon

3: Discrete Mathematics

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3

Prerequisites: None

Objectives: This course aims to develop understanding and appreciation of the finite nature inherent problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures.

Course Outline: Sets, Combinatorics, Sequences, Formal logic, Prepositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeon whole principle, Trees and Graphs, Optimization and matching.

Reference Material:

Discrete Mathematics and Its Applications, by Kenneth H Rosen, 2003, Amazon
Discrete Mathematical Structures by Rosen, 2004
Discrete Mathematics by Richard Johnsonbaugh, 5ed, 2004, Amazon
Discrete Mathematics and Its Applications -- by Kenneth H Rosen; 2004, Amazon

Discrete Mathematics with Applications -- by Susanna S. Epp, 2004, Amazon

4: Statistics and Probability

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3

Prerequisites: None

Course Outline: Introduction to Statistics, Descriptive Statistics, Statistics in decision making, Graphical representation of Data Stem-and Lead plot, Box-Cox plots, Histograms and Ogive, measures of central tendencies, dispersion for grouped and ungrouped Data, Moments of frequency distribution; examples with real life, use of Elementary statistical packages for explanatory Data analysis. Counting techniques, definition of probability with classical and relative frequency and subjective approaches, sample space, events, laws of probability. Conditional probability and Bayesian theorem with application to Random variable (Discrete and continuous) Binomial, Poisson, Geometric, Negative Binomial Distributions; Exponential Gamma and Normal distributions.

Reference Material

1. Probability and Statistics (3rd Edition) -- by Morris H. DeGroot, Mark J. Schervish, 2004, Amazon
2. Schaum's Outline of Probability and Statistics -- by Murray R Spiegel, et al, 2004, Amazon
3. Probability and Statistics for Engineers and Scientists (7th Edition) -- by Ronald E. Walpole, et al; 2004, Amazon
4. Probability and Statistics (3rd Edition), by Morris H. DeGroot, Mark J. Schervish, 2001, Amazon
5. *Introduction to Statistics* by Walpole, 2000
6. *Probability for Statistics for Engineers* by Walpole, 7th Edition, 2002
7. *Advanced Engineering Mathematics* by Kreyszig, E., 8th Edition, 2003

5: Geo-Statistics

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3

Prerequisites: None

Course Outline:

Sets and Probability, Concept of Random Variables, Possibilities, Probabilities and expectations, Some Rules of Probability, Sampling Theory, Estimation Theory, Testing Hypothesis: One sample Tests, Two Sample Tests, Regression and Correlation, Analysis of Variance, The Chi-Square Distribution, descriptive statistics, geographic sampling, inferential statistics, correlation, and simple regression. Extensive use is made of geographic examples. The student is required to analyze data both orally

and verbally in class assignments. Computer applications in Statistics

Reference Material:

1. Geostatistics by -Jean-Paul Chiles and Pierre Delfiner, Publisher - John Wiley and Sons, 2003
2. Apportioning historical agricultural statistics using geo-gridded data base elements (Technical memorandum) by Ronald W Willis, 2002, Amazon
3. Statistics for Management by Richard I. Levin, 2002
4. Introduction to Statistical Theory, Sher Muhammad Choudhry, 2000
5. Statistical Inference, Walpol, 2002
6. Statistics for Business & Economics by Mensfield, 2003

Stream 6: English and Communication Courses

Required English Courses				12/127
#	Course Code	Pre-Req	Course Title	Credit hours
1		-	Functional English	3
2		1	Oral Communication	3
3		2	Communication Skills & Report Writing	3
4		-	Research Methods	3

1. Functional English

Course Structure: Lectures: 3 / Labs: 0	Credit Hours: 3

Prerequisites: none

Objectives: Basic understanding of language skills including grammar and comprehension

Course Outline: Introduction, Need for English Skills, Listening Skills, Reading Skills, Language and Communication, Using Words Effectively, Parts of Speech, Non-Verbal Communication, Anonyms, Antonyms and Homonyms, Frequently Misused Words, Fundamental Writing Principles, Techniques and Style, Phrases, Sentences, Punctuation and Effective Use, Organizing the Thought Process, Brainstorming, Grouping, Sequencing, Outlining, Paragraphs, Compositions, Assignments and Short Paper, Improve Writing Techniques, Summary Development, Precise Development, Critical Review, The Research Paper, Letters, Vocabulary Development, Etymology, Abbreviations, Acronyms, Business Terminology, Increasing Word Power (Grammatical Rules) English Grammar, Punctuation Rules, Capitalization Rules, The Rules Of Grammar, Correct English Usage, Principles of Grammar

Reference Material:
English for Modern Business By Ketteley and Thompson
Write Better,Speak Better, By Readers Digest

2. Oral Communication

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours: 3**

Prerequisites: Functional English

Objectives:

Course Outline:
Introduction to Oral Communication and its Application: Communicating at Work, Communication in Process, Communication in Organization, Oral Presentation and Oral Reports, Presentation: Face to Face Information Gathering, Communicating non verbally, Types of Non Verbal Communication, Developing good listening habits, Listening Barriers, Active listening Techniques, Oral Communication/Planning Business Communications, Short Talks and Presentation Types of Short Presentation/Modes of Delivering the Speech, Guidelines for presenting the speech, Oral Communication / Delivering Business Presentations, The Long Presentation & the Purpose of Presentations: Analyzing your audience, Parts of presentations, Verbal Visual supporting Materials, Conducting successful interviews, meetings and conferences, Types of Interviews, Leading Group and holding Successful conferences, Techniques for participation in a meeting, Small group communication and Decision making, Use and values of small groups in effective organization, Basic problem solving procedure, Employment communication, Responsibilities of the interviewee, Responsibilities of the interviewer, Participation and leadership in small groups, Effective group participation, Effective group leadership, Old communication/methods of dictating techniques, Communication and telephone, Communicating effectively in international business, Non verbal communication in international business, Training needs in international business, Criteria for communicating effectively

Reference Material:

Business communication principles and applications by C.Glen Pearce, rossfi Steven P. Golden
Communication for result by Cheryl Hamilton, Cordell Parker, Doyle D. Smith

3. **Communication Skills and Report Writing**	
Course Structure: Lectures: 3 / Labs: 0	**Credit Hours: 3**
Prerequisites: None	
Objectives: To develop good Technical writing, language usage and reading skills. To appreciate the importance of communication and to develop understanding of communication concepts, principles, theories and problems. To develop good oral communication and presentation skills.	
Course Outline: Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs. Comprehension and expression. Use of grammar and punctuation. Process of writing, observing, audience analyzing, collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams. Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation. .	
Reference Material: *Business English* by Vawdrey, Stoddard and Bell	

4: Research Methods	
Course Structure: Lectures: 3 / Labs: 0	**Credit Hours: 3**
Prerequisites: None	
Course Contents: Introduction to Research: Definition & Nature, The Scientific Method, The Research Process, and Errors in Research. Research Design and Data Sources: Types of research and research designs, Primary data and its sources, Secondary data and its sources. Data Collection Procedures: The Measurement Process, Concepts of validity and reliability, The casual design procedures, Data Collection Methods, Observation, Documentary-Historical Method, The Survey Method, Data Collection Instruments: Questionnaire, Interview and Scheduling, Problems in Data Collection. Sampling: Sampling Concepts, The Sampling Procedures (Types of Sampling), Determining a sample size & Selection of sample	

Data Processing And Analysis: Basic concepts of data processing: Computer representation, Data Matrix, Data Storage Data Processing flow: Editing, Coding, Handling Blank Responses, Coding, Categorization, Converting, Weighting, Storing etc., Alternative processing flows, University data analysis, Measurement of central tendency, Measurement of dispersion, Hypothesis Testing, Bavaria data analysis, Linear Correlation, Simple Regression, The Chi-Square Test, The Cross-Tabular Tables, Elaboration of relationships, Multivariate data analysis: Interdependence Methods, Factor analysis, Cluster analysis, multidimensional analysis, Multivariate data analysis: Dependence methods, Multiple Regressions, Analysis of Variance & Covariance, Discriminate analysis.
Research Project Proposal: Rationale for the study defining the problem, Research Objectives, Information needs, Research design, Data collection procedure, Data processing & analysis, Research Team and its profile, Budget, Time Table

Reference Material:

Ranjit Kumar, Research Methodology, Sage Publications.
Ingeman Arbonor And Bjoran Berke, Methodology for Creating Business Knowledge, Sage Publications.
Dam Remenyl, Doing Research in Business and Management, Sage Publications.
David H. Folz, Survey Research for Public Administration, Sage Publications.
C. William Emory, Business Research Methods, IRWIN.

Stream 7: Elective Courses

On the recommendation of the BS (RS & GIS) program coordinator, students can choose electives either from the following list or any other undergraduate courses offerings of their respective institution. The following section provides brief details of some of the key elective of the 4 years BS (RS & GIS) program that may be chosen by the undergraduate students.

1: Spatial Data Modelling

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3
Prerequisites: Spatial data visualization	
Objectives: This course attempts to provide an introduction to GIS data models and data structures. The subject continues with a systematic overview of spatial data models (e.g. raster and vector) and the structures used to implement these, together with methods of spatial feature	

addressing, geometry of objects, topology, object hierarchies and aggregations, the modeling of fuzzy objects and the uncertainty aspects of spatial data.

Course Outline: Introduction to Fields, Objects, Geometry**,** Objects represented in raster, Vector Structure, Vector data representing the geometry of geographical objects, Networks and graphs, Properties of Graphs, graph areas and error checking procedures,
Terrain object classed and generalization hierarchies aggregation hierarchies, object association, Fuzzy set theory, fuzzy boundaries, Uncertainties of Spatial Objects.

Lab Outline: Preparation of Symbolic Charts for representation of Earth Features, Assignment on Geometry of spatial objects, Utility Network Analysis, Spatial data generalization and aggregation,

Reference Material:

1. Michael, N. D.(2003) " Fundamentals of Geographic Information Systems" Third Edition, John Wiley & sons.
2. Heywood, I., Cornelius, S. and Carver, S. (1999) " An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition.
3. DeMers, M. (1996) "Fundamentals of Geographic Information Systems", John Wiley & Sons, New York.
4. Burrough, P*.,* (1986) "Principles of Geographic Information Systems for Land Resources Management", Oxford University Press, Oxford.

2: Spatial Data Infrastructure

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites:

Objectives: This course attempts to provide an understanding to the data structures, processes and its standards which are involved in data sharing. Subject includes the applications and architecture of Spatial Data Infrastructure.

Course Outline: Need and main components of SDI, Clearing house architecture
National Geospatial Clearinghouse, Metadata concepts, its structures and functionality,
System Architecture for SDI Interoperability, Client Server Architecture, Data Quality Information (DQI) Accuracy, Precision, Bias Error Modeling, Data Modeling
Abstraction of real world, Types of abstraction, Problems of information sharing (Heterogeneities), Distributed database concept, GIS Internet Services and SDI Technologies, Available Services, Technologies that

support internet GIS services
Commercial tools for Internet GIS, legal aspects of SDI.

Lab Outline: Comparison of working SDI's, Development of Metadata according to Standards, Development of Architecture of SDI, Data Standardization, Data transformations and translations, Web Publishing & development.

Reference Material:

1. Robert, C. H. (2005) " SDI : A View from Europe" Oxford University Press, Oxford, ISBN: 089875982X.
2. Groot, R. (2001). Geospatial Data Infrastructure: Concepts, Cases, and Good Practice (Spatial Information Systems (Cloth)), Oxford University Press.
3. Beth E. Lachman (2001). Lessons for the Global Spatial Data Infrastructure: International Case Study Analysis, RAND Corporation.
4. Mapping Science Committee (1993), " Toward a Coordinated Spatial Data Infrastructure for the Nation,".National Academy Press.

3: Land Information System

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours:** 3

Prerequisites:

Objectives: This course attempts to give students a broad understanding of land tenure and the cadastre concept, how it has evolved historically and its role in documenting land rights. The course covers cadastral systems in the world as a means of understanding fundamental principles and design criteria underlying these systems. The final part of the course deals with the design of cadastre-based LIS.

Course Outline: Introduction to Land characteristics, Land information system, Cadastre, Land information management, LIS Taxonomy, classification of land information , Land Registration, Comparison of land registration and cadastre, Benefits of land registration for individuals and role of land registration for Government, Land Tenure Systems, Concept and definition, Forms of land tenure operational forms of land tenure, English, Anglo-American, Continental, Western European Concept and rights, Customary land tenure Islamic land tenure, Land Registration concept, process, Public registration, Principles of \registration, Deeds Registration, Title Registration, Features of Land Registration system, Private conveyancing, Positive and Negative Systems, Boundaries, Fiscal cadastre Multipurpose Cadastre, Institutional arrangement and technical matters, Procedures for introducing a land administration system.

Lab Outline: Studying and understanding the existing LIS examples, Development of work flow diagrams for the procedures, Comparison of

existing land information systems, Cadastral mapping through existing analogue maps/satellite imageries, Cadastral map editing, and updating, Development of database for land registration, Process verification and development of Registries, Titles, Integration of Revenue mapping and statistical analysis, Integration of cadastral system with other utility information system, LIS Project Development.

Reference Material:

1. Flower, C. (1998) “Geographic information systems, mapping, and spatial data for the coastal and ocean resource management community .NOAA's Coastal Services Canter.
2. Dale, P.F. and J. McLaughlin (1988). Land Information Management, Oxford University Press, New York.
3. United Nations (1996), “ Land Administration Guidelines: with special reference to countries in transition”. New York & Geneva.

4: Introduction to Computer Systems (ICS)

Course Structure: Lectures: 2 / Labs: 1	**Credit Hours: 3**

Prerequisites: None

Objectives: This course focuses on a breadth-first coverage of Information Technology discipline, introducing computing environments, general application software, basic computing hardware, operating systems, office working tools, Internet and computer usage concepts; Software engineering process, Social and ethical issues of computing.

Course Outline: Number Systems, Binary numbers, Boolean logic, History computer system, basic machine organization, Von Neumann Architecture, Algorithm definition and data structure design, and implementation, Programming paradigms and languages, Graphical programming, Overview of Software Engineering, Operating system, Compiler, Computer networks and Internet, Computer graphics, AI, Social and legal issues.

Lab Outline: Computation of Number Systems; Binary, Octal, Hexa, Decimal number Systems, Implementation of Boolean functions, and basic machine organization e.g. motherboard, memory, I/O Cards, Input/Output Devices, Networking Devices, Concepts of Flow Charts, Environment of different Operating Systems; Linux, Unix, DOS, MS Windows, Introduction to Office Tools (MS Word, MS Excel, MS Access etc), Internet browsers and exposure to web based programming.

Reference Material:

1. Bailey and Lundgaard, *Program Design with Pseudo-code,* Brooks/Cole Publishing,

2. Lesley Anne Robertson, *Simple Program Design: A step-by-step approach*, Course Technology, 2000
3. Larry Long and Nancy Long, Computers: Information Technology in Perspective, 9th edition, Prentice Hall, 2002 / ISBN: 0130929891
4. Schneider and Gersting, *An Invitation to Computer Science*, Brooks/Cole Thomson Learning, 2000
5. Sherer, *Computer Science: An overview of Computer Science*,

5: Technical and Business Writing (Elective)

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours: 3**

Prerequisites: None

Objectives: To develop efficient literature survey, analysis, report writing and document designing skills.

Course Outline: Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information. Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy. Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, cross-referencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Reference Material:
Research Method: Guidance for Postgraduates, Greenfield, T. Arnold

6: Physics

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:**

Prerequisites: None

Course Outline:
Review of Vector Motion: position, velocity, and acceleration vectors. *Applications of laws of motion:* Projectile Motion, motion in resistive media, rocket motion, motion of charged particles in electrical and magnetic fields**,** *Rotational motion:* constant angular acceleration, uniform circular motion,

torque, linear and angular momentum and their conservation, *System of Particles:* center of mass, two-body collisions in two-dimensions, moment of inertia of objects, *Wave Motion:* mathematical concepts of simple and damped harmonic motion, analytical treatments of superposition of waves, concepts and applications of diffraction and polarization of light and sound waves.
Reference Material: *University Physics* by Freedman and Young (10th or higher editions), *College Physics* by Resnick, Halliday and Krane (6th and higher edition)

7: Multivariable Calculus	
Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3
Prerequisites: Calculus	
Course Outline: Functions of Several Variables and Partial Differentiation. Multiple Integrals, Line and Surface Integrals. Green's and Stoke's Theorem. Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions, Fourier Transform. Laplace Transform, Z-Transform.	
Reference Material: *Calculus and Analytical Geometry* by Swokowski, Olinick and Pence	

8: Introduction to Economics	
Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3
Prerequisites:	
• **Agricultural Sector:** Major crops, cash crops, cultivated area, irrigated and un-irrigated area and agricultural inputs • **Industry:** Small, medium and large scale industries, major industries, employment, capital output ratio and industrial policy and prospects • **Population:** Population trend, birth rate, fertility rate, infant mortality rate, rural urban migration, male/female ratio, life expectancy and population pyramid • **Education:** Number of male/female educational institutions, student enrolment, teacher/student ratio, literacy ratio and education policy • **Health:** number of hospitals, doctors and paramedical staff; number of medical colleges, major diseases, access to clean water and sanitation • **Services industry:** Major services, hotels and motels, tourism and transportation • **Foreign trade:** Major imports and exports, commercial policy, tariffs and quotas, export subsidies and rebate, foreign exchange earnings	

and balance of trade

- **Monetary Policy:** Role of State Bank of Pakistan in money supply, tools of monetary policy, open market operation, bank rate and required reserve ratio
- **Fiscal Policy:** Direct and indirect taxes, excise duty, government budget and government expenditure
- **Banking:** Commercial banking, non-banking financial institutions, insurance companies, mutual funds, investment banks, consumer banking and interest-free banking
- **Inflation:** Measurement of inflation, consequences of inflation, inflation and unemployment
- **Labor Force:** Male/female, skilled/ unskilled, rural/urban self-employed/employed labor force and manpower planning
- **GDP:** Measurement of GDP, composition of GDP, growth rate of GDP, per capita GDP and growth vs. development
- **Capital Markets:** Stock exchanges and their functioning, role of Security Exchange Commission of Pakistan (SECP), stock index, and foreign portfolio investment
- **Infrastructure:** Roads, railway, airplanes and merchant ships, telephone, radio, tv, print media and Internet

Reference Material:

1. Saeed, Amjad Khawaja (latest edition) *Economy of Pakistan*
2. *Malik, Sohail (*latest edition) *Economy of Pakistan*
3. Waseer, Habibullah (latest edition)
4. Hussain Ch. M. (latest edition) *Economic Theory*
5. Pakistan Economic Survey (various issues)

9: Intro to Economics

Course Structure: Lectures: 3 / Labs: 0	**Credit Hours:** 3

Prerequisites:

Objectives:

Course Outline:

1. Introduction: Basic Economics Concepts, problems of Economic Organizations, Markets and Elements of supply and demand.
2. Supply, demand and product markets: demand, utility and consumer behavior and business organizations. Theory of production and marginal products, analysis of costs, competitive markets, monopoly and imperfect competition
3. Production Function and Distribution: Factors of Production, Pricing of factors of production.
4. Markets and Economic Efficiency, role of Government, Economic

Systems, Economic Growth and International Trade

5. National Economy facts: National income Accounting, Measurement. Income and Spending, Money, Monetary and Fiscal Policy, International Linkages
6. Aggregate Demand, Supply and Growth, Consumption and Saving, Inflation, Unemployment, Budget Deficit and International Adjustment.

Reference Material:

1. Robert S.Pindyck & Danial L. Rubinfeld: Microeconomics, 4e, Prentice Hall
2. Rudiger Dornbusch & Stanley Fischer: Microeconomics, 6e, McGraw Hill
3. C.E.Ferguson & J.P.Gould: Microeconomics Theory, 5e
4. Samuleson & Nordhausan: Economics,6e,Tata McGraw Hill

MS Remote Sensing & GIS Program

Eligibility:

1. 4 years BS (Remote Sensing & GIS) degree or Minimum of 16 years of education (HEC Recognized Institutes / Universities).
2. Other disciplines graduates will have to enroll in prerequisite / deficiency courses as proposed by the individual university and as per HEC prescribed guidelines.

Duration and Structure:

- Two years spread over 4 semesters (two semesters per year)
- 30 credit hours including thesis.

Course Structure	Credit Hours	Courses
Core Courses	**12**	**4**
Elective/Specialized	**12**	**4**
Thesis	**06**	**-**
Total	**30**	**9**

Core Course	Credits	Theory Cr + Practical Cr
Advanced Remote Sensing and Digital Image Processing	**3**	**2+1**
Advanced GIS	**3**	**2+1**
Advanced Geo-database and Programming Integration	**3**	**2+1**
Advanced Research Methods	**3**	**3+0**

Evaluation and Degree Requirement:

Minimum Cumulative Grade Point Average (CGPA) required is 2.0 out of maximum of 4.0 CGPA. For the thesis component a minimum of 50 percent marks.

Direct Postgraduate Entry

Those institutions that intend to introduce Masters level Remote Sensing & GIS degree program, it is recommended to offer the following four deficiency courses to all incoming graduates. Students with 4 years Bs (RS & GIS) degree need not to enroll in the deficiency courses. Following **Table 2** provides details of the deficiency courses.

Table 2. MS (RS&GIS) Deficiency Courses

Serial No.	Subject	Contact Hours
01	Introduction to GIS	6
02	Introduction to Remote Sensing and Digital Image Processing	6
03	Introduction to Spatial Analysis	4
04	Introduction to GIS Database and Programming	4

Deficiency Course 1: Introduction to GIS	
Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)
Prerequisite: None	
Objective: This course introduces principles, concepts and applications of Geographical Information Systems (GIS): a decision support tool for planners and managers of spatial information. Database development, manipulation and spatial analysis techniques for information generation will be taught. Students will have the scope of using GIS for applications in their related fields such as natural resource management, environment, civil engineering, agriculture, information system, etc will be discussed through mini project and laboratory exercises.	
Course Outline: Understanding Geographical Information System, Introduction to Arc GIS, Data Types (Spatial / Aspatial), Data Models & Structures (Raster / Vector), Exploring GIS Dataset in Arc Catalog, Data Sources and Capturing Techniques, Displaying and Manipulating spatial information, Vector Data Preparation (Digitization and Spatial Data Editing), Working on vector data in Arc GIS (Scanning, Digitization and Editing), GPS Survey, Integrating GPS data in GIS Environment, Multidisciplinary Applications of GIS	
Reference Material	
1. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective" WDL Publications, Ottawa, Fifth Edition. ISBN – 0912804008. 2. Clarke, K. (2004) “Getting started with Geographic Information	

System", Prentice Hall , New York, Second Edition. ISBN – 1879102897.
3. Heywood, I., Cornelius, S. and Carver, S. (2003) " An introduction to Geographic Information System", Addison Wesley Longman, New York, Second Edition. ISBN – 0130611980.
4. Matt Duckham, Michael F. Goodchild, Michael F. Worboys, (2003) Foundations of Geographic Information Science, Tylor & Francis, NewYork, USA.
5. Michael N. Demers (2002) Fundamentals of Geographic Information System, John Wiley & Sons, Inc., Singapore.
6. K,ang-tsung Chang (2002) Introduction to Geographic Information Systems, McGraw- Hill Company, New York, U.S.A
7. Burrough, P.(2002) "Principles of Geographic Information Systems for Land Resources Management", Oxford University Press, Oxford, Second Edition. ISBN - 0198233655.
8. McDonald, R. and Burrough, P. (2001) "Principles of Geographic Information Systems", Oxford University Press, Oxford, Second Edition ISBN–198233855
9. Foresman, T. (1997) "The history of Geographic Information System", Prentice Hall, New York. ISBN – 0138621454

Deficiency Course 02: Introduction to Remote Sensing and Digital Image Processing

Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)

Prerequisite: None

Objective: This course aims at providing students with principles of Remote Sensing (RS) technology, which is the tool to obtain information on the earth from sub meter level to km level locally and globally. Basic image processing techniques and skill to analyze remotely sensed image will be taught as well. Moreover, Further, this course will provide students with familiarize students with the essential of digital image processing techniques. Emphasis is given on implementation of digital image processing packages using a wide range of pre-image processing, image classification, accuracy assessment techniques. The main focus of this course will be hands on experience using real life remotely sensed data pertinent to its multidisciplinary applications.

Course Outline: Understanding the concept of Electromagnetic Spectrum, Physical basis of Remote Sensing, Atmospheric Interaction, Sensor Systems (Orbits, Satellites, Sensors and Platforms), Multidisciplinary Applications of Remote Sensing, Digital Image Processing Cycle Overview, ERDAS Imagine – Environnent, Data Formats, Image Pre-processing, Noise Corrections, Geometric Rectification, Registration and Resampling, Radiometric Corrections, Image Classification Types and Algorithms, Accuracy Assessment

Techniques, Confusion Matrices, Data Fusion and Mosaicing. Multidisciplinary Applications.
Reference Material
1. W. G. Rees (2001) Physical Principles of Remote Sensing Cambridge University Press, United Kingdom. ISBN**:** 0521669480 2. Robert A. Schowengerdt (January 15, 1997) Remote Sensing 2nd edition, Academic Press ISBN: 0126289816 3. Thomas M. Lillesand & Ralph W. Kiefer (Year 2000) Remote Sensing and Image Interpretation John Wiley & Sons, Inc. 4. James B. Campbell (1996) Introduction to Remote Sensing, The Guilford Press, New York, USA.

Deficiency course 03: Introduction to Spatial Analysis	
Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)
Prerequisite: None	
Objective: This course provides a detailed examination of the common spatial analytical tools used in a Geographical Information Systems environment. Students are given 'hands-on' experience with data extraction techniques, data reduction techniques, data modeling (statistical and inferential) and data evaluation methodologies. The students are also introduced to image processing in a spatial context. Real world applications provide the mechanism for gaining experience with the analytical techniques detailed above. Spatial analyses are undertaken using mainly ESRI's ArcGIS	
Course Outline: Understanding the concept (vector, raster and statistical analysis), Thematic Mapping, Distance Measurements, Vector Data Query and Object Selection, Buffering, Interpolation, Density Mapping and Map Overlay, Network analysis, Topographic Analysis 3D mapping	
Reference Material	
1. David O' Sullivan and David J. Unwin (2003) "Geographic Information Analysis", John Wiley & Sons, Inc., Canada. ISBN: 0-471-2117-1 2. Chang, Krang-tsung (2002) "Introduction to Geographic Information Systems" McGraw Hill. ISBN: 0-07-049552-1 3. David L. Verbyla (2002) "Practical GIS Analysis", , Taylor & Francis, London 4. Donald P. Albert & Wilbert M. Gesler (2000) "Spatial Analysis, GIS and Remote Sensing Application in Health Sciences" Ann Arbor Press, Michigan, USA.1-57504-101-4 5. John Stillwell & Graham Clarke (2004) "Applied GIS and Spatial Analysis", John Wiley & Sons, UK. ISBN: 1-57504-101-4 6. Peter M. Atkinson and Nicholas J. Tate (1999) "Advances in	

Remote Sensing and GIS Analysis" John Wiley & Sons, UK. ISBN:0-471-985070-5
7. Heywood, I., Cornelius, S. and Carver, S.(1999) "An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition. ISBN: 81-7808-982-3
8. Paul, L., Michael, G., David, M. & David, R.(1999) "Geographic Information Systems: Principles, Techniques, Applications and Management". John Wiley & sons. ISBN: 0-471-73545-0
9. Peter A. Burrough & Rachael A. McDonnell (2000) Principles of Geographical Information Systems**, ,** Oxford University Press Stewart Fotheringham
10. Robert Haining (2003) Spatial Data Analysis : Theory and Practice Cambridge University Press ISBN: 0521774373
11. Michael Batty & Paul A. (2003) Longley Advanced Spatial Analysis: The CASA Book of GIS Publisher: ESRI Press ISBN: 1589480732

Deficiency course 04: Introduction to GIS Database and Programming

Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)

Prerequisite: None

Objective:

Course Outline: Understanding Database System, Database Structure, Database Design, GeoDatabase, Working on attribute data in ArcGIS, Design and development of GeoDatabase in ArcGIS, SQL, Customization environment of ArcGIS, Programming Basics (GUI, Looping, Logics etc.), User Interface Controls, Macros

Reference Material:

1. Mark L. Gillenson (2005) Fundamentals of Database Management Systems John Wiley & Sons.
2. Kropla, B. (2005) "MapServer: Open Source GIS Development" Apress, Co. ISBN: 1590594908
3. Michael Worboys, Matt Duckham (2004) GIS: A Computing Perspective, 2nd Edition CRC Press; 2nd edition ISBN: 0415283752
4. C.J. Date, Database Systems, Addison Wesley Pub. Co. (2004) ISBN – 0201385902.
5. R.Connolly and P.Begg *Database Systems: A Practical Approach to Design, Implementation and Management,* , Addison-Wesley Pub. Co (2003) ISBN – 0321210255.
6. Elmasri, R. and Navathe, S.B (2004) "*Fundamentals of Database Systems"* Addison-Wesley Pub. Co ISBN – 0-

201760355
7. Les Kirkup (2002) Data Analysis with Excel®: An Introduction for Physical Scientists Cambridge University Press.
8. Terry Halpin (2001)Information Modeling and Relational Databases: From Conceptual Analysis to Logical Design (Morgan Kaufmann Series in Data Management Systems) Morgan Kaufmann; 1st edition ISBN: 1558606726
9. Rigaux, P. Scholl, M. and Voisard, A.(2001) "Spatial Databases: With Application to GIS" Morgan Kaufmann; 2nd edition ISBN – 01017386802.
10. Ralston, B. A. (2002), Developing GIS Solutions with MapObjects and Visual Basic, Onword Press, New York. ISBN: 0766854388.
11. Rigaux, P. Scholl, M. and Voisard, A.(2001) "Spatial Databases: With Application to GIS" Morgan Kaufmann; 2nd edition.ISBN: 1558605886.
12. Bugg, K.E (2003)"GIS programming: prepare for the gathering storm" GEO.

MS Remote Sensing & GIS Core Courses

Following table provides details of the core courses for the MS (RS & GIS) program.

Table 3.0

Core Course	Credits	Theory Cr + Practical Cr
Advanced Remote Sensing and Digital Image Processing	**3**	**2+1**
Advanced GIS	**3**	**2+1**
Advanced Geo-database and Programming	**3**	**2+1**
Advanced Research Methods	**3**	**3+0**

Core Course 1: Advanced Remote Sensing and Digital Image Processing	
Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)
Prerequisite: Intro to remote sensing and digital image processing	
Objective: This course aims at providing students with advanced Remote Sensing analytical techniques required in various applications; how to extract high-level information from RS data. The techniques taught covers coupling of model parameters and remote sensing data for several applications, atmospheric correction, Multi-temporal/Multi-Resolution data analysis, Web Image Server. In the digital image processing part, student will be exposed to advanced topics of digital image processing and their applications in optical, thermal and microwave remotely sensed data sets.	
Course Outline: In depth understanding of image processing, analysis and interpretation. Topics include human vision and colour, the construction, arithmetic operations, empirically based image transformations, filtering of images, discrete fourier transformations, principal components analysis, and spatial modeling, advanced image classifications such as fuzzy classifications, neural classifiers, spatial and spectral segmentation, sub pixel classification. SAR interferometry, applications of SAR interferometry, image spectrometry, Feature Extraction from Hyperspectral data, Image Residuals, Spectral Fingerprints, Absorption-band Parameters, Spectral Derivative Ratio, Classification Algorithms for Hyperspectral Data, radar remote sensing, speckle noise and suppression, texture analysis, data Fusion, DEM	

extraction from stereo SAR. Computer-based exercises are an essential part of this course.

Reference Material:

1. Mather, P (2004). Computer processing of remotely sensed images. Third Edition, J Wiley. ISBN 0-470-849193.
2. David A Landgrebe (2003) Signal Theory Methods in Multispectral Remote Sensing **(**Wiley Series in Remote Sensing and Image Processing**)** Wiley-Interscience; Bk&CD-Rom edition ISBN: 047142028X.
3. Campbell, James B. (2002*. Introduction to Remote Sensing*, 3rd Ed., (The Guilford Press) ISBN # 0-7484-0663-8 (pbk).
4. Henderson, F.M and Lewis, A.J (1998). Principles and applications of Imaging Radar. Manual of Remote Sensing, Third Edition Volume 2. John Wiley and Sons. ISBN 0-471029406-3.
5. Peebles, P.Z (1998), Radar Principles, Wiley Inter science, New York.
6. Elachi, C. (1988): Spaceborne Radar Remote Sensing: Applications and Techniques, IEEE Press, New York.
7. Roger M. McCoy (2004) Field Methods in Remote Sensing The Guilford Press ISBN: 1593850794
8. Walter G. Egan, Walter Egan (2003) Optical Remote Sensing: Science and Technology (Optical Engineering) Marcel Dekker ISBN: 0824741315
9. Fawwaz T. Ulaby (1986), Microwave Remote Sensing: Active and Passive, Volume I: Fundamentals and Radiometry (March, Artech House Publishers ISBN**:** 0890061904
10. Fawwaz Tayssis Ulaby (1986) Microwave Remote Sensing: Active and Passive, Volume II: Radar Remote Sensing and Surface Scattering and Emission Theory Artech House Publishers ISBN: 0890061912

Core Course 2: Advanced Geographical Information System

Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)

Prerequisite: Intro to GIS and Intro to Spatial Analysis

Objective: This course will familiarize students with advanced topics of GIS such as spatial database accuracy assessment, 2D and 3D spatial modeling, analysis of discrete and continuous entities in space. There will be special emphasis on statistical analysis of spatial data. Students will be trained to develop models based on regression analysis and logical analysis. Students will also learn customization and automation in GIS and also learn techniques to put the GIS on to Internet.

Course Outline: Co-ordinate System and Map Projection, Drawing of

Map Projections and Error Estimations, Understanding of Cartographic Errors and Rectification Procedures, Cleaning and Editing Cartographic Data Visualization of Geospatial Data, Symbolization and Map Layouts Development, 3D Visualization of Spatial Data, Alternate Approaches for Mapping (Geocoding, Survey Data Integration), Geocoding and Survey Data Integration in GIS, Point Pattern Analysis, Lines and Networks, Performing Network Analysis, Area Objects and Spatial Autocorrelation, Describing and Analyzing Fields, Spatial Interpolations, Geostatistical Analysis, Map Overlay Analysis, Multivariate Data, Multidimensional Space and Spatialization, GIS Modeling and Related Issues.

Reference Material:

1. John Stillwell (2004) Applied GIS and Spatial Analysis John Wiley & Sons, Ltd. England ISBN: 0470844094.
2. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth Edition. ISBN - 0912804008
3. Clarke, K. (2004) “Getting started with Geographic Information System”, Prentice Hall , New York, Second Edition. ISBN - 1879102897
4. Heywood, I., Cornelius, S. and Carver, S. (2003) “ An introduction to Geographic Information System”, Addison Wesley Longman, New York, Second Edition. ISBN - 0130611980
5. Burrough, P.(2002) “Principles of Geographic Information Systems for Land Resources Management”, Oxford University Press, Oxford, Second Edition. ISBN - 0198233655
6. McDonald, R. and Burrough, P. (2001) “Principles of Geographic Information Systems”, Oxford University Press, Oxford, Second Edition ISBN - 0198233855
7. Foresman, T. (1997) “The history of Geographic Information System”, Prentice Hall, New York. ISBN – 0138621454.
8. Stewart Fotheringham, Chris Brunsdon, Martin E Charlton (2000) Quantitative Geography: Perspectives on Spatial Data Analysis SAGE Publications ISBN: 0761959483.
9. Jacek Malczewski (1999) GIS and Multicriteria Decision Analysis John Wiley & Sons, Inc. ISBN: 0471329444.
10. Martien Molenaar (1998) An Introduction to the Theory of Spatial Object Modelling for GIS Taylor & Francis, Inc. ISBN: 074840774X.

Core course 4: Advanced Research Methods	
Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)
Prerequisite: Intro to GIS Database and Programming	
Objective:	
Course Outline: Introduction to Research, Defining the Research Problem, , Research Design, Sampling Design, Data Sources and Quality, Methods of Data Collections, Variables form Remotely Sensed Data, Processing and Analysis of Data, Sampling Spatial and Aspatial data, Parametric or Standard Tests of Hypothesis, Nonparametric Test of Hypothesis, Multivariate Analysis Techniques, Spatial Analysis, Cartographic Modeling, Interpretation and Report Writing, Seminar on Research Project findings.	
Reference Material: **Please see research project and thesis guide (Appendix 2) prepared by Professor Dr Waqar Ahmad**	
Core course 3: Advanced Geodatabase and Programming	
Course Structure: Lectures: 2 / Labs : 1	**Credit Hours:** 3 (2+1)
Prerequisite: Intro to GIS database and programming	
Objective:	
Course Outline: Database and Geodatabase, Integration of Data into Geodatabase Topology, Subtypes and Attribute Domains, Relationship Classes and Geometric Networks, UML and CASE Tools for Geodatabase, Overview of Visual Basic, Understanding MapObjects, Maps and Layers Controls, Coordinates and Map Projections, Geometrics, Map Display and Features Rendering, Data Access and Control, Address Matching, Application Deployment	
Reference Material	
1. Bruce Ralston (2002) Developing GIS Solutions with Map Objects and Visual Basic Onward Press, Thomson Learning, New York. ISBN: 0766854388 2. Kang-Tsung Chang Programming **(**2005) ArcObjects with VBA: A Task-Oriented Approach, CRC Press LLC. ISBN**:** 0849327814 3. Philippe Rigaux, et al (2002) Spatial Databases: With Application to GIS (Morgan Kaufmann Series in Data Management Systems) Academic Press, U.S 4. Menno-Jan Kraak (2001) Web Cartography, Taylor & Francis ISBN: 074840869X 5. Simon W. Houlding (2000) Practical Geostatistics: Modeling and Spatial Analysis (with CD-ROM) Springer; Bk&CD Rom edition ISBN: 3540668209	

MS (RS & GIS) Elective Courses

On the recommendation of the MS (RS & GIS) course, students can choose electives either from the following specialized field list or any other postgraduate courses offerings of their respective institution.

Specialization Fields

Natural Resource Management	(NRM)
Environmental Management	(EM)
Urban and Regional Planning	(URP)
Socio-economic and Infrastructure Development	(SID)
Geomatics	(GM)

The following Table provides brief details of some of the key elective of the MS (RS & GIS) program that may be chosen by the postgraduate students.

Electives Courses

Course Title	**Credits** Theory + Practical	**Specialization Field**
Agriculture and Food Security	2+1=3	NRM
Forest Management	2+1=3	NRM, EM
Soil Geomorphology and Classifications	2+1=3	NRM
Hydrology and Water Resources	2+1=3	NRM
Conservation of Biodiversity	2+1=3	NRM, EM
Management of Energy Resources	2+1=3	NRM
Management of Mineral Resources	2+1=3	NRM
Coastal Zone Management	2+1=3	NRM, EM
Natural Resources Explorations	2+1=3	NRM
Natural Hazards and Disaster Management	2+1=3	EM
Environmental Pollution	2+1=3	EM
Environmental Impact Assessment	2+1=3	EM
Environmental Decisions and Conflict Resolution	2+1=3	EM
Disease Ecology	2+1=3	EM
Climatology	2+1=3	EM
Land use Planning and Management	2+1=3	URP
District Planning and Management	2+1=3	URP
Urban Planning	2+1=3	URP
Infrastructure and Transport Planning	2+1=3	URP, SID
E-Governance	2+1=3	URP
Planning and Management of Housing	2+1=3	URP
Poverty Alleviation	2+1=3	SID
Tourism Development	2+1=3	SID
Education and Health Services	2+1=3	SID
Business and Marketing	2+1=3	SID
Land Information System	2+1=3	SID
Utilities and services Management	2+1=3	SID, URP
Geodesy	2+1=3	GM

GIS Standards, Security and Ethics	2+1=3	GM
Integrated Geo-Technologies	2+1=3	GM
Corporate GIS	2+1=3	GM
Web GIS	2+1=3	GM

MS (RS & GIS) Thesis Research

Credit Hours: 6

Prerequisite: 24 credits course work (RS & GIS)

Objective:

The thesis is seen as a major component of the programme in which the student will demonstrate an ability to independently integrate knowledge, skills and competencies acquired from all earlier courses, together with an opportunity to consolidate and develop additional skills in the use and application of research methodologies.

This independent study will be defined in consultation with the course co-ordinator and will be based on:

a) A specific research topic brought from the Remote Sensing & GIS industry. In this case, the topic will be discussed and finalized by mutual consultation of the corresponding industry, student and the MS (RS&GIS) course coordinator of the University.

b) A research project proposed by research supervisor or associate researchers within or outside the host university.

c) A development from a guided project pursued in RS and GIS, Applied Remote Sensing or an idea developed by the student during the earlier taught parts of the course.

In all cases there will be a close liaison prior to, and during the project between the student, the course contributors and relevant industry organizations.

4. Recommendations of the National Curriculum Review Committee

The final National Curriculum Revision Committee meeting in Remote Sensing & GIS that concluded on 18th May at HEC Regional centre at Lahore made the following recommendations. These recommendations focused on 3 key areas i.e. the curriculum development, adoption of hardware/software and a short/long term plans for the production of quality trained manpower and establishing RS & GIS research culture in Pakistan.

4.1 Curriculum

1.1 It is recommended that for **4 year BS degree and 2Year MS degree programs** standardized RS & GIS courses will be introduced so that the proposed curriculum could be adopted by the HEC approved Public and Private Universities. In these universities, core RS & GIS Courses will be identical. However, the Electives component may vary depending on the level of expertise available in individual academic institutions.

1.2 It is recommended that the focus of these Elective courses will be multidisciplinary applications of RS & GIS for the management of Natural and Environmental Resources.

1.3 It was agreed to launch 4 years RS & GIS BS degree program in early 2006. Whereas MS program may be launched successfully after having graduates of 4 years BS in RS & GIS and other relevant degree programs. However, other institutions that are interested in commencing MS program are advised to follow the instructions (see appendix 1) as agreed upon by this committee.

1.4 It was agreed to set up a national level autonomous **Pakistan Council of Remote Sensing and Geographic Information System (PCRGIS)** similar to the Pakistan Engineering Council, Pakistan Council of Architects and Town Planners etc. This council will be responsible for the following:

1. Approve all RS&GIS Courses for all HEC approved public and privately owned academic institutions.
2. Maintain and upgrade the quality and accreditations of RS&GIS courses.
3. To design guidelines for issuing membership to the RS & GIS graduates and professionals.
4. Maintain a data repository of all RS&GIS data for its dissemination to all stakeholders at a minimal cost.
5. Facilitate the exchange of lab manuals, exercises, teaching and other course materials that can be utilized by various academic institutions under strict acknowledgment and copyright guidelines.

6 Facilitate across institutional and postgraduate level supervisory arrangements under strict guidelines.

7 Facilitate in disseminating the research work, consultancy and projects originating at national and international platforms.

8 Build on web based facilitation application so as to provide a vehicle to foster collaboration and share information.

9 Will seek opportunities to secure funds at national and international levels to be used for the dissemination of RS and GIS technologies in Pakistan. This could be either in the form of conducting intensive training courses or setting up capacity building infrastructures at remote and less developed areas.

10 The committee also recommended that the individual member of the RSGIS Council should be initially selected from the current panel responsible for the development of RS & GIS curriculum for the BS and MS Program. The main task of this Council will be to ensure the implementation of the recommendations made in this report. It is also recommended that the executive members of this council should include renowned educationist / professionals from private and public sector universities. These executives will be required to develop their own website highlighting their educational qualifications and teaching/research experiences in the field of remote sensing and GIS. The membership of such an advisory body shall take place in a biannual Annual General Meeting to review the performance and contribution of the executive committee members. The selection will be purely based on experience and knowledge of the concerned professionals.

11 The PCRGIS agreed that this platform should formulate an interim sub-committee with a mandate to:

1 Craft constitution and detailed guidelines for its executive committee membership and election procedures.

2 Determine criteria for full and associate membership

3 Provide guidelines and time frame for the formal incorporation of PCRGIS

4 Make recommendations in the HEC sponsored workshop of RS and GIS. This is to solely to propagate the setup and the underlying objectives and the functioning of the PCRGIS at federal and regional levels.

5 The sub-committee shall comprise of all coordinators of 4 working groups as well as convener and secretary. The members selected for this committee are Professor Dr Waqar Ahmad, Dr Jamil Kazmi, Professor Dr Amir Khan, Professor Dr Imdad Ali Ismaili, Mr Muhammad Nawaz and Mr Mubashar Hussain.

4.2 Hardware and Software

1. It was recognized that Personal Computers (Pentium 4, with one GB RAM and at least 60 t0 80GB hard disk with CD/DVD R/RW drive) with dual monitors, should be the platform for practical training of RS&GIS courses. In addition to this, Scanners, Digitizers, Plotters, colored printers, GPS, Surveying Equipments, Server Networking Equipment etc should also be acquired for facilitating technology oriented RS & GIS teaching and research. It was agreed to adopt uniform Remote Sensing, Digital Image Processing and GIS software for teaching undergraduate RS&GIS curriculum. For this purpose ERDAS IMAGINE, Arc View and Arc GIS should be adopted for teaching at national level. However, it was unanimously agreed to introduce new and more diversified RS&GIS software for the MS and PhD students for their project and research work.

2. It was agreed that Public universities and RS&GIS oriented research institutes approach HEC for acquiring legal copies of RS & GIS software to be utilized by the undergraduate and postgraduate students. Also HEC should approach Foreign Funded Agencies like UNDP, EUFP, ADB etc. for the acquisition of critical RS&GIS software.

4.3 Trained Staff

1. This is an area that needs planning and actions on war footings. Unfortunately, there is a chronic shortage of trained manpower in this discipline. Currently, in India there are more than 1800 postgraduate level departments that are teaching RS and GIS to their students. Indian Government has a plan in place to introduce RS & GIS at college and high school levels. As we are awaking up to adopt these space age technologies, it is imperative that we realistically focus on the development of trained academic staff that could assist in the teaching

and development of RS&GIS technology adoption plans on scientific grounds.

2. It was agreed upon that HEC should set up National and Provincial level Institute of Remote Sensing and Geographic Information System Centers of excellence. In such national and regional level centers, HEC and Ministry of Science and Technology should fund (stage 1) training of Public universities academic staff. Leading national and international professors should be asked to run intensive teaching courses on core RS & GIS related courses. These courses should be designed to equip and upgrade potential academic staff who will be responsible for teaching RS and GIS courses at their respective institutions. This will act as a source of initial nursery for the large-scale dissemination and adoption of RS&GIS technologies in Pakistan.

3. In stage II, academically bright, young and promising candidates from stage I should be selected for Masters Degree program in the foreign universities.

4. In stage III, successful Masters Degree holders from the foreign universities will be asked to teach RS&GIS courses in their respective institutions. After completing three years of their return, they will be sent back to complete their PhD programs in foreign institutions.

5. It was also recommended to explore the possibility of recruiting (Foreign Professors Hiring Scheme) for teaching core RS&GIS courses in the Pakistani academic institutions. This will serve two purposes; firstly, it will ensure quality teaching to our students and academic staff, secondly, this will create linkages between Pakistani students, academic staff and foreign teaching/research staff that can later on be utilized to our national advantage.

4.4. Research

1. It was recommended that under the umbrella of Pakistan Council of Remote Sensing and Geographic Information System (PCRGIS), collaborative research projects be initiated between local and regional universities. This will provide a springboard to develop multi-disciplinary applications of remote sensing and GIS by focusing and utilizing individual staff member expertise spread across different institutions.

2. It was recommended that utilizing HEC appointed foreign professors, research linkage programs be developed between their parent institution/s so that the research skills and foreign lab infrastructures

could be utilized for Pakistani Natural Resource Management related problems.

3. It was also recommended to initiate a Split PhD Program where part of the PhD program could be spent in foreign universities associated with HEC appointed foreign professors.

4. It is recommended that national level RS & GIS institute should play a key role in organizing national and regional conferences on the applications of RS and GIS. This will not only induce RS&GIS research culture but will also bring in Pakistan on the regional screen to offer RS&GIS training and consultancy services.

Appendix 1:

This section provides detailed weekly theory and practical schedules for all core courses. This information is provided with the intention to maintain the required topics sequence and the corresponding recommended weights in theory as well in practical components. It is assumed that adopting the proposed sequence will assist in maintaining cross institutional standards and in determining recognition of prior learning and student transfers from one institution to another.

Stream 1: Remote Sensing (RS)

1: Introduction to Remote Sensing

Remote Sensing has become a standard technique for disciplines involved in the monitoring and management of earth resources. This unit introduces students to find out how pictures of the earth's surface are recorded from aircraft and satellites and different ways these images can be analyzed. Students gain an understanding of "common" remote sensing products such as earth resources satellite images, aerial photographs as well as more sophisticated research tools such as RADAR and multispectral scanner systems. In this course via field trips opportunity is provided to assess the usefulness of different types and scales of remotely sensed data via on the ground comparisons. Basic map reading skills required for Remote Sensing projects are also covered.

This subject provides basic training in:

- Physical basis of remote sensing
- Major data collection (sensor) systems
- Visual Interpretation of satellite images
- Applications of Remote Sensing

Theory	Week	Practical
Overview of the Course	01	
Definition and History	01	Introduction to labs
Physical Basis (EM Spectrum, Energy Interaction, Spectral Reflectance Curves, Image Characteristics)	02	Single band image interpretation False color predictions, False color composite Images Interpretation
Introduction to Aerial Photograph	01	Visual Interpretation
Sensor Systems (Space and airborne, MSS, TM, ETM, HRV, LISS, IKONOS-2, Quick bird-2, AVHRR and others)	02	
Platforms (Types and Orbital Characteristics)	1	Data comparison
Thermal Infrared (Characteristics, TIR Band Properties, TIR Image Interpretation	01	TIR Image interpretation
Intro to Microwave (Importance and applications)	01	Display and comparison of optical and RADAR images
Digital Image Processing (Over view of computer based image processing)	02	Intro to ERDAS Imagine Display, Geo-linking, Zooming, Identification of targets
Applications (agriculture, urban, natural resources etc.)	02	FIELD TRIP
Review	01	

2: Introduction to Cartography

Cartography is the art and science of map making. Map is one of the conventional sources of spatial data. From maps, information on distances, directions and area sizes can be retrieved, patterns revealed and relations understood. Subject provides the basic knowledge of portraying spatial features from reality by using cartographic techniques. Subject incorporates the fundamentals of coordinate and projection system and map classification techniques.

This subject provides basic training in:

- Map reading map making
- Coordinate and projection systems
- Map symbolization and generalization
- Map production

Theory	Weeks	Practical
Introduction to Cartography Nature of Cartography, Map Types A Short History of Cartography	1	Map reading Assignment on Types of Maps
Map Symbols, Lettering, Scale and direction	1	Understanding of SOP symbology and Development of Symbol Charts
Coordinate Systems	1	Assignment
Map Projections Graphical and datum	1	Development of Graphical Map Projections
Map Projections Mathematical Perspective, non-perspective, conventional	4	Development of at least two map projections each from conical, cylindrical, and plane projection
Generalization	1	Large to small scale map conversion
Thematic Maps Descriptive Statistics, Class Intervals, Choropleth Maps, Proportional Symbol Maps Dot Maps, Isarithmic Maps, Cartograms Flow Maps, Graduate Colour Maps	2	Data classification and Thematic Mapping
Map Compilation, Map Design	1	Map composite development
Cartography and Ethics	1	Assignment on misleading cartography
Map Production	1	Visit to SOP
Project	2	Seminar
	16	

3: Introduction to Photogrammetry

Theory	Weeks	Practical
Introduction, history and Overview	1	Introduction
Analog, analytical, and digital photogrammetry	1	Comparison of formats
Photogrammetric cameras	1	Sensor, films and filters
Photogrammetric flight planning parameters	1	Project

Review of data acquisition and single photograph properties	1	Data acquisition methods
Spatial measurement and scale calculation	1	Area and scale measurement
Problems with aerial photograph and rectification of a single aerial photograph	2	Parallax and redisplacement
Aerial Photograph Interpretation	2	Visual interpretation
Types of Aerial Photograph and mosaics	2	Vertical airphoto
Stereoscopic Analysis DEM generation	2	Mirror stereoscopic interpretation
Orthophotography/Orthoimage	1	Ortho-rectification
Applications	1	Case studies
	16	

4: Digital Image Processing

This unit builds on the introductory remote sensing unit and provides practical application of digital image processing of remotely sensed data for analysis of earth resources. This unit focuses on various aspects of digital image processing of remotely sensed data sets originating from a number of satellites. Various aspects of digital image processing to extract useful information such as land cover maps from the remotely sensed digital data are focused in this subject via working on a real life project.

This subject provides basic training in:

- Remotely sensed data formats
- Digital image pre-processing techniques
- Digital image data management & transformations
- Digital image classification techniques
- Accuracy assessment techniques
- Hands on experience by working on a real life project

Weeks	Theory	Practical
01	Course overview	Intro to lab and software
01	Data Sources and Procurement	Image Management (Import/Export & Display)
	Data Formats (BSQ, BIL, BIP, etc.)	
05	**Image Pre-processing**	Enhancement Techniques Spectral and spatial digitizing (image masking) Mosaicing and color
	Image Subsetting & Enhancement	
	Image Cleaning	
	Atmospheric Path Correction	

	Image Mosiacing and Color Balancing Image Rectification, Registration and Re-sampling	balancing Rectification and Registration and Re-sampling
03	**Image Transformations** Band Ratios, Vegetation Indices, Image Filtering, Difference Images, PCA	• Band Ratio • Vegetation Indices • Difference images • Image filters
03	**Image Classification** Classification Schemes, Types, Algorithms, Field data collection (training areas)	• Signature selection • Supervised, unsupervised and hybrid classification • ISODATA, MDM, MLC, and Baysian classification
02	**Accuracy Assessment** Qualitative and quantitative techniques, sampling techniques, Error matrices, Ground-Verification (Field Verification)	• Error Matrix Generation • Classification validation
01	Review	
	PROJECT COMPONENT	
	From third week students will be advised to commence their project work in a teamwork environment. Project work will be based on real life data sets obtained from resource monitoring agencies such as Department of Agriculture, Forestry, SUPARCO, SOP, Local Government and Rural Development etc.	

5: Microwave and Hyperspectral Remote Sensing

This unit introduces students about the new and advanced developments that are taking place especially in microwave and hyper spectral remote sensing. This unit focuses on the basic concepts, data acquisition, working mechanism, unique characteristics, data interpretation and applications of radar and hyper spectral data sets.

This subject provides basic training in:

- Spectral and spatial characteristics of microwave and hyper spectral data sets.
- Data compression and construction techniques
- Radar and hyper spectral image processing techniques
- Active and passive remotely sensed devices data fusion techniques
- Applications of Radar and hyper spectral data sets.

Weeks	Theory	Practical
01	Overview	
01	Types, History, Advantages and Disadvantages of Active Remote Sensing	Introduction to Microwave Image Processing Module
01	Sensor and Platform Types (RADAR, SAR, AIRSAR, SLAR etc.)	Microwave Image Comparisons
01	Working Mechanism, Spectral Characteristics of Microwave Images	Visual Interpretation
01	Key Concepts, RADAR Image Geometry and interferometry	3D Analysis of radar data
01	Data Compression and Reconstruction	Image pre-processing • Total Power Image • Like and Unlike Polarization • Ground Resolution • Rectification and Registration
02	RADAR Image Preprocessing and Classification	
01	Field Verification	
02	Fusion Techniques	Optical and RADAR data fusion case studies
02	Microwave applications	General Case Studies
01	Hyperspectral Remote Sensing Channels and Spectral Libraries Sensors (AIS, AIVIS etc.)	Student Projects: Application Areas such as mining, environmental monitoring, vegetation changes, cropping pattern, salinity/sodicity and water logging etc.
01	Application of Hyperspectral Data	
01	Review	

Stream 2: Geographic Information Systems

1: Introduction to GIS

The course aims at providing an understanding of GIS, its evolution, applications, spatial data models and data structures, design aspects of GIS; spatial data acquisition, sources and standards; spatial data manipulation, spatial analysis and visualization of data. This course also covers the understanding of GIS software environment. This subject provides basic training in understanding GIS data capture, storage, retrieval, analysis and display. It also helps to learn functionality of GIS software and to gain basic skills.

Theory	Weeks	Practical
Introduction and Overview of GIS: Introduction Definitions Components Functional Subsystem	1	**Introduction to GIS Lab (hardware / software)**
Evolution and Application of GIS	1	**Introduction to GIS software**
Data Models Raster Data Model Vector Data Model Attribute Data Model	1	**Raster/Vector/Attribute Data Display**
Data Acquisition Techniques Data sources Data capturing techniques and procedures	2	**Scanning, Digitization, Coordinate based point mapping**
Data Transformation	1	**Raster / Vector Conversion**
Visualization of spatial data Layers and Projections	1	**Data layer integration and display of different projections**
Map Design: Symbols to Portray Points , Lines and Volumes , Graphic Variables , Visual Hierarchy	1	**Map layout**
Data Classification Graphic Approach , Mathematical Approach	1	**Data Classification and Thematic Mapping**
Spatial Relationships (Topology)	1	**Handling with Topological Errors**
Spatial Analysis:	3	**Overlay Analysis**

Overlay Analysis ,Spatial analysis, Neighborhood functions, Network and overlay analysis, buffering		
Spatial data Quality: Components of Data Quality , Micro Level Components , Macro Level Components , Usage Components Sources Of Error , Accuracy	1	**Network Analysis**
Project	2	Seminar
	16	

2: Spatial Data Visualization

Spatial data visualization deals with the data classification and interactive displays. The overall objective of this subject is to teach the students how to make suitable cartographic visualizations of the spatial data they are working with, both on screen displays and on paper. The course will cover principles of scientific visualization, graphic design and cartographic symbolization, thematic mapping of statistical data over space and time.
It provides the basic training in construction of thematic layers to visualize spatial & attribute data. It also deals with web mapping, animations and simulations.

Theory	Week	Practical
Quantitative Revolution and Digital Cartography	1	Assignment
Introduction to Visualization, Visualization Process, Visualization Strategies.	1	Exploration of visualization tools in digital environment
Statistical and Visual Foundation	2	Thematic Mapping
Principles of Symbolization	1	Designing of point, line and polygon symbols
Principles of Color, Tri-Simulate(chromatic Model, Intensity, Hue and Saturation	1	Exercise: Color formation and Conversion (RGB, CMYK, IHS)
Map Design Process	1	Assignment: Cartographic Design and Reproduction (Example: Topographic Mapping)
Mapping Techniques	2	Mono, Bivariate and multivariate thematic Mapping
Cognitive, Social and Ethical Issues in Cartography and spatial data visualization	1	Assignment: War and Propaganda Maps

Internet Mapping	2	Map Server Application
3D Modeling Map Animation Virtual Reality	2	Perspective Viewing, Multi-layer Draping and Fly Through
Electronic Atlases and Multimedia	1	Assignment
Final Presentations	1	Seminar

3: Spatial Data Modelling

This subject provides an introduction to GIS data models and data structures. The subject continues with a systematic overview of spatial data models (e.g. raster and vector) and the structures used to implement these, together with methods of spatial feature addressing. Subject mainly deals with the geometry of objects, topology, object hierarchies and aggregations. It also includes the modeling of fuzzy objects and incorporates the uncertainty aspects of spatial data.

Introduction Fields Objects Geometry	**1**	Preparation of Symbolic Charts for representation of Earth Features
The Geometry of spatial objects Objects represented in raster Vector Structure, Vector data representing the geometry of geographical objects	**2**	Assignment on Geometry of spatial objects
Topology Networks and graphs Properties of Graphs Graphs and Areas Error checking procedures	**2**	Utility Network Analysis
Object hierarchies Terrain object classed and generalization hiearchies Aggregation Hierarchies Object Association	**2**	Spatial data generalization and aggregation
Fuzzy Objects Fuzzy set theory, fuzzy boundaries Uncertainties of Spatial Objects		

4: Spatial Analysis

To develop spatial analysis skills, this course reveals how basic understanding to spatial analysis concepts are implemented within geographic information systems. Techniques are not limited but will include the application of GIS analysis to the environment, urban planning and natural resource management issues. Beginning with an overview of the main functional components of GIS, the course moves into hands on experiences with data input, data management and spatial analysis components.

This subject provides basic training in:

- Point pattern analysis
- Line pattern and network analysis
- Area objects and autocorrelation
- Geo-computation

Theory	Weeks	Practical
Spatial Analysis Introduction to spatial data type, Potentials of spatial data, Spatial Analysis	1	Assignment on Spatial Analysis for various applications
Point pattern analysis Introduction, Describe point pattern Assessing point pattern statistically Practical point pattern analysis	1	Geocoding and Point analysis exercise
Lines and networks Introduction Representing and storing linear enteritis Network analysis	1	Network analysis exercise
Area objects and spatial autocorrelation Introduction, Types of area objects Geometric properties of areas, Boundary Analysis, Buffering and neighborhood function, Proximity Analysis, Neighborhood Function/Analysis	2	Areal analysis exercise
Describing and analyzing fields Introduction, Modeling and storing field data, Spatial interpolation, Type, Methods / algorithms, Application,	1	Buffer analysis exercise

Derived measures on surfaces		
Map overlay Introduction, Vector Overlay Operations Raster Overlay Operations, Problems in simple Boolean polygon overlay	1	Buffer analysis exercise
Multivariate data, multidimensional space Introduction, Multivariate data and multidimensional space Distance, difference and similarity, Cluster analysis, Reducing the number of variables: PCA	1	Multivariate analysis
New approaches to spatial analysis Introduction, Geo-computation	1	Assignment on advanced spatial analysis
Geo-computation Interpolation techniques, surface modeling, DTM/DEM	1	Interpolation of elevation data and surface modeling
Multi-criteria and Multi-attribute Modeling	2	Suitability analysis
Multi-objective Modeling	2	Risk Modeling
Uncertainties in spatial modeling	2	Assignment on uncertainties in spatial modeling
	16	

5: Spatial Data Infrastructure

Information is an asset that can be shared and traded. It has value; can be bought and sold; value can be added in various processing steps. This means that information becomes a commodity and, like all other commodities, needs to be transported and distributed. For this to be carried out effectively there is the need to setup an infrastructure. Geographical information utility (GIU) is an infrastructure set up for the efficient integration and distribution of geographic data/information to enhance its availability, accessibility and use. Despite the technological change, the free flow and use of the information is still in its infancy. Therefore the main objective of this course is to understand the structure and processes and its standards which are involved in data sharing. Subject includes the applications and architecture of Spatial Data Infrastructure

Introduction Need for SDI, Components of SDI	1	Comparison of working SDIs
Clearinghouse Clearing house architecture National Geospatial Clearinghouse Metadata concepts and functionality Structure of Metadata	3	Development of Metadata according to Standards
System Architecture System Architecture for SDI Interoperability, Client Server Architecture	3	Development of Architecture of SDI
Spatial Data Quality Data Quality Information (DQI) Accuracy, Precision, Bias Error Modeling	2	Standardization of Data
Data Modeling for SDI and Standards Data Modeling Abstraction of Real World Types of abstraction Problems of information sharing (Heterogeneities) Distributed database concept	3	Data transformations and translations
GIS Internet Services and SDI Technologies System Architecture Available Services Technologies that support internet GIS services Commercial tools for **Internet GIS** **+ legal aspects+ limitations**	3	Web Publishing & development

6: Global Positioning Systems

Now-a-days, geo-scientists are confronted with problems in geo-referencing satellite imagery or Arial photos. To this end, often an existing map of the area is used, in the absence of any maps, they would need to apply a fast but accurate method for geo-referencing, which will confront them with satellite positioning technology (GPS).
This course will start with the fundamental aspects of GPS, and then it will lead towards various GPS measurements, their corresponding accuracies, following in depth

+Int & Overview his U. S. Department of Defense Satellite Navigation System, Space Segment, Control Segment, User Segment	2	Value Reading
GPS Positioning Services Specified In The Federal Radionavigation Plan, Precise Positioning Service, Standard Positioning Service	3	Eating Northing & elevation Map Projections and Datum Settings
GPS Data Position and Time from GPS Code Phase Tracking (Navigation) Pseudo-Range Navigation Receiver Position, Velocity, and Time, Carrier Phase Tracking (Surveying)GPS Satellite Signals	3	GPS Surveys
GPS Error Sources Geometric Dilution of Precision	2	GPS Tracking, Data Processing
Differential GPS Techniques Differential Code-Phase Navigation, Differential Carrier-Phase Surveying, Common-Mode Time Transfer.	3	Planimetric & vertical errors calculations
GPS Techniques and Project Costs exploration of advance system as differential GPS. +App + integeration	33	GPS Project

7: Land Information System

To give students a broad understanding of land tenure and the cadastre concept, how it has evolved historically and its role in documenting land rights. The course covers cadastral systems in the world as a means of understanding fundamental principles and design criteria underlying these systems. The final part of the course deals with the design of cadastre-based LIS.

Theory	Weeks	Practical
Land information Introduction to Land characteristics, Land information system, Cadastre, Land information management	1	Studying and understanding the existing LIS examples
Location of land Registration and Cadastre in LIS Definition, LIS Taxonomy, classification of land information	1	Development of work flow diagrams for the procedures
Relation Land Registration and Cadastre Land Registration, Public and private part Definition of Cadastre, comparison of land registration and cadastre	1	Comparison of existing land information systems
General Role of land registration and cadastre Benefits of land registration for individuals and role of land registration for Government	1	Cadastral mapping through existing analogue maps/satellite imageries
Land Tenure Systems Concept and definition, Forms of land tenure operational forms of land tenure English concept and rights, Anglo-American Concept and rights, Continental west European Concept and rights Customary land tenure Islamic land tenure	2	Cadastral map editing, and updating
Land Registration process Concept of Registration, Private conveyancing, Public registration Principles of \registration, Deeds Registration, Title Registration	2	Development of database for land registration

Features of Land Registration system Positive and Negative Systems		
Boundaries Fixed boundaries, General boundaries Adjudication process, Boundary monument, boundary surveys, Parcel reference system	1	Process verification and development of Registries, Titles
Fiscal cadastre Origin, land property and taxation, Property Valuation, Valuation Methods Creation of fiscal cadastre	1	Integration of Revenue mapping and statistical analysis
Multipurpose Cadastre Concept, Components of multipurpose cadastre, Information in a multipurpose cadastre, Items that can be linked to the multipurpose cadastre, Quality of information	2	Integration of cadastral system with other utility information system
Institutional arrangement and technical matters land policy, land administrative activities land information management, organization and management intergovernmental coordination centralization and decentralization role of public and private sectors Administration of cadastral l data Control surveys Electronic data processing for land administration management, financial matters	2	LIS Project Development
Procedures for introducing a land administration system users need determination, adjudication & surveying, land information	2	LIS Project Development
	16	

Stream 3: Geography

1. Physical Geography

Theory	Weeks	Practical
Scope and Status of Physical Geography, Basic Concept and Theories Continental Drift, Plate Tectonics and Peneplain Concept	01	Drawing of World map showing the origin of continents and oceans Distribution of different plates Diagrams of peneplain
Factors of Landform Development and types; Rocks and Minerals, Weathering and Mass Wasting:	01	Demonstration of models relevant to the topics and diagrams to show the features, Identification of rocks and minerals
Fluvial Morphology; Desert Landforms; Glaciers and their Topographic Effects	03	Demonstration of models relevant to the topics and drawing of diagrams to represent the features
Karst Topography	01	Drawing of diagrams and models
Soil classification and Development:	01	Drawing of soil profile
Factors and Elements of Weather and Climate.	01	Study of weather maps
Composition and Structure of Atmosphere	01	Demonstration of model
Horizontal and Vertical Distribution of Temperature	01	Data display and drawing of isotherms
Distribution of Pressure and Seasonal Variations Wind Circulation: Humidity and Forms of Condensation	02	Wind arrow, wind-rose diagram, reading of dry and wet bulb and calculation of relative humidity, identification of clouds and drawing of isohyets
Classification of Climate	01	Demonstration on maps
Origin of Oceans and Seas. Floor of Oceans Physical Characteristic of the Ocean Basins.	01	Drawing of diagrams and models representing the relevant features
Temperature, Salinity Distribution, Cause and Effects.	01	Maps showing temperature and salinity variations

Ocean Circulation: Waves, Currents and Tides, El-Nino, La-Nina, their Nature, Causes; Effects and Impact on Man and Environment	01	Distribution maps of ocean currents differentiating cold and warm currents

2: Human Geography

Theory	Weeks	Practical
Scope and Status of Human Geography	01	Diagrammatic representation of different branches of Human Geography
Basic Concepts and Theories including Environmental Determinism, Possibilism, Probabilism and Cognitive Behaviourism	01	Demonstration of videos and slide show
Population: Population Distribution, Density and Growth; Population Change including Migration. Population Composition and Structure.	02	Exercises on calculation and application of formulas for growth, projection, doubling time etc. Drawing of population pyramids and distribution maps
Culture and Society, Components of Culture, Cultural Systems, Hearth, Diffusion and Cultural Ecology	01	Identification of world cultural regions. Video/slide show on the relevant themes
Human Activities: Primary, Secondary and Tertiary (Agriculture, Mining, Forestry Animal Husbandry, Poultry, Light and Heavy Industries, Transport; Trade and Tourism) and their impacts on Environment,	02	Slide and video show and field visits to the relevant areas
Natural Resources, Distribution and Utilization: Renewable and Non-renewable Resources e.g., Air, Land, Water, Fauna and Flora Fossil Fuel Metallic and Non metallic Minerals.	02	World maps showing the distribution of related features and concerned topics
Energy: Generation and Consumption.	01	Identifying different sources and discussions
Human Settlements: Evolution and Housing types, Urban and Rural	01	Showing and checking of cultural landscape on

Contrast.		topographical sheets
Land Use/land Cover Pattern: Commercial, Industrial, agricultural and Residential, Open and Green Spaces, Transportation.	01	Demonstration and drawing of land use maps, field visit to recognize different land use patterns
Theories of Urban Structure e.g., Concentric Zone Theory, Multiple Nuclei Theory, Sector Theory,	02	Drawing of different models and their application
Rural Settlements, Dispersed, Nucleated and Ribbon Settlements.	01	To recognize different patterns on large/small-scale maps
City-Size, Distribution, Rank-Size Rule, Primate/ Binary Distribution	01	Reading of different census data and tabulation, drawing of log-graph to show different patterns

3: Fundamentals of Geology

Theory	**Weeks**	**Practical**
Over view of the Earth, Geological Framework of the Earth, Structure & Composition	02	Demonstration of Models and drawing of diagrams
Deformation, Mountain Building Process including folding and faulting	01	Demonstration of models relevant to the topics and diagrams to show the features,
Rock cycle, the Process of Volcanism	02	Identification of rocks and minerals
Geological Time Scale	03	Drawing of Geological Time Scale models
Evolution of life on the Planet and Formation of Fossils	02	Video display of the earth Evolution, identification and study of Fossils
Geological Hazards: Earthquakes, Tsunamis, Floods, Landslides, Mass Movements	02	Video/slide show of the relevant hazards and documentation of the damages
Economic Geology	02	Identification of rocks as Raw Materials for different industries
Exploitation and Exploration of Minerals including Metallic and Non-metallic Minerals and Fossil-fuels	02	Field visit to different Mining areas

Appendix 2

Research Project and Thesis Guide

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1. Preamble

The guidelines and checklists in this handbook have been prepared in a generic way for use by MSc and PhD coursework and research students undertaking research projects and thesis that may range significantly in depth and complexity. It is left to the common sense of the user, within the context of individual projects, to expand, contract, or otherwise tailor these guidelines to suit their particular requirements. Please check with your lecturer or supervisor if there is any doubt in your mind as to the approach that you should take.

It is a synopsis of a wide range of literature and experience and is presented in this abbreviated format to assist students to get on with the primary task and hand in a manner that will provide them with a good learning experience and a successful outcome to their research projects. ***Students are strongly urged to pay more than lip service to the advice in this handbook.***

2. 0 Navigation

The research project and thesis guide lines has been divided into five logical sections. These are supplemented by a preface and an 'Other' section which deals with miscellaneous issues which you may need to think about depending on the nature of your thesis research project.

1. Project management
2. Project Proposal
3. Literature Review
4. Project Presentation
5. Project Report

2.1 Project Management

2.1.1 Significance:

The purpose of managing a project is to ensure that a defined goal or objective is successfully achieved on time within the constraints of available resources. In practice this means planning the project carefully by identifying the tasks and resources required to achieve the goal and putting in place processes to manage those activities and resources over the life of the project. It is also vitally important that progress and final outcomes of the project are communicated on time and effectively.

2.1.2 Process:

1. Define the goal or objective
   · Define the overall goal
   · Identify activities required to meet the goal
   · Identify outputs required to meet the goal
2. Plan tasks and resources
   · Identify tasks involved in activities
   · Identify resources required to complete tasks
   · Identify people/organisations to be involved
   · Identify time required to acquire resources and complete tasks
3. Organise tasks and resources
   · Create a schedule of tasks
   · Identify relationships between tasks (usually some tasks are prerequisite to others)
   · Identify milestones (reference points marking major events used to monitor progress)
4. Manage tasks and resources
   · Track progress against project schedule regularly
   · Amend schedule (tasks/milestones/goals) to reflect reality
   · Communicate progress as required

2.1.3 References:

There are numerous books and articles on project management. You might like to have a look at one or two but be careful not to get hung up on the topic of project management at the expense of the project you are supposed to be doing! Project management should generally be avoided unless you are undertaking a really major long-term project or you are already familiar with the software you intend to use.

The Busy Person's Project Management Book by R & C Thomasett can be found online.

2.1.4 Useful Tips:

2.1.4.1 Assessment: Planning and management is an integral part of any project and may be taken into account in student assessment. It may be appropriate to include an appendix to your project report detailing project planning and management – check with the person assessing your project.

2.1.4.2 Brainstorming: Sometimes it can be hard to get started on a project plan in a methodical way. Write down all the things you can think of relating to any aspect the project as they come into your head. Looking at these points will help you identify a pattern.

2.1.4.3 Divide and conquer: Complex objects can usually be viewed as a collection of numerous simpler objects. Decompose each activity into tasks and sub-tasks until they are easily planned and managed (see iterative approach).

2.1.4.4 Document as you go: Write up what you are doing at the time you do it preferably in a word processor – note form is better than nothing. This will make your life a lot easier when the time comes to communicate what you have been doing.

2.1.4.5 Flexible approach: Gold stars for bashing your head against brick walls are in short supply. Better to demonstrate an intelligent approach to finding a way around a problem. Seek help early if you think you are lost.

2.1.4.6 Flow charts: Flow charts are a great way to clarify what you are doing in your own mind as well as communicate this information to others (also good for brainstorming, divide and conquer, documenting, etc.).

2.1.4.7 Iterative approach: It may be hard to identify all the tasks or components in a project in a single step. An iterative procedure (sometimes

called stepwise refinement) may be called for and can be built into your plan.

2.1.4.8 Knowledge and understanding: You are a student not a consultant. Concentrate on the process rather than the outcome. Blind alleys and mistakes are a legitimate part of the learning process (see document as you go and prototyping).

2.1.4.9 Log: Keep a log of your progress on the project including computer filenames, backups, sources of data, derived data, etc. You should be prepared for a disaster in the computer laboratories. Remember a golden rule. You can never trust technology. Always prepare a back up copy of all of your files.

2.1.4.10 Prototyping: Student projects are usually severely constrained by time. It is often appropriate to work on a restricted data set and demonstrate proof of concept rather than attempting the full.

2.1.4.11 Sanity checking: Talk to fellow students/tutors/lecturers about what you are doing and ask them what they think and what they are doing. This will reduce the risk of falling in a hole.

2.1.4.12 Task development: List the tasks, establish interrelationships between tasks, identify milestones, layout tasks and milestones, review logic of the network, confirm reasonableness of items on the critical path.

2.1.4.13 Variation is OK: Everyone knows that life is not perfect so moving the goal posts is acceptable within reason (see sanity checking, knowledge and understanding, flexible approach, etc.). Refining your project plan as you go along is expected not frowned upon.

2.2 Project proposal

2.2.1 Significance:

The initial proposal is an important contributing factor to the ultimate success of a project and constitutes the basis for a significant part of the assessment. This is the foundation on which you will build your project – make sure it is solid. Foundations on shaky grounds can never produce positive results.

2.2.2 Contents:

A typical project proposal would have the following content. Revise this list to suit your specific project.

2.2.3 Student details: This should include:

- Student name
- Student number
- Supervisor/lecturer
- Course enrolled in
- Semester/Year
- Project type

2.2.4 Project proposal: This should include

- Title of project
- Aims
- Significance
- Resources
- Methods
- References
- Constraints & exclusions
- Benefits

2.2.5 Project Management: This should include:

- Project plan
- Schedule of tasks and milestones

2.2.6 Style: Use an accepted style and be consistent. Choosing a style which you can consistently use for your interim and final reports will save you time.

2.2.7 Assessment:

Assessment of project proposals will obviously vary substantially depending on the level of study and the given time & resource constraints. The following general considerations serve as a guide to what assessors will be looking for:

- Content (see above)
- Style (see above)
- Are the project aims well defined?
- Is the project logically structured and coherent?
- Have all the necessary resources been identified?
- Has a project plan including a schedule been prepared?
- Is the project feasible in view of constraints?

2.2.8 Useful tips:

2.2.8.1 Benefits: It is important to keep in mind what you want to gain from doing the project and make sure that your goals will be met.

2.2.8.2 Constraints: Do the constraints of the project clearly outline the budget, recognise possible difficulty with the schedule, recognise knowledge, skill, equipment and facility constraints?

2.2.8.3 Content: Use the Project Report content guide as a template for your proposal to make sure you have covered all the issues you need to deliver on.

2.2.8.4 Feasibility: Student projects (and others) are invariably limited by time and resource constraints. Identify the constraints on your project early in the piece and plan accordingly. It may be appropriate to restrict your area of interest and/or plan for a prototype or concept demonstrator as an outcome.

2.2.8.5 Goals: Are the goals of the project specific, realistic, measurable, and agreed upon by supervisor and/or coordinator.

2.2.8.6 Information technology*:* Make sure you use information technology to the fullest. Your project proposal should form the basis for one or more interim reports that in turn form the basis for the final report. With a little effort it should be possible to simply keep expanding your initial document as you go.

3.0 Literature Review

3.1 Significance:

Literature reviews are a core element of most scientific research reports and theses and in some cases may constitute the entire report. It is important to know where your project fits in order to assess it's significance and avoid re-inventing the wheel. You should generally be attempting to piggy-back on work already done if you want to be at the cutting-edge.

3.2 Process checklist

The review process is usually iterative with the number of iterations dependent on the complexity and depth of the topic under review. The following checklist provides a typical example of the process:

3.3 Preparation

- Define topic of interest
- Identify key words
- Identify target databases
- Establish resource and time constraints

3.4 Initial search and acquisition

- Do initial search
- Select articles for acquisition
- Acquire selected articles
- Read and summarise

3.5 Refine search criteria

- Pursue acquired information (references, authors, journals)
- Identify further articles of interest from references
- Refine search criteria (key words, date ranges, etc.)
- Identify any additional databases to search

3.6 Subsequent search and acquisition

- Additional search
- Select and acquire further articles
- Continue iterative process as required

3.7 Write review

Compile list of references reviewed (see below)

3.8 Writing the review:

A typical literature review would have the following content (these headings might be paragraphs, sections, or chapters depending on the extent of your review). Revise this list to suit your specific needs.

3.9 Outline

- The topic of interest and its significance
- Constraints in preparation of the review and their potential impact on the quality/outcome of the review
- The logical structure of the review

3.10 Detail

- The main authors and their view on the topic of interest
- The arguments developed for/against those views
- Analytical/critical comments/observations made by others

3.11 Discussion

- Analytical/critical comment of your own
- Identify holes or imbalances in the literature
- Recognised shortcomings/limitations in your review

3.12 Summary

- Summary of significant authors/views and identified shortcomings in the literature
- Significance of results of your review in context for which you are preparing it
  check you have covered the points mentioned under assessment (below)

3.1 Style:

Use an accepted style and be consistent. If the review is part of a larger document make sure the style is consistent with the document as a whole.

3.14 Reference section of review

References are usually contained in a separate section of the document. Cross-check review and list of references to ensure that all references in the review are included in the list and that all references on the list are cited in the review. Note that the word bibliography usually implies a complete/exhaustive list of references on a particular topic.

3.15 Source and acquisition of literature

Initial sources of literature include course materials (readings), the Internet and university staff, You should research these first to give you a chance to refine your ideas and search criteria before tackling the online databases available through the library.

Acquiring the content of articles identified may be free (borrowing from the library, downloading from the Internet), relatively inexpensive (photocopying journal articles), or photocopies from libraries elsewhere). Ensure you understand the resource requirements associated with a request. There are various sources of funds to tap for these purposes - check with your lecturer/supervisor.

If you are studying a popular topic, check with your lecturer/supervisor to see if there is an existing literature resource maintained which you can access and add to. This could save considerable time and expense and also provides a springboard for students following behind.

3.16 Assessment

Assessment of literature reviews will obviously vary substantially depending on the level of study, the significance of the literature review in the context of the overall assessment, and the given time and resource constraints. The following general considerations serve as a guide to what assessors will be looking for:

- Content (see above)
- Style (see above)
- Is the topic of interest well defined?
- Is the review logically structured and coherent?
- Have all major authors/views been covered?
- Has attention been paid to quality of articles reviewed?
- Is there critical analysis of the views presented?
- Quality of the summary including significance of results?
- Is the review appropriately comprehensive?
- Is the review relevant to topic of interest?
- Does the review articulate with the remainder of the document?
- Coursework students may include an appendix which outlines the literature review process - check with your lecturer

3.17 Internet literature resources:

Literature resources on the Internet range from bibliographies (some with abstracts) through to electronic journals. There is an increasing amount of information becoming available on the web but make sure of the credentials of the authors before accepting what you find as well-informed opinion.

3.18 Useful hints:

3.18.1 Bibliographic database software: If you are undertaking a major project or review you should explore using bibliographic database software (such as EndNotes) to store, search, and list your references.

3.18.2Early bird: The lead-times in identifying and acquiring literature mean you should get moving as soon as possible. History shows you will find yourself between a rock and a hard place if you do not!

3.18.3 Internet: Searching and downloading material from the Internet needs particular care to ensure the quality of information obtained. At the time of writing the Internet is useful for obtaining abstracts of journal and conference papers but peer-reviewed, on-line content is still scarce.

3.18.4 Log: Keep an audit trail or log of how you went about your searching and where you found the best results - you may have occasion to revisit these later or pass on the information to a colleague.

3.18.5 Quality*:* Part of the exercise is to learn which authors are well recognised, which journals are highly regarded, and to identify and use these good quality references to form the basis of your review, refine your search criteria, and identify other relevant references.

3.18.6 Time factor*:* Time is a major constraint for most students in identifying and acquiring selected literature. It is important to be realistic about what can be achieved and simply accept and document any shortcomings. Most of your time should be spent reading/analysing papers and writing a critical review not chasing potentially relevant articles and then summarising them at the eleventh hour.

3.18.7 Trends: Working backward from a good paper by following up references is useful but do not forget to work forwards as well. For example, a search on author name might reveal more recent publications

4.0 Presentation guide

4.1 Significance:

Presenting your work verbally to an audience requires an approach rather different from the written report. A presentation that is going to spark some interest (and be favorably assessed) needs to be more than just a summary of the report contents accompanied by numerous slides or overheads.

4.2 Process checklist

The review process is usually iterative with the number of iterations dependent on the complexity and depth of the topic under review. The following checklist provides a typical example of the process:

The **aim** of a student presentation is to demonstrate that you

- Are competent in and comfortable with your subject
- Are able to explain your work verbally
- Appreciate the significance of your topic and
- Understand what is important in the work you are presenting

4.3 Prepare for a presentation

- Think about what your audience want to hear
- Identify the main points you want to present
- Outline a presentation plan with time allocations
- Produce audio-visual aids
- Test presentation and delivery time with other students
- Anticipate what questions are likely to be asked of you

4.4 Deliver presentation (modify to suit your requirements)

- Introduce yourself and the topic of the presentation
- Outline the aims of your study and foreshadow the outcome
- Tell people what to expect from your presentation
- Overview of project planning and management (to demonstrate that although you do not have time to present full details that you have covered all the bases)
- Brief literature review (to set the context for your study)
- Materials (data and software)
- Methods (principles and examples rather than detail)
- Results (clear and logical)
- Discussion (main points only - include critical comment, limitations, error, etc.) acknowledgements

4.5 Style

Use an accepted style and be consistent. Whizbang Powerpoint tricks generally distract the audience and will receive a cool reception from people interested in what you are saying (e.g. assessors).

4.6 Assessment

Assessment will vary depending on the level of study and significance of the presentation within the overall assessment. Check with your lecturer/supervisor for specific details. The following assessment criteria are commonly used:

1. Verbal presentation (clarity of voice, eye contact)
2. Appropriate use of aids/graphics
3. The design of the study
4. Analysis and interpretation of results
5. Quality of science (adherence to scientific methods)
6. Response to audience questions
7. Ability to complete the presentation in the given time

4.7 Procedure

The procedure for presentation sessions is simple and will usually be along these lines:

1. Order of presentation, time allowed for presentation and questions, and ground rules for warning presenters going over time will be laid down before the session by the Chairperson
2. Audio-visual materials should, if possible, be loaded and tested at the venue before the presentations begin

The Chairperson will call for speakers, keep watch on the time, and control the question time at the end of each presentation.

4.7.1 Useful hints: Things To Do

1. Plan what you are going to do
2. Present factual material in a logical sequence
3. Prepare legible and simple visual aids
4. Use graphics (maps and simple diagrams) where possible
5. Practice your presentation with other students
6. Make sure any equipment you need is available and functional
7. Make sure you know when and where you are 'on'
8. Stick to the main points
9. Appear enthusiastic and interested in your topic
10. Talk to your audience

    - Prepare for questions likely to be asked such as: clarification of points made during the presentation
    - amplification of points not fully covered
    - seeking related information not included in the presentation

11. Have a backup plan if hardware/software fails (e.g. overheads)

4.7.2 Useful hints: Things Not To Do

1. Run over time
2. Get bogged down in detail
3. Read from a script
4. Look at the projection screen (unless you need to)
5. Prepare too many slides/overheads
6. Put too much detail on slides/overheads
7. Use flashy Powerpoint tricks which distract the audience
8. Use software applications in real-time (use screen dumps)

4.8 Let computers replace creativity

Real time software demonstrations can be impressive but need to be carefully rehearsed and a backup plan needs to be in place if the demo fails for some reason (which often seems to happen).

If the presentation is important (e.g conference) and you are preparing a power point presentation, it is worthwhile printing out overheads as a backup in case of hardware and/or software failure at the critical moment.

4.9 The Keogh Lab

Some dos and don'ts of giving a good 15 minute talk by Scott Keogh

- Do keep the message of your talk very simple, have only a few main points.
- Do think and plan carefully about the structure of your talk - make sure it follows a logical progression.
- Do be very prepared for your talk, practice, practice, practice.
- Do plan on about four minutes each for intro, materials and methods, and results/discussion.
- Do plan on about one slide per minute.
- Do speak slowly and clearly.
- Do have a joke or two ready if you are feeling confident, people like to laugh but be prepared to go on if they don't.
- Do have very good text slides, keep them simple.
- Do have good study species slides, at least 20% of total slide number.
- Do have conclusions slides.
- Do make sure that the people in the back of the room can see what's on your slides/overheads

- Do state your aims clearly and explain WHY you have done the research.
- Do try to reach as wide an audience as possible and reflect this attitude in the way you present statistics and complicated results.
- Do make sure that every slide/overhead means something.
- Don't read your talk if you can help it. If you are well prepared and have practiced you won't have to.
- Don't use a laser pointer until you have practiced using one, be slow and deliberate with your movements or it annoys everybody.
- Don't apologise for mistakes in your slides, just explain.
- Don't show complicated tables or DNA sequences - tables are death. If you have to show tables, keep them very simple and only show the data that you are actually going to talk about.
- Don't ever start explaining a slide by saying "I know you can't read this but....".
- Don't go overtime, it's disrespectful to everyone and unprofessional.
- Don't ever say "Now this is really interesting.....", just make it self-evident.
- Don't mix slides and overheads to much - try and have one or the other, preferably slides.
- Don't use more than three colours, and make sure they are highly contrasting.
- Don't say "that's it" at the end, have an ending prepared.
- Don't say "more work is required" because it always is.
- Don't show raw data.
- Don't go too much into well known methods.
- Don't use the shadow of the pointer unless you say that's what you're doing.

5.0 Project report

5.1 Significance:

The final project report is the key outcome of a project and constitutes the basis for a major part of the assessment. You should be working on it from day one of your project.

5.2 Report contents:

A typical project report would have the following content. Revise this list to suit your specific needs (if you are writing a major literature review for your project see guidelines above as well).

5.3 Preliminary pages

Title page
Table of contents
List of tables
List of figures
List of appendices
List of acronyms
Acknowledgments

5.4 Abstract

- Written at the beginning of the project
- Refined at the end of the project

5.5 Introduction

- Background
- Significance and scope of the project
- Aims of the project

5.6 Literature review

See Literature Review (above)

5.7 Resources

- Hardware/equipment
- Software
- Data

5.8 Methodology

- Detail methods used
- Justify methods adopted
- Flow chart processes

5.9 Results

- Figures, images, tables, maps, text
- Annotation to describe above
- Include comment on limitations, confidence in the results, and error

5.10 Discussion

- Significance of results
- Comparison of results with expected/intended results
- Relate results to aims of project

5.11 References

- Ensure all references are cross-referenced
- Use an accepted and consistent style

5.12 Appendices

- Include important procedural information that is not appropriate to put in the report due to size or level of detail. Ensure appendices are referenced in the body of the report
- Each appendix should start with a paragraph that summarises the content and outlines its relevance to the report
- Include project management information under this heading

5.13 Style:

Use an accepted style and be consistent. Reports for specific purposes (such as (a) PhD/Masters/Honours theses, (b) technical or consultancy report, and (c) reports prepared for submission to a journal for publication) will usually be required to meet specific style, format and content requirements. Make sure you are familiar with these where appropriate.

Styles are available for use in most word processors. Use these pre-defined styles for consistency. If you are undertaking a major project you may like to edit a style to suit your particular requirements.

Use headers and/or footers where appropriate. Information can include name, project/report title, version, date, page number and total number of pages. This is particularly important when you have intellectual property to protect and when you have several versions of a draft out for comment/review.

5.14 Assessment

Assessment of project reports will obviously vary substantially depending on the level of study, the significance of the report in the context of the overall assessment, and the given time and resource constraints. The following general considerations serve as a guide to what assessors will be looking for:

1. Concept, aims and significance (understanding)
2. Clarity of expression (communication skills)
3. Logical flow of processes (logic)
4. Technical content and competence (technical skills)
5. Competent analysis and interpretation (knowledge)

6. Coherent discussion of results (synthesis)
7. Critical thinking (evaluation)
8. Content and style (see above)
9. Quality of grammar, spelling, presentation, illustrations, etc.
10. Appendices which detail materials/processes - where appropriate/required

5.15 Useful hints:

5.15.1 Appendices: There is often information associated with the project that demonstrates the skills, knowledge, and understanding of the student but does not necessarily fit well in the report itself. Literature searching and review procedures, sourcing data and compiling metadata, and software application functionality are some examples. Information of this type should be included in the report by way of appendices.

5.15.2 Expand what you have: Preparation for the report should be inherent in the initial proposal at which time an outline of the expected content of the report is compiled. This outline should be used as a basis for the report and expanded as work proceeds on the project. Following this procedure will allow time to concentrate on the quality of the report at the end of the project rather than a desperate struggle to put together some content.

5.15.3 Focus on process rather than outcomes. Your assessor will usually be more interested in how you went about your project than where you ended up.

5.15.4 Publications: Publishing the results of scientific research and applied projects is an integral part of academic life. You should be thinking about potential publications arising out of your work. Look to your supervisor for assistance in identifying appropriate journals/conferences and topics.

5.15.5 Write as you go: The report should form an integral part of your work while you undertake the project. Writing the report as you go along will not only make life a lot easier at the end of the project but will also reduce the risk of finding out that you are lacking important content when it is too late to remedy the situation.

Check: Double check references to figures/tables and table of contents page numbers before your final print run.

6.0 Books on scientific writing

A Guide to Scientific Writing by David Lindsay

How to Write & Publish a Scientific Paper by Robert A. Day

Scientific English: A Guide for Scientists and Other Professionals by
Robert A. Day

Writing Papers in the Biological Sciences by Victoria E McMillan

see also
http://voxlibris.claremont.edu/research/lrs/science_cit.htm

6.1 General web resources

http://online.anu.edu.au/BoZo/Scott/Studentresources.html
http://www.columbia.edu/cu/cup/cgos/idx_basic.html
Information about citing references on the web.

6.1.1 Web sites related specifically to writing

http://www.cfr.msstate.edu/courses/wf4463/scientific.htm
Scientific writing tips from the College of Forest Resources, Mississippi State University.

http://owl.english.purdue.edu/internet/resources/index.html
A very useful index of topics. This is where you go for specific problems

http://www.powa.org/
Paradigm Online Writing Assistant is an interactive, menu-driven, online writer's guide and handbook written in HTML and distributed freely over the WWW.

http://www.ag.iastate.edu/aginfo/checklist.html
Word Usage In Scientific Writing

http://physics.gac.edu/~huber/misc/wricheck.html
a checklist

http://www.research.att.com/~andreas/sci.html
This is a long and general article published in the Scientific American

see also:

- http://www.srh.noaa.gov/ftproot/ssd/html/writetip.htm

- http://aerg.canberra.edu.au/pub/aerg/edupaper.htm
- http://duke.usask.ca/~kaminsky/writing.html
- http://www.deakin.edu.au/library/ScientificWriting.html

6.1.2 Web search and evaluation

There is a vast amount of information on the Internet. What is the best way to go about finding what you want and making sure it is good quality information? The best place to find the answer to these questions is on the web. Here are a few sites to get you started.

6.1.3 Searching the WWW

- http://owl.english.purdue.edu/internet/search/index.html
- http://
  http://www.lib.berkeley.edu/TeachingLib/Guides/Internet/FindInfo.html

6.1.4 Evaluating

Evaluating Internet Research Sources
Robert Harris, Southern California College, Version Date: November 17, 1997

6.1.5 General web resources relating to research proposals, funding and grants

(1) The art of grantsmanship by Jacob Kraicer:
http://www.hfsp.org/how_to_apply/Art_of_Grantsmanship/Art%20of%20grantsmanship.htm

(2) Guide for writing a funding proposal by S. Joseph Levine:
http://www.canr.msu.edu/aee/dissthes/proposal.htm

(3) Beginners Guide to the Research Proposal: from the University of Calgary
http://www.health.ucalgary.ca/bob/res_prop.htm

(4) Persuasive Proposal Writing:
http://www.biu.ac.il/RA/www/rserch/writing/write1.html

(5) Fundamentals of grantsmanship by Janet Rasey:
http://healthlinks.washington.edu/hsc/rfs/fundamentals.html

(6) Proposal Writer's Guide: from the University of Michigan
http://www.research.umich.edu/research/proposals/proposal_dev/pwg/PWGCONTENTS.HTML

(7) How to write a losing proposal by Alexander Scheeline:
http://www.cisab.indiana.edu/ABS/Grant/howtogrants.html

(8) Proposal Writing: Internet Resources: A link to other sites related to writing grant applications from the University of Wisconsin:
http://www.library.wisc.edu/libraries/Memorial/grants/proposal.htm

(9) Another link to other sites related to writing grant applications:
http://www.canr.msu.edu/aee/dissthes/links.htm

6.1.6 Presentation skills

Following is a list of some useful web sites on this topic. As you read these you will notice quite a bit of overlap, supporting the notion that this should be a very straight forward process. Try to think of reasons why so many people make so many mistakes in this regard.

GIS Project guide for students that has useful tips including presentation. How to give a good talk: Scott Keogh, ANU
http://online.anu.edu.au/BoZo/Scott/Talks.html

Effective presentations: University of Kansas Medical Center
http://www.kumc.edu/SAH/OTEd/jradel/effective.html

How to prepare a poster presentation: Northern Arizona University
http://jan.ucc.nau.edu/~mezza/nur390/Mod5/poster/lesson.html

How to make a great poster: Dept. of Botany, University of Washington
http://www.aspp.org/education/poster.htm

Introduction to poster presentations
http://www.kumc.edu/SAH/OTEd/jradel/Poster_Presentations/PstrStart.html

Several links under the heading: Tips for presenting talks and posters: Ecological Society of America, Physiological Ecology Section
http://www.botany.duke.edu/jackson/ecophys/awards.htm