Post Graduate Course on
Remote Sensing & Geographic Information System
(R.S. & GIS)

Syllabus

Host Institute: Indian Institute of Remote Sensing (IIRS)
National Remote Sensing Agency (NRSA)
Govt. of India, Dept. of Space
Dehradun, India

Centre for Space Science & Technology Education in Asia and The Pacific (CSSTEAP)

(Affiliated to the United Nations)
IIRS, Campus
Dehradun, India

Preface

The CSSTEAP Post Graduate Course in Remote Sensing and Geographic Information System (RS & GIS) is being conducted at Indian Institute of Remote Sensing (IIRS), National Remote Sensing Agency (NRSA), Govt. of India, Dehradun. Since the inception of the Centre in November 1995, twelve courses have been conducted and 248 participants from 23 countries in Asia-Pacific region have benefited by this post graduate educational programme. Based on the guidelines of the United Nations, the education curriculum for this nine months course has been prepared. The syllabus attempts to cover a broad perspectives in Satellite Remote Sensing and GIS technology and their applications in natural resources and environmental inventory and management for the operational RS & GIS users as well as researchers.

Educational curriculum development is a continuous process that should address issues like technological developments, new emerging applications scenarios and the feedback received from the participants and faculty. A mechanism for in –depth review at the end of each course by Board of Studies (BOS) consisting of subject matter experts, based on the above considerations exists for this course.

An expert committee was constituted by Director, CSSTEAP to review the current syllabus of the RS & GIS course and make recommendations on changes needed, based on the advancement in the field. The expert committee met on September o3, 2007 at New Delhi and critically reviewed the existing syllabus and recommended suitable modifications considering the present operational and research earth observation systems and planned future missions; emerging application scenarios; and feed back of the students and faculty. The entire course syllabus was so revised that it will fulfill the requirements and aspirations of the participating organizations for a period of five years. The recommended revised curriculum shall be implemented from 13th RS & GIS course starting from October 2008.

1. Introduction

A fundamental requirement for improving quality of life and development of a region is to support sustainable development while safeguarding the eath's environment. This will require optimal management of natural resources which depend on the availability of reliable and timely information at national, regional and local levels. Satellite remote sensing data play an increasingly important role as source of reliable and timely information needed for sustainable management of natural resources and for environmental protection. Through GIS (Geographic Information System), remote sensing data can be integrated with data from other resources to facilitate the efforts of resource managers, planner and decision makers in obtaining the relevant information they need. In view of facilitating such sustainable natural resources and environmental management in the countries of Asia-Pacific region, CSSTEAP organized at Indian Institute of Remote Sensing (IIRS), Dehradun, India, every year a post graduate course in Remote Sensing and Geographic Information System (RS & GIS) as applied to various earth resources applications disciplines as specializations. The educational programs of CSSTEAP aim at development of indigenous capability of participating countries, in designing and implementing space-based research and application programs. At the end of RS & GIS educational program, the participating scholars will be able to serve as catalysts for furthering skills and knowledge of other professionals in their countries, contribute to policy making, planning development and management of RS and GIS technology and its applications in their countries, and enhance the self-reliance in their countries.

So far, IIRS had conducted 12 nos. of P.G. course on R.S. & GIS for CSSTEAP which was found to be very popular in the Asia – Pacific region. Total 248 participants from 23 countries of Asia – Pacific region had been benefited from R.S. & GIS Educational program of CSSTEAP.

2. Course Structure

The course structure is designed to meet the needs of P.G Diploma as well as the M. Tech Degree program. The whole program consists of three Semesters. The P.G Diploma course is covered in the framework of Semester-I and Semester-II. M. Tech program will commence (Semester-III) following the completion of Semester-I and II. The brief course structure is presented in Fig. 1. The successful candidates of Semester-I and II will be admitted to the M. Tech degree program for the continuation of project work towards the award of M. Tech degree. To initialize this program both CSSTEAP and Andhra University have signed "Memorandum of Understanding" (MOU).

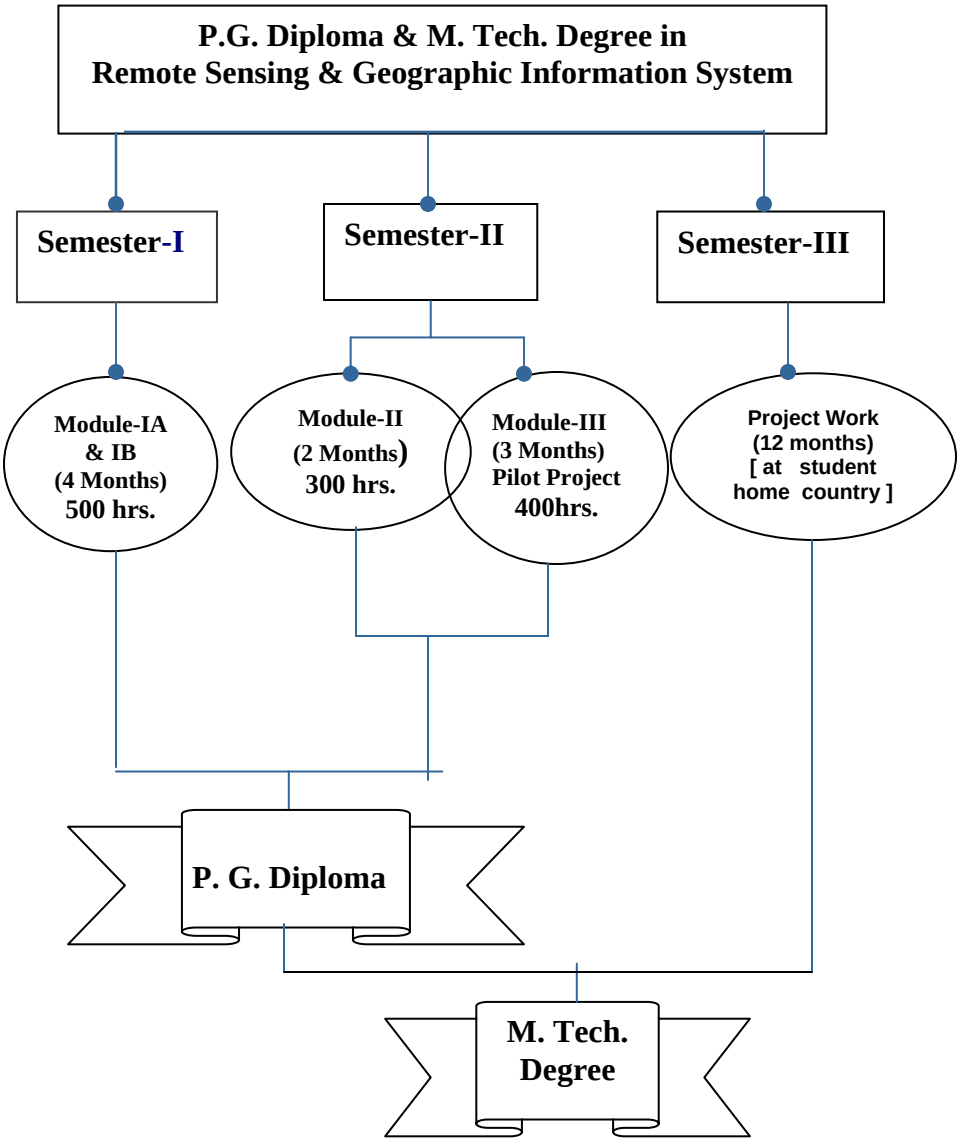

Fig. 1: P.G. Diploma and M. Tech Degree.

3. Admission Requirement

The applicant for P.G. Diploma and M. Tech course is required to have passed, at least in second class with not less than 55% marks in anyone of the following subjects as presented in Table 1.

Table1: Required qualification for admission

M. Sc / M. Tech Degree	B.E. / B. Tech. Degree
Physics, Mathematics, Applied Mathematics; Statistics, Geophysics, Meteorology, Oceanography, Geology, Geography, Urban and Regional Planning, Any Natural / Environmental Science discipline	Civil Engineering, Electrical Engineering Computer Science Computer Engineering, Electronics, Agriculture Engineering Urban and Regional Planning, B. Sc Agriculture / Forestry (4 years)

3.0 Comparative Analysis of Course Curricula between Last and Present revisions

The United Nations Office for Outer Space Affairs (UN-OOSA) in February / March in 1995 developed a model curriculum for RS & GIS post graduate course to be followed in regional Centers for Space Science and Technology Education (CSSTEs). This syllabus was followed with minor modifications suggested by BOS for seven RS & GIS courses organized by CSSTEAP at IIRS. The model course syllabus developed in 1995 was modified again in 2003 by UN-OOSA to incorporate the latest developments in technology and applications in RS & GIS during that period and this syllabus with year to year minor modifications was implemented and followed for five RS & GIS courses including 12th RS & GIS course (2007 – 2008). Salient points in the revisions of RS & GIS course syllabus between 2003 and current are presented below –

- **Module - I**

- More emphasis on the topics like *Non-sun synchronous satellites; Satellite image quality & structures; and principles of Microwave Remote Sensing*, in the subject of *Remote Sensing* covered in Module –I;

- Increase emphasis on the topics such as *Interpretation of Microwave imagery; Digital image transformation techniques; and Spectral indices*, in the subject of *Image Interpretation and Analysis* covered in Module –I;

- Major revisions of lecture topics covered under *Photogrammetry* subject taught in Module – I *with high emphasis on recent developments in digital satellite photogrammetry (Softcopy Photogrammetry) and less emphasis on aerial analytical photogrammetry;*

- Increase emphasis on the topics like *Principles and applications of Hyperspectral and Laser Remote Sensing,* in the subject of *Recent trend in RS & GIS and Environmental Assessment & Monitoring* covered in Module – I;

- Inclusion of new topics such as SAR interferometry and its applications; Approaches of Multi-criteria Decision making; Concepts & applications of Geo-statistics; Fundamentals & applications of mobile mapping, in the subject of *Recent trend in RS & GIS and Environmental Assessment & Monitoring* covered in Module – I;

- **Module - II**

- Introduction of new optional elective *" Advanced Techniques in RS & GIS"* in Module – II specifically for the participants with non natural resources and environmental science academic backgrounds such as Mathematics; Statistics; Physics; Electrical Engineering etc.; This optional elective consist of four subjects viz. *Advances in Remote Sensing and Image Analysis; Advances in Photogrammetry and Automated feature Extraction; GIS customization, Internet GIS & Mobile Mapping; and Spatial Decision Modeling & Geo-statistics;*

- Inclusion of new topic on *FAO Land Cover Classification System (FAO LCC)* in the subject on *Crop Inventory & Land Use* covered in optional elective in *Agriculture & Soils;*

- Increase emphasis on the topic on *Soil morphology & classification* in the subject on *Soil Survey & Mapping* covered in optional elective in *Agriculture & Soils*;

- Inclusion of new topic on *Soil spatial variability* in the subject on *Soil Survey & Mapping* covered in optional elective in *Agriculture & Soils;*

- Inclusion of new topic on *FAO – AEZ AP approach in agricultural land use planning* in the subject on *Land Evaluation & Soil Conservation Planning* covered in optional elective in *Agriculture & Soils*;
- Inclusion of additional topics such as *Forest growth modeling; Use of microwave RS in forest biomass assessment*, in the subject of *Forest Inventory* in optional elective in *Forestry & Ecology*;

- Inclusion of several new topics viz. *Forest encroachment; Forest fire detection & monitoring; and Wildlife habitat evaluation* in the subject of *Forest Management* in optional elective in *Forestry & Ecology*;

- More emphasis on the topic on *GIS for groundwater resource estimation*, in the subject of *Hydro-geology* covered in optional elective in *Geosciences;*

- More emphasis on the topic on RS & GIS for *natural hazard studies*, in the subject of *Engineering Geology* covered in optional elective in *Geosciences;*

- Inclusion of new topic on *Urban Hydrology* in the subject of *Urban & regional planning, mapping and analysis* covered in optional elective in *Human Settlement Analysis;*

- More emphasis on the topic on *Fundamentals of wave, tide & ocean circulation pattern,* in the subject of *Coastal geomorphology & coastal processes* covered in optional elective in *Marine science;*

- Deletion of lectures on the topic on *Fundamentals of submarine geology & geomorphology* in the subject of *Coastal geomorphology & coastal processes* covered in optional elective in *Marine science;*
- Inclusions of new topics such *RS applications in mangrove, coral reefs & sea grass studies; and Coastal land use inventory* in the subject of *Coastal & Marine Ecology* covered in optional elective in *Marine science;*

- More emphasis on the topics on *Retrieval of oceanic parameters from ocean color sensor, and TIR & Passive and active microwave ocean satellites sensors,* in the subject of *Satellite Oceanography* covered in optional elective in *Marine science;*

- Inclusion of new topics such as *Coastal predictive modeling; Ocean state forecasting; Coastal Hazard monitoring; EIA in coastal zone; Ocean observing systems (GPS, Ships, Buoys, Platforms etc.)* in the subject of *Marine GIS* covered in optional elective in *Marine science;*

- More emphasis on the topics on *Spectral characteristics of water, snow, and surface water inventory* in the subject of *Water resource assessment* in optional elective in *Water Resources*;

- More emphasis on the topic on *Watershed hydrology and physical processes in watershed* in the subject of *Watershed Characterization* in optional elective in *Water Resources;*

4. 0 Revised Course Syllabus

The contents of the Semester-I have been covered in Module-IA & IB which are common for all the candidates. Module- IA covers fundamentals of Remote Sensing, Photogrammetry, Image interpretation and analysis, Geo-Graphical information system. Module-1B deals with Advance topics in R.S. & GIS and Environmental analysis & Management issues. The duration of Semester-I is four months. The Semester-II covers the different specialized optional electives. The Semester-II consists of two modules: Module-II and Module-III. The Module-II covers the theory and practical aspects of each optional elective discipline. The duration of Module-II is two months. In Module-III the candidate has to do a dissertation work in his or her own specialized discipline. The duration of Module-III is three months. The specialized themes are - ***2.1 Agriculture & Soils; 2.2 Forestry & Ecology; 2.3 Geosciences; 2.4 Human Settlement Analysis; 2.5 Marine Science 2.6 Water Resources; and 2.7 Advanced Techniques in R.S. & GIS*****.** The final revised curriculum of RS & GIS Post Graduate course, taking into account all the recommendations ***(Annexure – I)*** of the members of course curriculum revision committee is provided in following sections:

MODULE - I

1.0 Fundamentals of Remote Sensing & GIS

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
			Module – 1A				
1.1	**Remote Sensing**	**RS**	**20**	**40**	**10**	**5**	**75**
1.2	**Image Interpretation & Analysis**	**IA**	**40**	**95**	**10**	**5**	**150**
1.3	**Photogrammetry**	**PG**	**20**	**40**	**10**	**5**	**75**
1.4	**Geoinformatics**	**GE**	**30**	**50**	**15**	**5**	**100**
			Module – 1B				
1.5	**Recent Trends in RS and GIS & Environmental Assessment and Monitoring**	**RE**	**40**	**50**	**-**	**10**	**100**
	Total		**150**	**275**	**45**	**30**	**500**

MODULE – 1A

1.1 Remote Sensing

(Lecture – 20; Practical + Tutorial – 40; Field Work – 10; Self Study / Guest Lectures – 5; Total –75 hrs.)

LECTURE NO.	DESCRIPTION
RS 1	Definition and Overview of Remote Sensing History and Evolution of Remote Sensing and Remote Sensing Systems
RS 2	Electromagnetic Radiation, Terms and Definitions, Laws of Radiation, EM Spectrum, Sources of EMR
RS 3	---do---
RS 4	Interaction between EM Radiation and matter, Reflection, Absorption and Transmission.
RS 5	Interactions between EM Radiation and Atmosphere, Atmospheric windows
RS 6	Remote Sensing Systems - Active and Passive Systems, Imaging and Non Imaging Systems, Concept of Resolutions in RS - Spatial, Spectral, Radiometric and Temporal
RS 7	Orbits and Platforms for Earth Observation
RS 8	Earth Observation Satellites (LANDSAT, SPOT, IRS, IKONOS and sensors for Stereo Data {MOMS, CARTOSAT}) and their characteristics
RS 9, 10, 11 & 12	Satellite Imaging modes and geometric errors; Image Quality & Structures; Non-sun synchronous satellites
RS 13	Data Reception, Processing and Data Products Generation
RS 14 & 15	Principles of Thermal Remote Sensing including its uses
RS 16, 17 & 18	Principles of Microwave Remote Sensing (imaging and non imaging)
RS 19	Ground truth data collection - use of radiometers, and spectrophotometers etc.
RS 20	Spectral Reflectance, Physical basis of spectral signatures of the objects and Spectral Signature for Vegetation, Soil, Water and Snow.

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
EX. RS 1	Study of Satellite Image Annotation (information) LANDSAT, SPOT and IRS and Referencing Scheme (Analog)	3
EX. RS 2	Referencing Scheme (Digital) and Browsing Satellite data from NRSA website	7
EX. RS 3	Study on spectral and image characteristics of optical and microwave SAR data for identification / characterization major earth features	14
EX. RS 4	Study and use of IR - Thermal Radiation Measuring Instruments and drawing of Isotherms	6
EX. RS 5	Study of Thermal Image and Interpretation, Computing Radiance Image from Satellite data, Derivation of Brightness Temperature	5
EX. RS 6	Interpretation of SAR data (from Satellite) for Landuse studies	5
EX. RS 7	*Study of Ground Data collection instruments, Radiometers, Spectrometers etc. and Ground Data collection in a given area with the help of Radiometers and Spectrometers*	10 **(Field Work)**

Suggested Readings:

Books

1. Lillesand Thomas M. & Kiefer Ralph: Remote Sensing and Image Interpretation Third Edition John Wiley
2. Campbell John B.: Introduction to Remote Sensing Taylor & Francis
3. Floyd F. Sabins : Remote Sensing and Principles and Image Interpretation
4. Manual of Remote Sensing: American Society of Photogrammtery and Remote Sensing.
5. George Joseph: Fundamentals of Remote Sensing; Universities Press India Pvt Ltd, Hyderabad,India
6. Editors:John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos, 2001. Manual of Geospatial Science and Technology, November 2001, Vol 1 Part 1and II.
7. Paul M. Mather, 1999. Computer Processing of Remotely sensed Images: An Introduction. John Wiley

Journal Articles

1. Dozier J 1984 Snow reflectance from Landsat-4 Thematic Mapper; IEEE Transactions on Geoscience and Remote Sensing, GE-22 (3) 323{328
2. Dozier J 1985 Spectral signature of snow in visible and near- infrared wavelengths; In: Proceedings of the Third Inter-national Colloquium on Spectral Signatures of Objects in Remote Sensing, ESA SP-247, pp. 437{442, Les Arcs, France, Dec 16{20)
3. George Joseph, 1996: Imaging Sensors for Remote Sensing, Remote Sensing Reviews, vol 13 pp257-342
4. Gyanesh Chander, *Member, IEEE*, Michael J. Coan, and Pasquale L. Scaramuzza, 2008. Evaluation and Comparison of the IRS P6 with Landsat sensor. IEEE Transactions on Geosciences and Remote Sensing, Vol. 46, No. 1, January 2008.
5. John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos, (Editors), 2001. Photogrammetric and remote sensing considerations; Chapter 16, Manual of Geospatial Science and Technology, Vol 1 Part 4 Pages 233 – 252
6. John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos (Editors), 2001.The remote sensing process: how do we collect the required in situ and remotely sensed data? Chapter 17, Manual of Geospatial Science and Technology, November 2001, Vol 1 Part 4 Pages 253 – 275K.
7. Kasturirangan, 1985. The evolution of satellite-based remote-sensing capabilities in India, International Journal of Remote Sensing, Volume 6, Issue 3, 1985, Pages 387 – 400
8. T. W. Foresman; T. B. Serpi, 1999. Mandate for Remote Sensing Education and the Remote Sensing Core Curriculum Geocarto International, Volume 14, Issue 2, 1999, Pages 81 – 85
9. T Toutin,. Review article: Geometric processing of remote sensing images: models, algorithms and methods International. Journal of Remote Sensing, 20 May, 2004, Vol. 25, No. 10, 1893–1924
10. U.R. Rao; S. Chandrashekar, 1986. An international regime for remote sensing-problems and prospects. International Journal of Remote Sensing, Volume 7, Issue 1, 1986, Pages 3 – 18

Websites:

1. http://www.itc.nl/~bakker/rs.html
2. www.ccrs.nrcan.gc.ca/resource/tutor/fundam/index_e.php
3. rst.gsfc.nasa.gov/
4. http://www.r-s-c-c.org/rscc/v1m1.html
5. www.isprs.org
6. www.spaceimaging.com
7. www.landsat.usgs.gov
8. www.spotimage.fr
9. www.nrsa.gov.in
10. IRS 1C handbook: http://www.euromap.de/docs/doc_013.html
11. IRS P6 Users handbook. http://www.nrsa.gov.in/IRS_Documents/Handbook/Resourcesat-1_handbook_HTML
12. asterweb.jpl.nasa.gov

1.2 Image Interpretation and Analysis

(Lecture – 40; Practical + Tutorial – 95; Field Work – 10; Self Study / Guest Lectures – 5; Total –150 hrs.)

LECTURE NO.	DESCRIPTION
1A 1	Principles of visual Interpretation of aerial photos and satellite imagery
1A 2	Recognition Elements and Interpretation keys for Visual Interpretation
1A 3	Techniques of Visual Interpretation and Basic Interpretation Equipment
1A 4	Interpretation of Multi-spectral Imagery
1A 5	Interpretation of Thermal Imagery
1A 6 & 7	Interpretation of Microwave Imagery (SAR)
1A 8	Introductory Mathematics - Linear Algebra
1A 9	Introductory Mathematics - Linear Algebra
1A 10 & 11	Introductory Mathematics - Matrices - Terms & Definitions
IA 12	Introductory Mathematical – Statistics
IA 13 & 14	Introductory Mathematical Statistics –Measures of Central tendency Correlation –Regression, Variance-Covariance
IA 15	Introductory Mathematical Concepts – Probability
IA 16	Introduction Mathematical Concepts – Least Square Analysis
IA 17	Introduction Mathematical Concepts - Time series analysis
IA 18	Fundamentals of Computers, Image Processing Systems
IA 19	Fundamentals of Computers, Image Processing Systems
IA 20	Fundamentals of Image Display
IA 21	Fundamentals of Image Analysis and Digital Data Format
IA 22 & 23	Fundamentals of Image Rectification and Registration
IA 24	Image Enhancement Techniques- Linear
IA 25	Non- linear Contrast Enhancement
IA 26	Filtering - Low Pass, High Pass and Edge Enhancements
IA 27	Non Linear Filters
IA 28, 29, 30 & 31	Image Transformation: HIS, Image Fusion, FFT etc.
IA 32 & 33	Spectral Indices
IA 34	Principles of Image Classification
IA 35	Feature Selection & Separability Analysis
IA 36	Supervised Classification
IA 37	Supervised Classification
IA 38 & 39	Unsupervised Classification
IA 40	Classification Accuracy

Note: Paper –I (Theory): Lectures – IA 1 to 20
Paper – II (Theory): Lectures – IA 21 to 40

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
EX.IA 1	Identification of Features on single vertical aerial photograph	4
EX.IA 2	Study of given area in B/W, B/W IR, Colour IR Imagery	5
EX.IA 3	Study of Satellite imagery (B/W) in different bands and visual interpretation	5
EX.IA 4	Interpretation of cultural details from different Satellite image data (IRS, IKONOS)	5
EX. IA 5	Interpretation of Land use detail from satellite imagery	5
EX. IA 6	Familiarization with image Processing system, startup procedure,	5
EX. IA 7	Importing NRSA data into software's format, creating subset image.	5
EX. IA 8	Loading image data and display, identification of objects on video display, display of Histograms	5
EX. IA 9	Image Registration - Image to Map, Image to Image, Image to user coordinates	12
EX. IA 10	Image enhancement techniques Contrast Enhancement, Density Slicing and Transfer functions	5
EX. IA 11	Filtering,- High Pass Low pass, Edge Enhancement	6
EX. IA 12	Spectral Indices	6
EX. IA 13	Image Fusion, Principal Component Analysis	8
EX. IA 14	Image classification techniques - supervised and unsupervised, fuzzy	8
EX. IA 15	Accuracy Assessment	5
EX 1A 16	Digital Analysis of Microwave data – Rectification, Speckle Removal and Fusion with Optical data	6
EX. IA 17	*Ground data collection for training sets in Image processing system for classification of image*	10 **(Field Work)**

Note: Paper –I (Practical): EX IA 1 to 8
Paper – II: Lectures – EX IA 8 to 16

Suggested Readings

Books:

1. Jensen John R. Introduction to Digital Image Processing: A Remote Sensing Perspective Prentice hall, New Jersey
2. Richards John A& Xiuping Xia, 2006. Remote Sensing Digital Image Analysis: An Introduction. Birkhäuser.
3. Lillesand Thomas M. & Kiefer Ralph: Remote Sensing Image Interpretation John Wiley and Sons, New York
4. Campbell John B. Introduction to Remote Sensing, Taylor & Francis, London
5. Sabins Floyd. F: Remote Sensing and Principles of Image Interpretation, W H Freeman, New York
6. Manual of Remote Sensing: American Society of Remote Sensing and Photogrammetry, Virginia, USA
7. Gonzalez Rafael C and Woods Richard E.: Digital Image Processing Addison Wesley, New York
8. Pratt William K.: Digital Image Processing, John Wiley and Sons, New York
9. Jain Anil K. Fundamentals of Digital Image Processing, Prentice Hall, New Jersey:
10. Pohl Christine: 1996 Geometric Aspects of Multisensor Image Fusion for Topographical Map updating in humid Tropics: ITC Publication, Enschede

Journal Articles:

1. Govil S.K, Kumar Minakshi *Accuracy evaluation of Different rectification methods for aerial photographs,* Map India 2005
2. Huete, A. R. (1988)'A soil-adjusted vegetation index (SAVI)', *Remote Sensing of Environment*, 25, 53-70.
3. Kaufman, Y. J. and D. Tanre (1992) 'Atmospherically resistant vegetation index (ARVI) for EOS-MODIS', in 'Proc. IEEE Int. Geosci. and Remote Sensing Symp. '92*, IEEE, New York, 261-270.*
4. Mondal, S., Kumar, Minakshi.,et. al, (2004). *Land use / Land cover assessment and its spatio-temporal dynamics using multi-temporal satellite images in the southern parts of lower Garhwal Himalayas*, Proc. National Seminar on 'Role of Geoinformatics in decentralized planning for better governance', Dept. Of Remote Sensing, Birla Institute of Technology, Mesra, Ranchi, October 7-8, 2004.
5. Myneni, R. B., F. G. Hall, P.J. Sellers, and A.L. Marshak (1995) 'The interpretation of spectral vegetation indexes', *IEEE Transactions on Geoscience and Remote Sensing*, 33, 481-486.
6. Prince, S. 1991, Satellite Remote Sensing of Primary Production: Comparison of Results for Sahelian Grassland 1981-1988-Special Issue - Coarse Resolution Remote Sensing of Sahelian Environment. International Journal of Remote Sensing. Vol. 12, pp. 1301-1311.
7. Richardson, A. J. and C. L. Wiegand (1977) 'Distinguishing vegetation from soil background information', *Photogrammetric Engineering and Remote Sensing*, 43, 1541-1552.
8. Sellers, P. J. (1985) 'Canopy reflectance, photosynthesis, and transpiration', *International Journal of Remote Sensing*, 6, 1335-1372.
9. Tucker, C.J. (1979) 'Red and Photographic Infrared Linear Combinations for Monitoring Vegetation', *Remote Sensing of Environment*, 8(2),127-150.

10. Holben, B. N. (1986)'Characteristics of Maximum-Value Composite Images from Temporal AVHRR Data', *International Journal of Remote Sensing*, 7(11), 1417-1434.
11. Tucker, C.J., Townshend, J.R.G., and Goff, T.E. (1985) African Landcover Classification using Satellite Data. Science. Vol. 227, pp. 369-375.
12. Unganai, L. S., and Kogan, F. N. (1998) Drought Monitoring and Corn Yield Estimation in Southern Africa from AVHRR data. Remote Sensing of Environment. Vol. 63, No. 3, pp. 219-232.

Websites:

1. www.ccrs.nrcan.gc.ca/resource/tutor/fundam/index_e.php
2. http://www.r-s-c-c.org/rscc/v1m1.html
3. A comparative assessment of classification methods http://portal.acm.org/citation.cfm?id=873866
4. Classification Techniques in Pattern Recognition
5. http://wscg.zcu.cz/wscg2005/Papers_2005/Poster/K43-full.pdf
6. http://en.wikipedia.org/wiki/NDVI
7. Manipulation of Normalized Difference Vegetation Index (NDVI) for Delineating Drought Vulnerable Areas
   http://www.gisdevelopment.net/application/natural_hazards/drought/nhdr0005.htm
8. http://www.csc.noaa.gov/crs/definitions/NDVI.html
9. http://en.wikipedia.org/wiki/Principal_components_analysis
10. http://www.cs.otago.ac.nz/cosc453/student_tutorials/principal_components.pdf
11. http://en.wikipedia.org/wiki/High-pass_filter
12. http://www.fmrib.ox.ac.uk/analysis/techrep/tr01mw1/tr01mw1/node15.html
13. http://www.photoshopessentials.com/photo-editing/sharpen-high-pass/
14. http://www.cas.sc.edu/geog/rslab/Rscc/mod6/6-3/linear.html
15. http://www.cee.hw.ac.uk/hipr/html/stretch.html
16. http://www.fas.org/irp/imint/docs/rst/Sect1/Sect1_12a.html
17. http://www.castle.geographie.uni-kiel.de/r-kiel4/s3l4p080.htm
18. http://www.cee.hw.ac.uk/hipr/html/histeq.html
19. http://www.ph.tn.tudelft.nl/Courses/FIP/noframes/fip-istogram.html
20. http://en.wikipedia.org/wiki/Histogram_equalization

1.3 Photogrammetry

(Lecture – 20; Practical + Tutorial – 40; Field Work – 10; Self Study / Guest Lectures – 5; Total – 75 hrs.)

PG 1 & 2	Basics of aerial Photography, Camera, Films, Filters, Film density, Characterstic curves , Image movement ,Exposure Interval, Resolution.
PG 3	Basic Geometry of aerial Photograph, Central and orthographic projection, Difference between map and aerial photograph , Types of Aerial photographs- wide angle,narrow angle,Horizontal, Vertical, Oblique
PG 4	Scale and Ground Coverage of aerial photograph
PG 5	Relief Displacement in aerial photographs and its characteristics
PG6	Geometry of tilted/oblique photograph, Isocentre, Nadir point, Principle point and Principle plane, Tilt Displacement
PG 7	Stereoscopy and binocular vision, Concept of Depth perception in Monocular and Binocular vision ,Base-eight ratio, stereoscopic exaggeration.
PG 8	Stereoscopes, Stereoscopic parallax, Parallax bar, Floating mark and Parallax Bar formula
PG 9	Use of Parallax bar in height measurement ,Parallax formula
PG10	Stereophotogrammetry, Degrees of freedom in single photograph, Principle of reprojection, stereo restitution
PG 11	Orientation of aerial photograph – Inner, relative and Absolute orientation and Model Deformation in Stereophotogrammetry, Mapping frm stereo aerial photos.
PG 12 & 13	Basics of Analytical Photogrammetry- Collinearity and Coplanarity conditions, Concept of Rotation Matrix
PG 14 - 16	Introductory concepts in Digital Photogrammetry (Digital data input(photogrammetric scanners, Digital Photogrammetric camera), H/W and S/W requirements, Photogrammetric triangulation in DPWS, Stereo view in DPWS,feature extraction on DPWS)
PG 17	Stereo Sensors in Space- tilt across the track, tilt along the track, Single push broom scanners (IRS-1C/1D, SPOT, IKONOS), Three line scanners (MOMS)
PG 18 & 19	Satellite based Digital Photogrammetry (Orbital Parameters, Orbital Modeling, Data Processing for stereo generation)
PG 20	Concept of DEM, DSM and DTM, DEM extraction and Orthoimage generation- Concept of Image Matching, Automatic DEM generation, Orthoimage generation,Digital maps and their characteristics

PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
EX. PG 1	Stereo Test and Determination of photo scale	2
EX. PG 2	Preparation of Base map from toposheet including legend, scale and annotation	3
EX. PG 3	Locating nadir point and principal point on aerial photo and Determination of height from single vertical aerial photograph	3
EX. PG 4	Orientation of Stereo model under mirror stereoscope	8
EX. PG 5	Tracing of details from Stereopair	4
EX. PG 6	Use of parallax bar and determination of heights	8
EX. PG 7	Familiarization with DPWS, Project creation, data input, orientation, generation of DEM and orthoimage.	8
EX. PG 8	Feature extraction of topographic details using DPWS	4
EX. PG 9	Ground data collection and Verification on aerial photo (FIELD EXERCISE)	10

Suggested Readings:

Books:

1. Toni Schenk: Digital Photogrammetry, Volume I., TerraScience.
2. Paul Wolf, Elements of Photogrammetry, , McGraw Hill.
3. Cliff Greve and ASPRS Digital Photogrammetry: An Addendum to Manual of Photogrammetry
4. Mikhail Edward, bethel James and Mcglone J Chris Introduction to Modern Photogrammetry, John Wiley & sons Inc.
5. Kasser Michel and Egles Yves Digital Photogrammetry. Taylor & Francis. London & New York.
6. Sanjib K. Ghosh, 1979: Analytical Photogrammetry, New York: Pergamon Press
7. Sanjib K. Ghosh. 2005. Fundamentals of computation Photogrammetry. Concept publishing, New Delhi.
8. Schmidt Milton O and Rayner William Horace Fundamentals of Surveying, Van Nostrand Reinhold Company
9. Leick Alfred, 1995: GPS Satellite Surveying, Wiley Interscience.
10. Robinson, A.; Morrison, J.; Muehrke, P.; Kimmerling, A.; & Guptill, S. *Elements of Cartograpy* New York: Wiley

Journal Articles:

1. Ackermann F (1996) Techniques and strategies for DEM generation. In: Greve C (ed) Digital Photogrammetry: An Addendum to the Manual of Photogrammetry. American Society of Photogrammetry and Remote Sensing, Falls Church, VA, pp 135-141.

2. Chen, L. C., and Liang-Hwei Lee. 1993. Rigorous Generation of Digital Orthophotos from SPOT Images. Photogrammetric Engineering and Remote Sensing. Volume 59. Number 5. Pages 655 - 661.

Web sites:

1. www.univie.ac.at/Luftbildarchiv/wgv/intro.htm
2. http://www.geodetic.com/Whatis.htm
3. http://www.kth.se/student/studiehandbok/index.asp?lang=1
4. http://web.pdx.edu/~emch/maps/maps.html#A
5. http://www.ccrs.nrcan.gc.ca/resource/tutor/fundam/index_e.php
6. http://www.r-s-c-c.org/rscc/v1m1.html
7. ISPRS website: Links to several related sites
8. www.asprs.org/

1.3 Geoinformatics

(Lecture – 30; Practical + Tutorial – 50; Field Work – 15; Self Study / Guest Lectures – 5; Total –100 hrs.)

LECTURE NO.	DESCRIPTION
GE 1 & 2	Spatial Information System: An Overview
GE 3	Hardware and Software requirements of GIS
GE 4	Data Models
GE 5	Conceptual Model of Spatial Information
GE 6 & 7	Concept of databases
GE 8	Conceptual Model of Non-Spatial Information
GE 9 & 10	Digitizing, Editing and Structuring Map Data
GE 11	Data Quality and Sources of errors in GIS
GE 12,1,3 & 14	Projections in GIS
GE 15 & 16	Introduction to Spatial Analysis
GE 17 & 18	Spatial data Analysis (Vector Based)
GE 19 & 20	Spatial data Analysis (Raster based)
GE 21 & 22	Network Analysis in GIS
GE 23, 24 & 25	Digital Elevation Models
GE 26	Recent Trends in GIS
GE 27	Fundamental Concepts of GPS
GE 28 & 29	Types of GPS, GPS Satellite, Constellation of GPS Satellites
GE 30	Applications of GPS in resource surveys, mapping and navigation

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
EX. GE 1	Arc GIS 9 Software Overview	4
EX. GE 2	Working with ArcMap	4
EX. GE 3	Working with Arctool Box	4
EX. GE 4	Georeferencing and Projection	4
EX. GE 5	Spatial Data Entry-Digitisation	4
EX. GE 6	Spatial Data Editing	4
EX. GE 7	Non Spatial Data Entry	4
EX. GE 8	Query & Analysis	8
EX. GE 9	Map Composition	4
EX. GE 10	Generation of DEM	2
EX. GE 11	Familiarization with different Types of GPS receivers	4
EX. GE 12	Checking of existing map coordinates using single GPS	4
EX. GE 13	*Calculation of Coordinates with differential GPS receiver*	**10 FIELD EXERCISE**
EX. GE 14	*Survey of Small area with the help of GPS receivers*	**5 FIELD EXERCISE**

Suggested Readings:

1. Chrisman, N.R. (1997) Exploring Geographic Information Systems. John Wiley and Sons.
2. deMers, M.N. (1997) Fundamentals of Geographic Information Systems. John Wiley and Sons.
3. Laurini, R. and Thompson, D. (1992) Fundamentals of Spatial Information Systems. London, Academy Press.
4. Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (eds.) (1991) Geographical Information Systems: Principles and Applications. Avon, Longman Scientific and Technical.
5. Martin, D. (1991) Geographical Information Systems and their Socioeconomic Applications. London, Routledge.
6. Peuquet, D.J. and Marble, D.F. (eds.) (1990) Introductory Readings in Geographic Information Systems. London, Taylor and Francis.
7. Star, J. a
8. Burroughs, P.P. & McDonnel, R.A. 1998, Principles of GIS, Oxford University Press, pp. 299.
   Burrough, P.A. (1986) Principles of Geographic Information Systems for Land Resource Assessment. Monographs on Soil and Resources Survey No. 12, Oxford Science Publications, New York
9. Foote, K.E. and Lynch, M. (1995) Database Concepts. The Geographer's Craft Project, Department of Geography, The University of Colorado at Boulder. URL: http://www.colorado.edu/geography/gcraft/notes/sources/sources_f.html
10. Goodchild, M. (1997) Rasters. NCGIA Core Curriculum in Geographic Information Science. Unit 055, URL: http://www.ncgia.ucsb.edu/giscc/units/u055/u055.html.
11. Tomlin, C.D. (1990) Geographic Information Systems and Cartographic Modelling. Prentice Hall, New Jersey. Trimble Navigation Limited (2000) web site http://www.trimble.com/
12. Burroughs, P.P. & McDonnel, R.A. (1998) Principles of GIS, Oxford University Press, pp. 162 -166.

MODULE – 1B

1.5 Recent Trends in RS And GIS and Environmental Assessment and Monitoring

(Lecture – 40; Practical + Tutorial – 50; Self Study / Guest Lectures – 10; Total –100 hrs.)

Lecture No.	Topic
TRG– L1 & L2	Principles and applications of hyperspectral RS
TRG – L3 & L4	Laser RS and its Applications
TRG – L5 to L7	Advances in DIP (Concept of mathematics-Fuzzy, ANN, Expert system, Image Segmentation etc.)
TRG – L8 & L9	SAR Interferrometry and its applications
TRG – L10	GIS customization concepts
TRG – L11 to L13	Concept and approaches of Multi-criteria decision making
TRG – L14	Fundamentals & application of mobile mapping
TRG – L15	Concepts & applications of Geostatistics
EA – L1 & L2	Meteorological satellites & sensors; assessment of cyclones, rainfall, atmospheric humidity etc.
EA – L3 & L4	Ocean colour Monitor and its applications
EA – L5 & L6	Weather analysis, forecasting and modeling
EA – L7 & L8	Concept of sustainable development & Integrated resource management for sustainable development
EA – L9 & L10	Watershed management for soil & water conservation planning
EA – L11 & L12	Urban resource planning –an integrated approach
EA – L13 & L14	Greenhouse gasses & their atmospheric chemistry & impact of climatic change on terrestrial eco-systems
EA – L15 & L16	Integrated Coastal zone management
EA – L17 & L18	Geological disasters (landslides, earthquakes & volcanoes etc.)
EA – L19	Forest fires
EA – L20 & L21	Hydro-meteorological disaster (Flood & Droughts)
EA – L22	Environmental management problems; prospective; & socio-economic issues
EA – L23	Land degradation & Desertification
EA – L24 & L25	Biodiversity characterization & management using Remote Sensing & GIS

DEMONSTRATIONS /PRACTICALS

CODE	DESCRIPTION	PRACTICAL (HRS)
TRG – EX 1	Advance DIP Fuzzy, ANN, Expert system, Image Segmentation etc .	15
TRG – EX 2	SAR Interferrometry and its applications	10
TRG – EX 3	Analysis of hyperspectral satellite data	5
TRG – EX 4	GIS customization concepts Concept and approaches of Multi-criteria decision making	15
TRG –EX 5	Geostatistics	5

Suggested Readings:

1. John Randolph, Environmental Land Use Planning and Management, Island Press 576 pages, 2004.

2. J. R. Jensen, Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition) (Prentice Hall Series in Geographic Information Science)

3. Rao, U. R. Space Technology for Sustainable development. New Delhi, Tata McGraw-Hill, 1996.

4. Rao, U. R., M.G. Chandrasekhar and V. Jayaraman. Space and Agenda 21-caring for the planet earth. Bangalore, prism Books, 1995.

5. Engman, E. T., and R. j. Gurney. Remote sensing in hydrology. London, Chapman and Hall, 1991.

6. Ustin Susan, Remote Sensing for Natural Resource Management and Environmental Monitoring. Wiley; 3 edition (April 19 2004)

7. Peter M. Atkinson, Nicholas J. Tate, Advances in Remote Sensing and GIS Analysis.

8. Chein-I Chang, Hyperspectral Imaging: Techniques for Spectral Detection and Classification, Springer; 1 edition (July 31, 2003).

9. Andrew Skidmore, Environmental Modelling with GIS and Remote Sensing, Published 2002 CRC Press.

10. Gert A. Schultz, Edwin T. Engman, Remote Sensing in Hydrology and Water Management, Springer; 1 edition (June 8, 2000).

11. Jonathan Li, Sisi Zlatanova, Andrea Fabbri, Geomatics Solutions for Disaster Management, Springer; 1 edition (Jun 12 2007)

12. Kenneth N. Brooks, Hydrology and the management of Watersheds, Blackwell Publishing(2003).

MODULE – II : Optional Elective

2.1 RS & GIS Applications in Agriculture and Soils

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.1.1	Crop Inventory & Land Use	CL	12	48	10	5	75
2.1.2	Soil Survey & Mapping	SM	12	48	10	5	75
2.1.3	Agro-meteorology & Agricultural Water Management	AW	12	48	10	5	75
2.1.4	Land Evaluation & Soil Conservation Planning	LC	12	48	10	5	75
	Total		48	192	40	20	300

2.1.1 Crop Inventory & Land Use

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
CL 1 & CL 2	Background and introduction of remote sensing in agriculture; Spectral Characteristics of Crops
CL 3	Land use mapping and change analysis using remote sensing technique
CL 4	FAO Land Cover Classification System (FAO LCCS)
CL 5 & CL 6	Principles of crop identification and acreage estimation using remote sensing technique
CL 7	Crop yield modeling using remote sensing & GIS
CL 8	Crop condition/ stress assessment using remote sensing technique
CL 9	Microwave Remote Sensing Applications in Crop Inventory
CL 10	GIS applications in crop inventory
CL 11	Use of hyper-spectral remote sensing in crop inventory
CL 12	Precision agriculture

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
CL – EX 1	Agriculture land use mapping using aerospace data following visual analysis	7
CL – EX 2	Agriculture land use mapping following digital techniques	10
CL – EX 3	Crop identification, area estimation using digital techniques	12
CL – EX 4	Crop stress assessment	6
CL – EX 5	Demonstration of Use of Hyderspectral data in crop inventory	3
CL – EX 6	Creation of spatial and non-spatial database of land use and crop inventory using GIS	10
CL – EX 7	*Ground truth collection for crop inventory & agriculture land use analysis*	10 ***(Field work)***

Suggested Readings:

1. Patel NR and Saha, SK (2004).Satellite remote sensing and GIS applications in Sustainable Agriculture In: Geoinformatics in Tropical Ecosystems (PS Roy Ed).

2. Jackson, R. D., Pinter, P. J., Reginato, R. J. and Idso, S. B. (1986). Detection and Evaluation of Plant Stresses for Crop Management Decisions. IEEE Transactions on Geosciences and Remote Sensing, **24**: 99-106

3. Macdonald R. B. and Hall, F. G. (1980). Global crop forecasting. Science, **208**: 670–679.

4. Moran, M. S., Mass, S. J. and Pinter, P. J. (1995). Combining remote sensing and modeling for estimating surface evaporation and biomass production. Remote Sensing of Environment, **12**:335-353.

5. Moulin, S., Bondeau, A. and Delecolle, R. (1998). Combining agricultural crop models and satellite observations from field to regional scale. International Journal of Remote Sensing, **19**: 1021 – 1036.

6. Doorenbos, J. & Pruit, W. O. (1977) Guidelines for predicting crop water requirements. FAO Irrigation and Drainage Paper no. 24. Food and Agriculture Organization, Rome, Italy.

7. Remote Sensing and Large-Scale Global Processes (ed. by A. Rango) (Proc. Baltimore Symp.), 67–74. IAHS Publ. 186. IAHS Press, Wallingford, UK.

8. Baret, F. and Guyot, G. (1991). Potentials and Limits of Vegetation Indexes for LAI and APAR assessment. *Remote Sens.Environ.*, 35: 161-173

9. Moran, M.S., Inoue, Y., & Barnes, E.M. (1997). Opportunities and limitations for image-based remote sensing in precision crop management. *Remote Sensing of Environment*, 61, 319-346.

10. National Academy of Sciences. (1997) *Precision Agriculture in the 21st Century*

11. Quantitative Remote Sensing of Land Surfaces (Ed. By Shunlin Liang), Willey Publishers

Websites

http://vegetation.cnes.fr/vgtprep/meyer/final1.html
http://www.space.gc.ca/asc/eng/satellites/hyper_agriculture.asp
http://nespal.cpes.peachnet.edu/pa/home/
http://agrifish.jrc.it/marsstat/
http://www.cmis.csiro.au/rsm/intro/index.htm

2.1.2 Soil Survey & Mapping

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
SM 1	Background and introduction of remote sensing in soil surveys
SM 2 & SM 3	Soil Morphology & Classification
SM 4	Spectral Characteristics of Soils
SM 5	Scales and kinds of soil mapping
SM 6 & SM 7	Physiographic analysis and soil mapping using aerial and satellite remote sensing data
SM 8	Hyperspectral RS in Soil Studies
SM 10	Soil Information System in Sustainable Use of land Resources
SM 11	Digital terrain modelling (DTM) for terrain slope, aspect and physiography analysis for soil mapping
SM 12	Soil spatial variability

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
SM – EX 1	Physio-graphic analysis and soil mapping using aerospace data following visual analysis	10
SM – EX 2	Soil morphology and classification	7
SM – EX 3	Soil mapping and physio-graphic analysis using digital techniques	12
SM – EX 4	Creation of spatial and non-spatial databases of physio-graphy, soils, slope etc. using GIS	10
SM – EX 5	Generation of DTM and slope, aspect and physio-graphic analysis using GIS	9
SM – EX 6	*Ground truth collection for physio-graphic analysis, soil classification and mapping and demonstration of spectro-radiometer for hyper spectral data analysis*	10 ***(Field work)***

Suggested Readings:

1. Brady, Nyle, C. and Ray R. Weill (2000). Elements of nature and properties of soils. Prentice-Hall, Inc.

2. Summer, M.E. (2000). Handbook of Soil Science. CRC Press, Boca Raton, FL.

3. Ashman, M.R. and Puri, G. (2002). Essential Soil science: a clear and concise introduction to Soil Science, Blackwell Science Ltd.

4. Sehgal, J. (1996). Pedology : Concepts and Applications , Kalyani Publishers, New Delhi.

5. Soil Survey Staff, (2002). Soil Survey Manual, U S. Department of Agriculture, 532 pages.

6. Soil Survey Staff (1996). Keys to Soil Taxonomy. Government Printing Office Staff, United States Soil Conservation Service, 646 pages.

7. Wilson, John P and Gallant, John C. (2000). Terrain Analysis: Principles and Applications, 512 p

Websites

http://www.pedosphere.com/
http://www./soils.rr.ualberta.ca/soils210/lectures/index.html
http://www./ag.ohio-state.edu/~natres/courses/300note.html
http://www.itc.nl/~rossiter/research/rsrch_ss_apps.html#ussl
(A Compendium of On-Line Soil Survey Information)
http://www.fao.org/waicent/faoinfo/agricult/agl/agll/aez.stm
http://www.iiasa.ac.at/Research/LUC/SAEZ/in47.htm
http://www.css.cornell.edu/landeval/landeval.htm
http://www.cartage.org.lb/en/themes/sciences/Earthscience/Geology/Soils/mainpage.htm
http://soils.usda.gov/technical/manual/
http://websoilsurvey.nrcs.usda.gov/app/

2.1.3 Agro-meteorology & Agricultural Water Management

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
AW 1	Fundamentals of agro-meteorology and its importance in agriculture
AW 2 & AW 3	Satellite agro-meteorology
AW4	Use of satellite remote sensing in land surface climatology
AW 5 & AW 6	Soil moisture assessment using Remote Sensing Techniques
AW 7	Drought assessment and monitoring through remote sensing
AW 8	GIS applications in agro-climatic and agro-ecological zoning
AW 9	Regional water balance modeling
AW 10 & AW 11	RS & GIS applications in agricultural water management
AW 12	Impact of Global climatic change on agriculture

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
AW-EX 1	Irrigated and un irrigated crop land inventory using satellite data, and crop water requirement estimation using GIS	15
AW-EX 2	Study on spectral characteristics of soil under varying moisture content using ground radiometer	6
AW-EX 3	Digital analysis for retrieval of agro-meteoologial parameters, soil moisture and drought assessment	15
AW-EX 4	Creation of databases of agromet and terrain information and analysis of agro-ecological zonation following GIS	12
AW-EX 5	*Ground truth collection for irrigated crop land inventory and drought management*	10 ***(Field work)***

Suggested Readings:

1. Evapotranspiration and irrigation water requirement, edited by M.E. Jenson, R.D. Burman and R.G. Allen (1994). ASAE Manual and Reports on Engineering Practice.

2. Scaling up in Hydrology using Remote Sensing (1996). John Wiley Publication. Edited by J.B. Stewert, E.T. Engman, R.A. Feddes and Y. Ken.

3. Introduction to Agrometeorology (1994), Second edition by H.S. Mavi, Oxford & IBH Publishing Co. Pvt. Ltd.

4. Mutreja, K.N. (1986). Applied Hydrology. Tata McGraw-Hill Pub. New Delhi, pp: 314-171.

5. Navalgund, R.R., Parihar, J.S.; Ajai and Rao, P.P.N. (1991). Crop inventory using remote sensed data. Current Science, 61: 162-171.

6. Remote Sensing applications in Agriculture by JA Clarke and MD Steven

7. Applications of Remote Sensing to agrometeorology (Ed. F. Toselli), Kluwer Academic Publishers.

8. Kustas, WP and Norman, JM (1996).Use of remote sensing for evapotranspiration monitoring over land surfaces. Hydrological sciences Journal, 41(4): 495-515.

9. Moriondo, M., Maseli, F. and Bindi, M. (2007).A simple model of regional wheat yield based on NDVI data. Europ. J. Agronomy, 26:266-274.

10. Michel Deshayes et al. (2006).The contribution of remote sensing to the drought assessment. Ann. For. Sci. 63 (2006) 579–595.

11. Satellite Remote Sensing and GIS Applications in Agricultural Meteorology (2005). Edited by Sivakumar et al , CaMG, WMO, Geneva.

Websites

http://www.wamis.org/tools/
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag5779
http://www.bgc-jena.mpg.de/bgc-mdi/index.php/Publ/Publications
http://www.civenv.unimelb.edu.au/~jwalker/pub.html
http://cybele.bu.edu/download/download.html
http://www.fao.org/waicent/Faoinfo/Agricult/AGL/aglw/cropwater/sugarcane.stm

2.1.4 Land Evaluation & Soil Conservation Planning

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
LC 1 & LC 2	Concept and approaches of land evaluation
LC 3	Identification and mapping of degraded lands
LC 4	Soil erosion inventory and hazard assessment
LC 5	Soil erosion modeling
LC 6 & LC 7	Watershed analysis and soil conservation prioritization
LC 8	Soil conservation planning
LC 9	Decision support system for land use planning
LC 10	Optimal land use planning for sustainable development
LC 11 & LC 12	FAO-AEZ approach in Agricultural Land Use Planning

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
LC – EX 1	Degraded land mapping using aerospace data following visual analysis	6
LC – EX 2	Degraded land mapping by digital techniques	10
LC – EX 3	GIS applications for soil erosion inventory & modeling	10
LC – EX 4	Land evaluation and suitability analysis	12
LC – EX 5	Watershed analysis: prioritization and suggested soil conservation measures	10
LC – EX 6	*Ground truth collection for watershed parameters and degraded lands*	10 ***(Field work)***

Suggested Readings:

1. Metternichta, G.I. and Zinck, J.A. (2003) A review of Remote sensing of soil salinity: potentials and constraints, Remote Sensing of Environment 85:1 –20.

2. Schoenholtza, S. H , Van Miegroetb, H., Burger, J.A. (2000). A review of chemical and physical properties as indicators of forest soil quality: challenges and opportunities, Forest Ecology and Management 138: 335-356.

3. Aksoy, Hafzullah and Levent Kavvas, M.A. (2005). Review of hillslope and watershed scale erosion and sediment transport models, Catena

4. Dent, D. L. and A. Young (1981). Soil Survey and Land Evaluation. Geo Allen and Unwin, London.

5. Davidson, D.A. (1992). Evaluation of Land Resources. Harlow, Longman Group UK Limited, 198 p.

6. F.A.O. (1991). Land Use Planning applications: World Soil Resources Reports; 68. Rome, FAO, 206 p.

7. Terrence, J. Toy; Foster, George, R. and Renard, Kenneth, G. (2002). Soil Erosion: Processes, prediction, measurement and control. John Wiley & Sons, Inc. New York.

8. Sabine Grunwald (2006). Environmental Soil –Land Scape Modeling ; Geographic Information System and Pedomatrics, Taylor & Francis Group, LLC.

Websites

www.isric.nl/ISIS.htm
www.soilslab.cfr.washington.edu/s-7/soil glossary.html
www.nhg.nrcs.usda.gov/WSr/Welcome.html
www.silsoe.cranfield.ac.uk/sslrc
http://www.forester.net/ec.html
http://topsoil.nserl.purdue.edu/nserlweb
http://topsoil.nserl.purdue.edu/weppmain/wepp.html
http://soilerosion.net/doc/models_menu.html
http://skagit.meas.ncsu.edu/~helena/gmslab/reports/CerlErosionTutorial/denix/Approach/etable.htm (Modeling erosion at multi scale)
http://www.soils.org
http://www.cirad.fr/isss/aisse.html
http://www.usda.gov/
http://www.fao.org
http://www.nrcss.org/

MODULE – II : Optional Elective

2.2 RS & GIS Applications in Forestry and Ecology

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.2.1	Forest Classification & Mapping	FCM	12	48	10	5	75
2.2.2	Forest Inventory	FI	12	48	10	5	75
2.2.3	Forest Management	FM	12	48	10	5	75
2.2.4	Ecosystem Analysis	EA	12	48	10	5	75
	Total		48	192	40	20	300

2.2.1 Forest Classification & Mapping

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
FCM 1	Forest density assessment using aerospace remote sensing data
FCM 2	Forest mapping using aerial photographs
FCM 3	Spectral properties of vegetation
FCM 4	Spectral vegetation indices
FCM 5 & FCM 6	Visual interpretation of satellite image for forest cover type mapping
FCM 7, FCM 8 & FCM 9	Digital image processing for forest mapping
FCM 10	Forest change detection and monitoring
FCM 11	Insect pest damaged forest detection
FCM 12	Microwave remote sensing in forestry

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
FCM – EX1	Forest mapping & density assessment	6
FCM – EX2	Measurement of spectral signatures of Vegetation cover and their interpretation	3
FCM – EX3	Visual interpretation of satellite image for forest mapping	9
FCM – EX4	Digital interpretation of satellite image for forest mapping	15
FCM – EX5	Forest change detection	9
FCM – EX6	Insect pest damage detection	6
FCM – EX7	*Ground truth collection for forest mapping & density assessment*	10 *(Field Work)*

Suggested Readings:

1. Curran, P.J. 1985. *Principles of Remote Sensing*. Longman Group Limited, England.

2. Kuchler, A.W. and Zonneveld, I.S. 1988. *Vegetation Mapping*. Kluwer Academic Publishers, AH Dordrecht, The Netherlands.

3. Manual of Remote Sensing. 1983. American Society of Photogrammetry. Falls Church, Virginia.

4. Gates, D.M., Keegan, H..J., Scheleter, J.C. and Weidner, V.R. (1965). Spectral properties of plants. *Appl. Opt.* 4:11-20.

5. Lillesand, T.M. and Krefer, R.W., (1979). Remote Sensing and Image Interpretation, John Wiley & Sons,

6. Hord, R.M. 1982. Digital Image Processing of Remotely Sensed Data, Academic, New York.

7. Jensen, J.R. 1986. Introduction Digital Image processing: A Remote Sensing Perspective. Prentice-Hall, Englewood Cliffs, NJ.

8. Sabins, F.F. 1986. Remote Sensing: Principles and Interpretation, 2nd Freeman New York.

9. Schmitz, R.F. & K.E. Gibson (1996). Douglas-fir Beetle. Forest Insect and Disease Leaflet 5. USDA Forest Service. Rl-96-87.

10. Leckie, D.G. (1984). Preliminary results of an examination of C-band SAR for forestry applications. *Proc. 14th Int. Symp.Remote Sensing Environ.* Costa Rica, pp. 943-944. Richards, J.A. *et al.* (1987). L-band radar backscatter modelling of forest stands. *IEEE Trans. Geosci. Remote Sensing* 25, 487-498.

11. Tucker, C.J.; I.Y. Fung; D.C. Kealing and R.H. Ganmon (1986). Relationship between atmosphere CO_2 variation and satellite derived vegetation index. *Nature* 319, 195-199.

12. Wooley, J. T. (1971). Reflectance and transmittance of light by leaves. *Plant. Physiol.* 47: 556-662.

Websites

http://forestry.about.com/od/forestdiseases/Most_Damaging_Forest_Diseases.htm
http://www.csc.noaa.gov/products/sccoasts/html/rsdetail.htm

2.2.2 Forest Inventory

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
FI 1	Principles of forest Inventory
FI 2 & FI 3	Forest sampling techniques
FI 4 & FI 5	Planning forest inventory
FI 6 & FI 7	Stock mapping for preparation of forest management plan
FI 8	Forest growth modeling
FI 9 & FI 10	Use of microwave SAR data for forest biomass assessment
FI 11	Fuel wood and fodder resource assessment
FI 12	Lidar remote sensing for forest ecosystem studies

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
FI – EX1	Measurement of tree height and crown density on aerial photographs	10
FI – EX1	Forest sampling techniques	6
FI – EX1	Field data analysis	8
FI – EX1	Growing stock estimation	14
FI – EX1	Digital analysis of Microwave SAR data for forest biomass assessment	12
FI – EX1	*Field work for tree height & crown density measurements; Field sampling*	10 *(Field Work)*

Suggested Readings:

1. Loetsch, E.and Haller, K.W.1973. Forest Inventory, vol. I & II, BLV Verlagsgesellschaft, Munchen Bern Wein, 60 p.

2. Cocharn, W.G. 1953. Sampling Techniques, Willey, New York

3. Becalm, S. S. and Parapet, R.C. 1998. Modeling for Forest Growing Stock Assessment using Satellite Data – A Case Study; Journal of the India Society of Remote Sensing, 26 (1&2).

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10. Tomar, M.S. & Maslekar, A.R. (1974). Aerial photographs in Land use & Forest Surveys, Jugal Kishore & Sons, Dehradun.

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2.2.3 Forest Management

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
FM 1, FM 2 & FM 3	Site suitability analysis for afforestation; Reforestation and social forestry
FM 4	Stock maps and their revision and updating for working plan preparation
FM 5 & FM 6	Integrated approach for sustainable forest management, Forest Encroachment
FM 7 & FM 8	Forest fire detection and monitoring, Fire risk zonation
FM 9 & FM 10	Wasteland development planning
FM 11	Forest resource information system (FRIS)
FM 12	Geo-spatial technology for wildlife habitat evaluation

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
FM – EX1	Site suitability analysis for forestry	11
FM – EX2	Revision and updating of stock maps	9
FM – EX3	GIS database creation for forest management	28
FM – EX4	*Field work for data collection for site suitability analysis and forest stock map preparation*	10 *(Field Work)*

Suggested Readings:

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11. Dabral, S.L., 1992. Use of remote sensing in preparing stock maps. Proc. Silver Jubilee Seminar, Indian Institute of Remote Sensing (IIRS), 18-19 Feb. 1992, pp 168-176.
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2.2.4 Ecosystem Analysis

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
EA 1, EA 2 & EA 3	Remote sensing for landscape analysis
EA 4 & EA 5	Biodiversity characterization at landscape level using remote sensing and GIS
EA 6 & EA 8	Environmental impact assessment (EIA)
EA 9 & EA 10	Ecosystem analysis
EA 11	Grassland ecosystem analysis
EA 12	Carbon cycling and productivity analysis

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
EA – EX1	Landscape analysis	12
EA – EX1	Disturbance Index and Bio-richness Analysis	15
EA – EX1	Forest vegetation analysis	10
EA – EX1	Biomass estimation	11
EA – EX1	*Field data collection for landscape analysis and biomass estimation*	10 *(Field Work)*

Suggested Readings:

1. Forman, T.T.R. and Gordon, M., 1986. *Landscape Ecology.* John Wiley Publications, New York.
2. Johnson, P.L. 1969. *Remote Sensing in Ecology.* University of Georgia Press, Athens.
3. Lulla, K. and Mausel, P. 1993. Ecological applications of remotely-sensed multispectral data. In : *Introduction to Remote Sensing of Environment*, 2nd ed. B.F. Richason, Jr., Dubygue, Kendall/Hunt, Iowa.
4. Mueller-Bombois, D. and Ellenberg, H. 1971. *Aims and Methods of Vegetation Ecology*. Wiley, New York.
5. Odum, E.P., Cantlon, J.E. and Kornicker, L.S. 1960. An organisational hierarchy postulate for the interpretation of species individuals distribution, species entropy and ecosystem evolution and the meaning of species variety index. *Ecology* 11, 395-399.
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15. Varshney, C.K. (1994). Environmentla management system: environmental impact assessment, *Lecture Notes,* Commonwealth Training Programme. March 7- May 13, IIRS, Dehradun

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www.amazon.com/Forest-Ecosystems-Analysis-Multiple-Scales
www.Wildnet.org

MODULE – II : Optional Elective

2.3 RS & GIS Applications in Geosciences

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.3.1	**Geology**	**GEL**	**12**	**48**	**10**	**5**	**75**
2.3.2	**Geomorphology**	**GEO**	**12**	**48**	**10**	**5**	**75**
2.3.3	**Hydro-geology**	**HYG**	**12**	**48**	**10**	**5**	**75**
2.3.4	**Engineering Geology**	**EGL**	**12**	**48**	**10**	**5**	**75**
	Total		**48**	**192**	**40**	**20**	**300**

2.3.1 Geology

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
GEL 1& GEL 2	Remote Sensing in Geology - An Overview
GEL 3	Aerial Photo/Satellite image interpretation in Lithological Analysis
GEL 4	Aerial Photo/Satellite image interpretation in Structural Analysis
GEL 5	Geological Interpretation of Thermal Remote Sensing Data
GEL 6	Geological Interpretation of Microwave Remote Sensing Data
GEL 7	Hyperspectral Remote Sensing for lithological mapping & mineral exploration
GEL 8	Organization and Design of Spatial/Non-Spatial Geoscientific Data under a GIS environment
GEL 9 & GE 10	Integration of Geoscientific Data under a GIS environment
GEL 11	Remote Sensing and GIS in Oil Exploration
GEL 12	Remote Sensing and GIS in Mineral Exploration and Management

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
GEL – EX1	Geological Mapping using Aerial Photographs	6
GEL – EX2	Geological Mapping using Satellite Imagery	9
GEL – EX3	Geological Interpretation of Microwave Remote Sensing data	6
GEL – EX4	Geological Applications of Remote Sensing data in mineral and oil exploration	12
GEL – EX5	Digital Image Analysis and GIS in Geosciences	15
GEL – EX6	Field work – lithological and structural data collection	10 *(Field Work)*

Suggested Readings:

Books

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2. Bonham-Carter, G.F., 1994. Geographic Information Systems for Geoscientists. Love Printing Service Ltd., Ontario, Canada.
3. Burbank, D.W. and Anderson, R.S., 2001. Tectonic Geomorphology (Illustrated), Blackwell Science Inc., Malden, Massachusetts, USA.
4. Burrough, P.A., 1986. Geographic Information System for Land Resources Assessment. Clarendon Press, Oxford, UK.
5. Drury, S.A., 2001. Image interpretation in Geology, Blackwell Science Inc., Malden, USA.
6. Gupta, Ravi P., 2003. Remote Sensing Geology, Springer-Verlag, Berlin Heidelberg, Germany.
7. Jensen, J.R., 1986. Introductory Digital Image Processing : A Remote Sensing Perspective. Pentice Hall, New Jersey, USA.
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15. Vincent, Robert K., 1997. Fundamentals of Geological and Environmental Remote Sensing, Prentice Hall.
16. Rencz, A.N. (Ed.), 1999. Manual of Remote Sensing, Remote Sensing for the Earth Sciences (3ed.), Volume 3, American Society of Photogrammetry and Remote Sensing, John Wiley & Sons Inc.
17. Henderson, F.M. and Lewis, A.J., 1998. Manual of Remote Sensing, Principles and Applications of Imaging Radar (3ed.), Volume 2, American Society of Photogrammetry and Remote Sensing, John Wiley & Sons Inc.

Journal Articles

1. Davis, P.A., Breed, C.S., McCauley, J. F. and Schaber, G.G., 1993. Surficial geology of the Safsaf region, south-central Egypt, derived from remote-sensing and field data, Remote Sensing of Environment, 46(2), 183-203.
2. Drake, N.A., Mackin, S. and Settle, J. J., 1999. Mapping vegetation, soils, and geology in semiarid shrublands using Spectral Matching and Mixture Modeling of SWIR AVIRIS imagery, Remote Sensing of Environment, 68(1), 12-25.

3. Goestz, A.F.H., Rock, B.N., Rowan, L.C., 1983. Remote sensing for exploration – an overview. Economic Geology and the Bull. of Soc. of Economic Geologists. 78(4), 573-590.
4. Green, R.O., Eastwood, M.L., Sarture, C.M., Chrien, T.G., Aronsson, M., Chippendale, B.J., Faust, J.A., Pavri, B.E., Chovit, C. J., Solis, M., Olah, M. R. and Williams, O., 1998. Imaging Spectroscopy and the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS), Remote Sensing of Environment, 65(3), 227-248.
5. Mustard, J.F., 1993. Relationships of soil, grass and bedrock over the kaweah serpentinite melange through spectral mixture analysis of AVIRIS data, Remote Sensing of Environment, 44(2-3), 293-308.
6. Ninomiya, Y., Fu, B. and Cudahy, T.J., 2005. Detecting lithology with Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) multispectral thermal infrared "radiance-at-sensor" data, Remote Sensing of Environment, 99(1-2), 127-139.
7. Schetselaar, E.M., Chung C.J.F. and Kim, K.E., 2000. Integration of Landsat TM, gamma-ray, magnetic, and field data to discriminate lithological units in vegetated granite-gneiss terrain, Remote Sensing of Environment, 71(1), 89-105.
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2. http://www.gsj.jp/
3. http://www.gsi.gov.in/
4. http://ccrs.nrcan.gc.ca/radar/
5. http://www.uwsp.edu/geo/internet/geol.html
6. http://www.geologynet.com/geologylinks.htm

2.3.2 Geomorphology

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
GEO 1	Outlines of geomorphology - an overview
GEO 2 & GEO 3	Landform Analysis based on Aerial/Satellite data Interpretation
GEO 4	Drainage basin Morphometry and Slope Analysis
GEO 5 & GEO 6	Remote Sensing for Geomorphological Mapping and Terrain Evaluation
GEO 7 & GEO 8	Morphostructure / Morphotectonics / Neotectonics
GEO 9 & GEO 10	Integrated digital Terrain Evaluation using GIS
GEO 11 & GEO 12	Land System Analysis

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
GEO – EX1	Geomorphological Interpretation of aerial photos and satellite imagery for landform analysis	12
GEO – EX2	Drainage basin Morphometry and Slope Analysis	6
GEO – EX3	Morphotectonics / Neotectonics Analysis	9
GEO – EX4	Remote Sensing for Geomorphological Mapping	6
GEO – EX5	Integrated Terrain Evaluation using Remote Sensing, Digital Image Analysis and GIS (DIA & GIS)	15
GEO – EX6	*Ground Data Collection on different landforms*	10 *(Field Work)*

Suggested Readings:

Books

1. Lueder, D.R.(1959) Aerial Photographic Interpretation- Principles and Applications, Mc. Graw Hill Book Co. Inc., New York, USA.
2. Fairbridge, R.W. (Ed.)(1968) The encyclopedia of Geomorphology, Reinhold Book Corporation, New York, USA.
3. Doornkamp, J.C. and King, C.A.M.(1971) Numerical analysis in Geomorphology –An Introduction.
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5. Demek, J. (Ed.)(1972) Manual of detailed Geomorphological Mapping, IGU Commission on Geomorphic Survey and Mapping, Czechoslovak Academy of Sciences, Academia, Prague.
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   Victor R. Baker, R. Craig Kochel, Peter C. Patton (1988) Flood Geomorphology, published by Wiley-Interscience
8. William B. White (1988) Geomorphology and Hydrology of Karst Terrains, Publisher: Oxford University Press, USA
9. Victor C. Miller, Mary E. Westerback (1989) Interpretation of Topographic Maps, Publisher: Merrill Pub Co; Facsimile edition
10. Cooke, R.U., Doornkamp, J.C.(1990) Geomorphology in environmental management- a new introduction, Clarendon Press, Oxford, UK.
11. Thornbury, W.D. (1991) Principles of Geomorphology, John Wiley & Sons, New York, USA.
12. Helmut Blume, R. Gardner, Rita Gardener, Andrew Goudie, Bjorn Wygrala(1992) Color Atlas of the Surface Forms of the Earth, Publisher: Harvard University Press
13. Don J. Easterbrook (1988) Surface Processes and Landforms (2nd Edition), Publisher: Prentice Hall; 2 edition (October 30, 1998)
14. Manual of Remote Sensing (1999) Vol. I & II, Falls Church, Virginia, U.S.A, American Society of Photogrammetry & R.S
15. Andrew S. Goudie, Ian Livingstone, Stephen Stokes (2000) Aeolian Environments, Sediments and Landforms, Publisher: Wiley
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18. G. Taylor, R. A. Eggleton (2001) Regolith Geology and Geomorphology, Publisher: Wiley; 1 edition
19. Robert Allison (2002) Applied Geomorphology: Theory and Practice, Publisher: Wiley
20. Rao P Ramakrishna (1975) Modelling of non-linear behaviour of drainage basins, Publisher: Indian Institute of Technology
21. V Gardiner (1975) Drainage Basin Morphometry, Publisher: Geo Abstracts
22. Ion Zavoianu (1985) Morphometry of drainage basins (Developments in water science), Publisher: Editura Academiei Republicii Socialiste Romania; 2nd rev. ed edition

23. G.P.O. Reddy, A.K. Maji, K.S. Gajbhiye (2004) Drainage Morphometry and its influence on landform characteristics in a basaltic terrain, Central India - a remote sensing and GIS approach, Publisher: Elsevier
24. Donald W. Knight, Asaad Y. Shamseldin (2005) River Basin Modeling for Flood Risk Mitigation, Publisher: Taylor & Francis

Journal Articles

1. Chris Thompson, Jacky Croke, Ingrid Takken (2008) A catchment-scale model of mountain stream channel morphologies in southeast Australia, Geomorphology 87, 95 119–144.
2. Meisina, S. Scarabelli (2007) A comparative analysis of terrain stability models for predicting shallow landslides in colluvial soils C, Geomorphology 87, 207–223.
3. Montana, USA Emmanuel J. Gabet, Andy Bookter (2008) A Morphometric analysis of gullies scoured by post-fire progressively bulked debris flows in southwest, Geomorphology 96, 298‒309.
4. N.Sh. Chen, Z.Q. Yue, P. Cui, Z.L. Li. (2007) A rational method for estimating maximum discharge of a landslide-induced debris flow: A case study from southwestern China, Geomorphology 84, 44–58.
5. Lucian Drăguț, Thomas Blaschke (2006) Automated classification of landform elements using object-based image analysis. Geomorphology 81, 330–344.
6. Tommaso De Pippo, Carlo Donadio, Micla Pennetta, Carmela Petrosino, Francesco Terlizzi, Alessio Valente(2008) Coastal hazard assessment and mapping in Northern Campania, Italy, Geomorphology 97 , 451‒466.
7. T. Takagi, T. Oguchi, J. Matsumoto, M.J. Grossman, M.H. Sarker, M.A. Matin (2007) Channel braiding and stability of the Brahmaputra River, Bangladesh, since 1967: GIS and remote sensing analyses, Geomorphology 85, 294–305.
8. Mirco Galli, Francesca Ardizzone, Mauro Cardinali, Fausto Guzzetti, Paola Reichenbach (2008) Comparing landslide inventory maps. Geomorphology 94, 268–289.
9. Frank Weirich, Leonhard Blesius(2007) Comparison of satellite and air photo based landslide susceptibility maps, Geomorphology 87 , 352–364.
10. Adriano Ribolini, Matteo Spagnolo.(2008) Drainage network geometry versus tectonics in the Argentera Massif (French–Italian Alps), Geomorphology, 253–266.
11. Jozef Minár, Ian S. Evans (2008) Elementary forms for land surface segmentation: The theoretical basis of terrain analysis and geomorphological mapping, Geomorphology 95, 236–259.
12. Mario Floris, Francesca Bozzano (2008) Evaluation of landslide reactivation: A modified rainfall threshold model based on historical records of rainfall and landslides, Geomorphology 94, 40–57.
13. Vishwas S. Kale (2007) Geomorphic effectiveness of extraordinary floods on three large rivers of the Indian Peninsula, Geomorphology 85, 306–316.
14. Editorial (2007) Geomorphic instability and change–Introduction: Implications of temporal and spatial scales, Geomorphology 84,153–158.
15. Entlebuch Marco Schwab, Dirk Rieke-Zapp a, Heinz Schneider, Markus Liniger , Fritz Schlunegger (2008) Landsliding and sediment flux in the Central Swiss Alps: A Photogrammetric study of the Schimbrig landslide, Geomorphology 97, 392–406.

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20. Arjun M. Heimsath b, Robert McGlynn (2008) Quantifying periglacial erosion in the Nepal high Himalaya, Geomorphology 97, 5–23.
21. Ellen Wohl, David M. Merritt (2008) Reach-scale channel geometry of mountain streams, Geomorphology 93, 168–185.
22. David R. Montgomery, Drew B. Stolar (2006) Reconsidering Himalayan river anticlines, Geoomorphology 82 (2006) 4–15
23. Neil M. Hunter, Paul D. Bates, Matthew S. Horritt, Matthew D. Wilson (2007) Simple spatially-distributed models for predicting flood inundation: A review, Geomorphology 90, 208–225.
24. J.M. Hooke (2007) Spatial variability, mechanisms and propagation of change in an active meandering river, Geomorphology 84, 277–296.
25. Marcus Gustavsson, Arie C. Seijmonsbergen, Else Kolstrup (2008) Structure and contents of a new geomorphological GIS database linked to a geomorphological map — With an example from Liden, central Sweden,Geomorphology 95, 335–349.
26. M.J. García-Rodríguez , J.A. Malpica , B. Benito , M. Díaz (2008) Susceptibility assessment of earthquake-triggered landslides in El Salvador using logistic regression, Geomorphology 95, 172–191.
27. Jürgen Herget, Richard Dikau, Ken J. Gregory, Jef Vandenberghe(2007) The fluvial system — Research perspectives of its past and present dynamics and controls, Geomorphology 92, 101–105.
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2. www.microimages.com/getstart/watershd.htm
3. http://rst.gsfc.nasa.gov/Sect17/Sect17_1.html
4. http://pubs.usgs.gov/gip/deserts/contents/
5. http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_COMPLETE_TOC.html
6. http://www.gpc.peachnet.edu/~pgore/geology/geo101/coastal.htm

2.3.3 Hydro-geology

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
HYG 1 & HYG 2	Principles of remote sensing in hydrogeological mapping and groundwater exploration
HYG 3 & HYG 4	Significance of geological mapping of rocks & structures and their hydrological properties in ground water exploration
HY G 5	Significance of different landforms & their hydrological properties in ground water exploration
HYG 6& HYG 7	Remote Sensing & GIS in ground water exploration and management in hard rock/unconsolidated material
HYG 8, HYG 9 & HYG 10	GIS for Groundwater Resource Estimation
HYG 11	Groundwater Management, Artificial Recharge and Rain Water Harvesting
HYG 12	Groundwater Quality

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
HYG – EX 1	Geologic and Geomorphic Interpretation of aerial photographs for groundwater exploration.	9
HYG – EX 2	Geologic and Geomorphic Interpretation of satellite imagery for groundwater exploration.	6
HYG – EX 3	Groundwater Targeting in different terrains – unconsolidated, semi-consolidated and hard rock types	20
HYG – EX 4	Remote Sensing and GIS for groundwater targeting and management	13
HYG – EX 5	Field work – ground truth collection for hydro-geomorphological conditions in different terrain conditions, water table / quality etc.	10 *(Field Work)*

Suggested Readings:

Books

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2. Fetter, C.W. (1988). Applied Hydrogeology. Merrill Publishing Company, Ohio, USA.
3. Karanth, K.R. (1987). Groundwater Assessment, Development and Management. Tata McGraw Hill Pub., Delhi.
4. Ragunath, H.M. (1987). Ground Water. Wiley Eastern Limited, New Delhi.
5. Schwartz FW and Zhang H (2003). Fundamentals of Ground Water. John Wiley & Sons, Inc. USA.
6. Todd DK and Mays LW (2005). Ground Water Hydrology. John Wiley & Sons, Inc. USA.

Journal Articles

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2. Custodio E (2002). Aquifer overexploitation: what does it mean? Hydrogeology Journal, 10, pp 254–277.
3. Eaton TT (2006). On the importance of geological heterogeneity for flow simulation. Sedimentary Geology, 184, pp 187–201.
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2. http://pubs.usgs.gov/fs/OFR93-643/
3. http://water.usgs.gov/software/ground_water.html
4. http://www.purdue.edu/dp/envirosoft/groundwater/src/ground.htm
5. http://www.ctic.purdue.edu/KYW/Brochures/GroundSurface.html
6. http://cgwb.gov.in/documents/Guide_on_ArtificialRecharge.pdf
7. http://water.usgs.gov/ogw/artificial_recharge.html

2.3.4 Engineering Geology

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
EGL 1	Remote Sensing for Engineering Geological Studies
EGL 2 & EGL 3	Remote Sensing for construction material investigations and estimation of rock mass strength
EGL 4 & EGL 5	Remote Sensing for Mapping of Erosion and Mass Movement Processes
EGL 6	Remote Sensing for Highway Alignment Studies
EGL 7	Remote Sensing for Investigation of River Valley Projects
EGL 8, EGL 9 & EGL 10	Remote Sensing and GIS for Natural Hazard studies
EGL 11 & EGL 12	Application of Interferometry for analysis of geological hazards

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
EGL – EX 1	Remote Sensing for Construction material investigations and estimation of rock mass strength	12
EGL – EX 2	Remote Sensing for Erosion and Mass Movement Processes	12
EGL – EX 3	Remote Sensing for Highway Alignment Studies	3
EGL – EX 4	Remote Sensing for Investigation of River Valley Projects	3
EGL – EX 5	Remote Sensing and GIS for geologic hazards	18
EGL – EX 6	*Field work – Geo-engineering aspects*	10 *(Field Work)*

Suggested Readings

Books

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16. Mitchell James K., Soga Kenichi (2005), Fundamentals of soil behavior, (3rd Ed.)
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    Richard E. Goodman (1993) Engineering Geology: Rock in Engineering Construction John Wiley and Sons.
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4. P. K. Rajmeny, U. K. Singh and S. S. Rathore (2004) A new model to estimate rock mass strength accounting for the scale effect. International Journal of Rock Mechanics and Mining Sciences, Volume 41, Issue 6, 1013-1021
5. Youn-Kyou Lee and S. Pietruszczak (2008) A new numerical procedure for elasto-plastic analysis of a circular opening excavated in a strain-softening rock mass. Tunneling and Underground Space Technology, vol. 23, Issue 5, 588-599 pp.
6. Nobuhiko Oka. (1998) Application of Photogrammetry to the field observation of failed slopes, Engineering Geologyol-50, 85-100
7. Catrin Edelbro, Jonny Sjöberg and Erling Nordlund. (2007) A quantitative comparison of strength criteria for hard rock masses, Tunnelling and Underground Space Technology. vol. 22, Issue 1, 57-68.
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10. M. Cai, P.K. Kaiser, Y. Tasaka and M. Minami (2007) Determination of residual strength parameters of jointed rock masses using the GSI system, International Journal of Rock Mechanics and Mining Sciences. vol 44, Issue 2, 247-265
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    Abdallah I. Husein Malkawi , Mohanned Al-Sheriadeh (2000) Evaluation and rehabilitation of dam seepage problems. A case study: Kafrein dam, Engineering Geology, vol. 56 (2000), 335–345.
13. Zhou Wei , Chang Xiaolin, Zhou Chuangbing and Liu Xinghong (2007) Failure analysis of high-concrete gravity dam based on strength reserve factor method, Computers and Geotechnics
    Y. Okura, H. Kitahara, T. Sammori (2000) Fluidization in dry landslides, Engineering Geology, vol. 56, 347–360.
14. Mahendra Singh' and Bhawani Singh (2008) High lateral strain ratio in jointed rock masses, Engineering Geology, vol. 98, Issues 3-4, 75-85
15. Gyanendra L. Shresthaand Einar Broch (2007) Influences of the valley morphology and rock mass strength on tunnel convergence: With a case study of Khimti 1 headrace tunnel in Nepal, Tunnelling and Underground Space Technology
    Fausto Guzzetti (2000) Landslide fatalities and the evaluation of landslide risk in Italy Engineering Geology, vol. 58, 89–107.
16. Rafael Jimenez, Alcibiades Serrano and Claudio Olalla (2008) Linearization of the Hoek and Brown rock failure criterion for tunneling in elasto-plastic rock masses, International Journal of Rock Mechanics and Mining Sciences, Volume 45, Issue 7, 1153-1163.

17. Magnitude–distance relations for earthquake-induced landslides in Greece, Gerassimos A. Papadopoulos , Areti Plessa. Engineering Geology, vol. 58, (2000), pg 377–386.
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19. C. Tan, Y. Sun , R. Wang (2000) Present day activity of the Shenzhen fault zone and its impact on the safety of a planned diversion tunnel in Shenzhen, China, Engineering Geology, vol. 57, 73–80.
20. S. W.C Au (1998) Rain induced slope instability in Hong Kong, Engineering Geology, vol- 51, 1-36.
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22. Maurizio Polemio, Francesco S. Dao. (1999) Role of rainfall in Landslide Hazard: the case of the Avigliano urban area , Sorhtern Apennines, Italy, Engineering Geology, vol. 53, (1999), 297-309.
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MODULE – II : Optional Elective

2.4 RS & GIS Applications in Human Settlement Analysis

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.4.1	Urban & regional planning, mapping and analysis	UR	12	48	10	5	75
2.4.2	Urban Land use planning and monitoring of urban areas	UL	12	48	10	5	75
2.4.3	Urban resources management, urban services & land evaluation	UR	12	48	10	5	75
2.4.4	Physical planning of urban and regional environment	PP	12	48	10	5	75
	Total		48	192	40	20	300

2.4.1 RS & GIS Applications Urban & regional planning, mapping and analysis

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
UR 1	Remote sensing and its data products for urban/ regional planning
UR 2 & UR 3	Image interpretation, visual and digital image interpretation principles and techniques
UR 4 & UR 5	Urban area interpretation and analysis using satellite imagery as well as aerial photographs
UR 6	Urban Hydrology
UR 7	Remote sensing application in large scale mapping for cadastral data base and urban areas
UR 8	Residential area evaluation
UR 9	Methods of population estimation using remote sensing
UR 10	Slum, squatter settlement detection, interpretation, delineation and analysis
UR 11 & UR 12	Traffic and parking survey with aerial photographs

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
UR – EX1	Identification of urban objects on aerial photographs of various scales	8
UR – EX1	Urban area interpretation on satellite imagery at different scales	8
UR – EX1	Urban area interpretation and analysis - Residential area interpretation; Traffic and parking surveys; Slum and squatter analysis	12
UR – EX1	Population estimation	12
UR – EX1	Urban growth monitoring	8
	Urban area object identification and ground data collection	10 *(Field Work)*

Suggested Readings:

1. American Society of Photogrammetry, Manual of Remote Sensing 2nd ed. Falls Church, Va. 1983.
2. Avery, T.E. & G.L. Berlin (1985). Interpretation of Aerial Photographs, 4th ed. Burgen, Minneapolis, Minn.
3. Juppenlatz, M. (1970). Cities in Transformation. University of Queenland Press, Hong Kong.
4. Sundaram, K.V. (1977). Urban & Regional Planning in India. Vikas Publishing House, New Delhi.
5. Krishna Babu, P. (1988). Regional Planning in India. Chugh Publications, Allahabad, India
6. Kadiyali, L.R. (1978). Traffic Engineering and Transport Planning. Khanna Publisher Pvt. Ltd., New Delhi.
7. Lo, C.P. (1986). Applied Remote Sensing. Essex, Longman.
8. Branch, M.C. (1971). City Planning & Aerial Information. Harvard University Press, Cambridge, Man.
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10. Subudhi, A.P., Sokhi, B.S., Roy P.S. (2001). Remote Sensing and GIS Applications in Urban and Regional Studies. Human Settlement Analysis Group, Indian Institute of Remote Sensing, Dehradun.
11. OECD (1992). Cities and New Technologies. Organisation for Economic Co-operation & Development, Paris.
12. Mesev, Victor (2003). Remotely Sensed Cities. Taylor & Francis, London.
13. Kulshrestha, S.K. (2006). Dictionary of Urban and Regional Planning. Kalpaz Publications, New Delhi.
14. Knowles, R & Waring, J. (1996). Economic and Social Geography. Rupa & Co., New Delhi.
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17. Brail K. Richard (2001). Planning Support Systems. ESRI Press, California.
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19. Chenli et.al. (2002). Assessment of Urban Development Plan of Beijing Using C.A. Based Urban Growth Model. PE & RS Journal, Vol. 68, No. 10, Oct. 2002.
20. Whit R. and Engaleen G. (1997). Use of constrained Urban Model for high resolution modelling of urban landuse dynamics. Environment & Planning – B, Vol. 27, 1997.
21. Anderson et.al. (1997). A Landuse and Landcover Classification system for use with remote sensing data. Available at USGS sits.
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23. Batty, M. et.al. (1999). The Dynamics of Urban Sprawl Working Paper 15. Available at http://www.casa.ucl.as.wc.

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www.casa.ncl.ac.uk
www.GISdevelopment.net
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2.4.2 RS & GIS Applications in Urban Land use planning and monitoring of urban areas

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
UL 1 & UL 2	Planning background, principles of urban area development planning and land use
UL 3 & UL 4	Urban land use classification systems, interpretation, monitoring and change detection analysis using satellite imagery and aerial photographs
UL 5	Urban land use mapping and analysis using satellite imagery and aerial photographs : advantage and limitation
UL 6 & UL 7	Urban land use mapping and analysis using satellite imagery and aerial photographs : specific case studies
UL 8	Role of small format aerial photography in monitoring urban land use changes and development plans
UL 9	Airborne laser terrain mapping for space use
UL 10	Urban land conservation using remote sensing
UL 11 & UL 12	Urban information system for resources and integrated development planning with remote sensing inputs

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
UL – EX1	Urban area classification	12
UL – EX2	Urban plan monitoring and change detection	12
UL – EX3	Urban area land use mapping and classification	24
UL – EX4	Ground data collection for verification and updating of urban areas	10 *(Field Work)*

Suggested Readings:

1. Rhind, David & Hudson, Ray (1980) : Landuse, Methuen Publishers, New York.
2. Lillesand, T.M. & Kiefer, R.W. (1987). Remote Sensing & Image Interpretation (4th Ed). John Wiley & Sons, New York.
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5. Rateliffe, John (1976). An Introduction to Town & Country Planning (2nd Ed.). Hutchinson, London.
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8. Breese, Gerald (1966). Urbanization in Newly Developing Countries, Bureau of Urban Research, Prentic Hall Inc. New Jersey, pp. 38-70.
9. Drabkin, Darin H. (1978). Land Policy and Urban Growth, New York, Paragamlon Press.
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13. Dubey, M.K. (2000). Rural and Urban Development in India. Common Wealth Publishers, New Delhi.
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15. Volpe, F. and Rossi, L. (2005). Mapping Towns from Quickbird Imagery: Sub-metre Resolution and High Positioning Accuracy. GIM International, Vol. 19, Issue 5, May 2005.

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www.itpi.org
www.GISdevelopment.net
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http://en.wikipedia.org/wiki/photogrammetry

2.4.3 RS & GIS Applications in Urban resources management, urban services & land evaluation

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
UR 1	Database design vector / raster and statistical analysis for urban / regional resources and land use planning (raster based)
UR 2 & UR 3	Database design vector / raster and statistical analysis for urban / regional resources and land use planning (vector based)
UR 4	Urban geomorphology for hazard Identification
UR 5 & UR 6	Urban environment, services and utility planning
UR 7 & UR 8	Land evaluation and suitability analysis with regard to urban development
UR 9 & UR 10	Base mapping for urban/ Zonal area Planning
UR 11 & UR 12	Urban trends in mapping and analysis using remote sensing / GIS / GPS

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
UR – EX1	Urban area mapping, zoning and classification	15
UR – EX2	Urban area environment monitoring	8
UR – EX3	Urban area planning – facility mapping	10
UR – EX4	Urban area land suitability analysis and land evaluation	15
UR – EX5	Urban area utility and services ground data collection	10 *(Field Work)*

Suggested Readings:

1. Herbert, D.T. & Johnston, R.J. (1984). Geography and the Urban Environment, Vol. I-VI, John Wiley & Sons, New York.
2. Marsh, W.M. (1978). Environmental Analysis for Landuse and Site Planning. McGraw Hills Book Co., New York.
3. Rubenstein, H.M. (1980). A Guide to Site and Environmental Planning (2nd Ed.). John Wiley & Sons, New York.
4. Ramesh, A. (1984). Resource Geography. Heritage Publishers, New Delhi.
5. Mahavir (1996). Modelling Settlement Pattern For Metropolitan Regions Inputs from Remote Sensing. ITC Publication No. 35, ITC, Enschede, Netherlands.
6. Lynch, Kerin & Hack, Gary (1985). Site Planning (3rd Ed.). MIT Press, Cambridge.
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11. Rashid, S.M. (1993). Remote Sensing in Geography, Manak Publisher Pvt. Ltd. New Delhi
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15. Anand, P.B. (1999). Waste Management in Madras revisited. Environment and Urbanisation, Vol. 11, No.2, Oct. 1999.
16. Erb. T.L., et.al. (1981). Analysis of Landfills with Historic Airphotos, Photogrammetric Engineering & Remote Sensing, Vol. 47, No. 9. September 1981, pp. 1363 – 1369

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2.4.4 RS & GIS Applications in Physical planning of urban and regional environment

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
PP 1	Remote sensing application in regional and district planning
PP 2	Process of built form and environment an integrated analysis using remote sensing techniques
PP 3	Urban land use planning and land evaluation
PP 4	Suitability analysis for residential development
PP 5	Vertulizing of 3D real world for urban design
PP 6	Digital surface modelling
PP 7	Route alignment
PP 8	Modelling for urban environment impact analysis
PP 9	Appraisal of development plan implementation
PP 10	Human health and environment analysis
PP 11	Urban structure and transportation study
PP 12	Urban hazards and risk management

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
PP – EX1	Database creation for urban area analysis – creation of spatial database	12
PP – EX2	GIS/ LIS applications - utility planning; urban growth monitoring land use planning ;developmental planning	36
PP – EX3	Ground data collection for Physical planning of urban and regional environment	10 *(Field Work)*

Suggested Readings:

1. White, R.R. (1994). Urban Environmental Management. John Wiley & Sons, New York.
2. Sokhi, B.S. & Rashid, S.M. (1999). Remote Sensing of Urban Environment, Manak Publisher Pvt. Ltd., New Delhi.
3. Bandhu, Desh (1981). Environmental Management. Indian Environmental Society, New Delhi.
4. Singh, V.N. (1986). Spatial Urban Pattern and Growth of Urbanization, Inter-India Publication, New Delhi.
5. Rashid, S.M. (1993). Remote Sensing in Geography. Manak Publication Pvt. Ltd., New Delhi.
6. Johnson, J.H. (1983). Sub urban Growth : Geographical Process at the Edge of the Western City : London. John Wiley & Sons.
7. Mayer, H.M. & Clyde, F.K. (1967). Readings in Urban Geography, Central Bank Depot, Allahabad.
8. Report of National Commission on Urbanization, 1988, Vol. IV, pp. 93-301, Govt. of India.
9. Subudhi, A.P., Sokhi, B.S., Roy, P.S. (2001). Remote Sensing and GIS Applications in Urban and Regional Studies, Human Settlement Analysis Group, Indian Institute of Remote Sensing, Dehradun.
10. Hall, Peter (2000). Urban Regional Planning (3rd Ed). Routledge, London
11. Colombo, Luigi & Marana, Barbara (2005). Building Information System : A System Based on Terrestrial Laser Scanning. GIM International, Vol. 19, Issue 1, Jan. 2005.
12. Jain, Sadhana, Sokhi, B.S. and Sur, Ujjwal (2005). Slum Identification Using High Resolution Satellite Data : Informed Settlements Patterns in India. GIM International, Vol. 19, Issue 9, Sept. 2005.
13. Maithani, S., and Sokhi B.S. (2004). RADINS : A Methodology for Earth Quake Hazard in Urban Areas in GIS Environment : Case Study Dehradun Municipal Area. ITPI Journal, Vol. 1, No. 3, July-Sept. 2004.

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MODULE – II : Optional Elective

2.5 RS & GIS Applications in Marine Sciences

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.5.1	Coastal geomorphology & coastal processes	CG	12	48	10	5	75
2.5.2	Coastal and marine ecology	CE	12	48	10	5	75
2.5.3	Satellite oceanography	SO	12	48	10	5	75
2.5.4	Marine GIS	MG	12	48	10	5	75
	Total		48	192	40	20	300

2.5.1 RS & GIS Applications in Coastal geomorphology & coastal processes

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
CG 1	Coastal zone: definition, concepts and issues
CG 2 & CG 3	Coastal geomorphology & landforms
CG 4 & CG 5	Temporal—spatial dynamics of coastal landforms, coastal landform analysis, shoreline changes etc.
CG 6& CG 7	Principles of visual interpretation techniques in coastal geomorphology
CG 8, & CG 9	Principle of bathymetry and depth surveying and methods of retrieval of coastal bathymetry from visible remote sensing, SAR and lidar data.
CG 10, CG 11 & CG 12	Fundamentals of wave tide, and circulation patterns

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
CG – EX1	Satellite Image visual interpretation for identification and delineation of coastal landforms	20
CG – EX2	Coastal landform analysis and mapping shoreline changes	10
CG – EX3	Digital image processing techniques in mapping costal landforms	10
CG – EX4	Digital image processing technique as applied to coastal zone density measurement, circulation pattern, bathymetry, suspended sediment analysis etc.	28

Suggested Readings

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13. Introduction to Environmental Remote Sensing, 1992, E.C.Bennett and L.F. Curtis, 3rd Edition, New York, Chapman and Hall
14. Managing Marine Environment, 1990, R. Kenchington, New York, Taylor and Francis
15. Remote Sensing and GIS in Ecosystem Management, 1994, V.A. Sample ed. Washington D.C: Island Press

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http://www.environment.sa.gov.au/coasts/management.html

2.5.2 RS & GIS Applications in Coastal and marine ecology

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
CE 1 & CE 2	Principles of remote sensing of sea, satellite sensors and hyperspectral remote sensing for identification of coastal features, Coastal Land Use inventory
CE 3 & CE 4	Fundamentals of marine ecology
CE 5, CE 6 &	Remote sensing applications in coastal and marine ecology (Mangrove, Coral reefs, Sea grass etc.)
CE 7, CE 8& CE 9	Remote sensing application in Coastal resources mapping and monitoring (Coastal Fisheries, Aquaculture and Coastal water Primary Productivity estimation)
CE 10	Critical Habitat Analysis
CE 11 & CE 12	Coastal ecosystem's mapping and monitoring, sea level change and impact on coastal ecosystem

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
CE – EX1	Coastal Ecosystem Mapping and monitoring using satellite data	30
CE – EX2	Bioresources mapping and monitoring using satellite data (Aquaculture/Fisheries)	15
CE – EX3	Productivity Estimation	13

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2.5.3 Satellite Oceanography

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
SO 1	Interaction of electromagnetic radiation with water
SO 2, SO 3 & So 4	Fundamentals of ocean optics and their utility in remote sensing of ocean colour
SO 5, SO 6 & SO7	Retrieval of Oceanic parameters from ocean colour sensor (Techniques, Algorithms and Applications)
SO 8 & SO 9	Principles of TIR/Passive microwave radiometer –Retrieval of oceanographic parameters (SST, WV, Wind speed)
SO 10, SO 11 & SO 12	Principles of SAR, Altimeter, Scatterometer and their applications in Ocean studies

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
SO – EX1	Insitu optical data analysis	8
SO – EX2	Processing of Ocean Colour Sensor data	20
SO – EX3	Processing of Sea Surface Temperature Retrieval	15
SO – EX4	Processing of Active microwave data	15

Suggested Readings:

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2. Davis F W & Simonett D S, 1991. GIS and remote sensing. In *Geographical Information Systems* (Edited by Maguire D J , Goodchild M F et, al,.). Longman Scieintific and Technical and John Wiley, New York.
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http://www.dhigroup.com/Software/Marine/MIKEMarineGIS.aspx
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http://arch.her.hcmr.gr/announce.html

2.5.4 Marine GIS

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
MG 1 & MG 2	GIS - concepts, models and information system and database design for coastal zone
MG 3, MG 4 & MG 5	GIS applications to Integrated Coastal Zone Management
MG 6	Integrated Coastal Fisheries Management
MG 7	Coastal Predictive Models
MG 8	Ocean State Forecasting
MG 9	GIS for Environment Impact Assessment
MG 10	GIS for Coastal Hazard Monitoring
MG 11 & MG 12	Ocean Observing System (GPS, Ships, Buoys, Platforms)

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
MG - EX1	Creation of spatial and non spatial databases	16
MG - EX2	Integrated Fisheries Forecasting and Productivity studies	10
MG - EX3	GIS (ICZM Case Study)	10
MG - EX4	CRZ Mapping	10
MG - EX5	Ocean State Forecasting	6
MG - EX6	Coastal Disaster Mapping and Monitoring	6

Suggested Readings

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6. Cracknell, A.P., (Ed), 1982, Remote Sensing Applications in Marine Science and Technology, D.Reidel Publishing Company.
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8. Dalal, S.G., and Bhargava, R.M.S., 1986, Relationship between chlorophyll-a and column primary production. Mahasagar, Bulletin of the National Institute of Oceanography, 19(1), 63.
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21. Kaufman, Y.J., 1989, The atmospheric effect on remote sensing and its correction. In Theory and applications of optical Remote Sensing_, edited Ghassem Asrar (New York:John Wiley & Sons).
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6. http://www.noc.soton.ac.uk/lso/
7. http://oceanworld.tamu.edu/students/satellites/satellite1.htm
8. http://www.orbit.nesdis.noaa.gov/star/socd_index.php
9. http://www.nesdis.noaa.gov/
10. http://www.ioccg.org/

MODULE – II : Optional Elective

2.6 RS & GIS Applications in Water Resources

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.6.1	Water Resources Assessment	WRA	12	48	10	5	75
2.6.2	Water shed Characterization	WSC	12	48	10	5	75
2.6.3	Water Resources Development	WRD	12	48	10	5	75
2.6.4	Water resources Management	WRM	12	48	10	5	75
	Total		48	192	40	20	300

2.6.1 RS & GIS Applications in Water Resources Assessment

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
WRA 1 & WRA 2	Principles of Remote Sensing in Water Resources Assessment
WRA 2 & WRA 3	Spectral Characteristics of Water/Snow and Surface Water Inventory
WRA 5	Hydrologic Elements and Quantification through Remote Sensing, Collection, Transfer and Processing of Hydrological Measurements
WRA 6 & WRA 7	Groundwater Exploration in Consolidated Material- Rock Terrain
WRA 8 & WRA 9	Groundwater Exploration in Unconsolidated Material- Alluvial Terrain
WRA 10 & WRA 11	Snow Hydrology, Snowmelt Runoff Modelling and glacier Inventory
WRA 12	Water Quality using multispectral and hyperspectral Remote Sensing

Practical + Tutorial

CODE	DESCRIPTION	PRACTICAL (HRS)
WRA – EX1	Interpretation of Satellite Imagery on different scales and Surface Water Bodies Mapping for water resources applications	12
WRA – EX2	Groundwater Targeting in different rock types	12
WRA – EX3	Precipitation and Soil moisture Estimation using remote sensing	12
WRA – EX4	Snow Ice mapping using Remote Sensing	12
WRA – EX5	Field Work: Spectral Response of different Water Features	10 (Field Work)

Suggested Readings

Books

1. American Society of Photogrammetry and Remote Sensing. Manual of remote sensing. v. II. Falls Church, Virginia, 1983.
2. Philip, S., and M. D. Shirley. Remote sensing: the quantitative approach. New York, McGraw-Hill, 1978.
3. Engman, E. T., and R. J. Gurney. Remote sensing in hydrology. London, Chapman and Hall, 1991.
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6. Pratap Singh and Vijay P. Singh (2001). Snow and Glacier Hydrology. Kluwer Academic Publishers. Netherlands.

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2. Meijerink, Allard M.J. et.at. 1994, "Introduction to the use of Geographic Information Systems for Practical Hydrology" International Hydrological Programme IHP IV M 23, ITC, The Netherlnads.
3. Singh, P., *and others*. Snow and glacier contribution in the Ganga river at Devprayag. National Institute of Hydrology, Roorkee, India, 1994.

Web site

- Runoff snow modelling:www.apogeeinstruments.com

2.6.2 RS & GIS Applications in Watershed Characterization

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
WSC 1 & WSC 2	Creation, Organization and Design of Spatial and Non-Spatial Data in Water Resources Engineering
WSC 3 & WSC 4	DEM Application in Water Resources
WSC 5 & WSC 6	Watershed Hydrology and Physical Processes in Watershed
WSC 7	Basic concepts of Hydrological Modeling
WSC 8	Principles of Aerial Photo/ Satellite Image Interpretation in Lithological Identification and Structural Analysis
WSC 9 & WSC 10	Erosion, Erodibility & Sediment Yield Modeling and Watershed Prioritization
WSC 11 7 WSC 12	Watershed conservation planning.

2.6.2 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
WSC – EX1	Database Creation for Water Resources – Spatial and Non-Spatial Databases	12
WSC – EX2	DEM Applications in Water Resources	12
WSC – EX3	Identification of Erosion Prone Areas in Watershed	12
WSC – EX4	Hydrologic Modelling Using Remote Sensing and GIS	12
WSC – EX5	*Field Work: Resource Data Collection in Small Watershed*	10 (Field Work)

Suggested Readings

Books:

1. Beven K.J., 2001. "Rainfall runoff modeling", Wiley & sons..
2. Dingman S. Lawrence Physical Hydrology (2002). 2nd edition. Prentice Hall , Upper saddle river , New Jersey. USA.
3. Gregory, K. J., and D. E. Walling. Drainage basin form and process: a geomorphological approach. London, Edward Arnold, 1973.
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5. Mutreja, K. N. Applied hydrology. New Delhi, Tata McGraw-Hill, 1990.
6. Pimentel, D. ed. World soil erosion and conservation. Cambridge, Cambridge University Press, 1993.
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Report:

1. Sarda, V.N, and others. (2007) Manual of soil and water conservation practices. Three Volumes. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. David Maidment and Dean Djokic (Editor) (2002). Hydrologic and Hydraulic Modeling Support with Geographic Information Systems. ESRI press.
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1. Schultz, G. A. and Engman, E. T. (2000). "*Remote Sensing in Hydrology and Water Management*," Springer-Verlag, Berlin, Germany.
2. Jirayoot, K., Sawamoto, M., Kazama, S., 1992. Quasi-physically based distribution rainfall-runoff model incorporating GIS data. Annu. J. Hydraulic Eng., JSCE 36, 659–664.

Website

http://www.wmo.int/pages/prog/wcp/agm/publications/html/miscellaneous_en.html

2.6.3 RS & GIS Applications in Water Resources Development

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
WRD 1 & WRD 2	Geo-engineering Consideration for Investigation of Hydel Resources
WRD 3 & WRD 4	Mapping Waterlogged and Salinization Area in Irrigation Command
WRD 5 & WRD 6	River Morphology
WRD 7 & WRD 8	River Valley Project Planning
WRD 9	Evaluation of Water Management in Irrigation Command Area
WRD 10 & WRD 11	Irrigation Water Scheduling and Conjunctive Water Use Planning
WRD 12	Environmental Impact Assessment of Water Resource Project

2.6.3 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
WRD – EX1	Geo-engineering Mapping for Investigation of Hydel Resources	12
WRD – EX2	Mapping Water Logged and Saline areas using Remote Sensing	12
WRD – EX3	Geomorphological Feature Identification of Rivers and Deltas	12
WRD – EX4	Irrigation Command Area Mapping and Crop Water Requirements	12
WRD – EX5	*Field data collection for water resources development*	10 (Field Work)

Suggested Readings

Books

1. Bastiaanssen, W. G. M. 1998. *"Remote sensing in water resources management: The state of the art."* Colombo, Sri Lanka: IWMI.
2. Doorenbos, J., and W. O. Pruitt. Guidelines for predicting crop water requirements. Irrigation and drainage paper No. 24. Rome, Food and Agriculture Organization of the United Nations, 1977.
3. Subramaniam K. (1998). Engineering Hydrology. TATA-McGRAW – HILL Publication
4. Ven Te Chow, David R. Maidment, and Larry W. Mays (1988). Applied hydrology. McGRAW – HILL Publication.
5. Borchardt, D., Davis, J., 1998. Ecological impact of urban storm water runoff studies in experimental .flurnes: population loss by drift and refugial space. Aquat. Sci. 52, 299–314

Reports:

1. Veeranna, M. Groundwater resources and development potential of Karimnagar District, Andhra Pradesh. Central Ground Water Board, Ministry of Water Resources, Government of India, 1990.
2. Ministry of Irrigation. Groundwater estimation methodology. Report of the Groundwater Estimation Committee. New Delhi, Government of India, 1984
3. Ministry of Irrigation. A guide for estimating irrigation water requirements. Technical series No. 2, rev. 144. New Delhi, Government of India, Ministry of Irrigation, Water Management Division, 1984.

Journal Article:

Ritchie, J. T. A model for predicting evaporation from a row crop with incomplete cover. *Water resources research*. 8:5, 1972.

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2.6.4 RS & GIS Applications in Water Resources Management

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
WRM 1 & WRM 2	Groundwater Modeling
WRM 3	Drought Monitoring
WRM 4	ET Estimation using Remote sensing
WRM 5	Reservoir Sedimentation Studies by Remote Sensing and GIS
WRM 6 & WRM 7	Flood Mapping, Simulation and Damage Assessment using Optical and Microwave data
WRM 8	Water Balance
WRM 9 & WRM 10	Site Suitability Analysis for Water Harvesting Structures – A Remote Sensing & GIS Approach
WRM 11 & WRM 12	Integrated watershed management for sustainable development

2.6.4 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
WRM– EX1	Drought Monitoring, ET Estimation	12
WRM– EX2	Water Balance Studies	12
WRM– EX3	Remote sensing and GIS for Flood Mapping, simulation, Risk Zoning	12
WRM– EX4	Reservoir sedimentation studies using remote sensing and GIS	12
WRM– EX5	*Field Work: Data Collection for Water Resources Management*	10 (Field Work)

Suggested Readings

Books:

1. Bedient B. Philip and Huber C. Wayne (2002). Hydrology and floodplain analysis, Prentice Hall , Upper saddle river , New Jersey. USA.
2. Bonham-Carter, G. F. Geographic information systems for geoscientists: Modelling with GIS. Kidlington, Pergamon Press, 1994.
3. Dunne, T. and L. B. Leopold, (1978), Water in Environmental Planning, W H Freeman and Co, San Francisco.
4. Kaushish, S. P. and Murthy, T. S. 2001. Reservoir sedimentation. Proceedings of seminar organised by Central Board of Irrigation and Power held in Ooty.
5. Laurini, R., and D. Thompson. Fundamentals of spatial information systems. Apic series No. 37. New York, Academic Press, 1994.
6. Kirkby, M. J., ed. (1978), Hillslope Hydrology, John Wiley, Chichester.
7. Thornthwait, C. W and J. R. Mather. Instructions and tables for computing potential evapotranspiration and the water balance. Publications in climatology. v. 10, Centerton, New Jersey, 1957.

Reports:

1. Goel, R. K. Tutorial on GIS basics (preconference). Ahmedabad, Indian Society of Geoinformatics, 1996.
2. de Brouder, J.A.M. Flood study in the Meghna-Dhonagoda polder, Bangladesh. Paper presented to the 15th Asian Conference on Remote Sensing, Bangalore, India, 17-23 November 1994
3. Aggarwal, A., S. Narain and I. Khurana, eds. New Delhi, Center for Science and Environment
4. Government of India. Handbook of hydrology. New Delhi, Ministry of Agriculture, 1972.
5. National Remote Sensing Agency. Integrated mission for sustainable development: technical guidelines. Department of Space, Government of India, 1975.
6. Vijayalakshami, K., K.P.R. Vittal and R. P. Singh. Water harvesting and reuse. Decade of dryland agriculture research in India (1971-1980). Hyderabad, All India Coordinated Research Project for Dryland Agriculture, Council of Agriculture Research, 1987

Journals Articles:

1. Economic and Social Commission for Asia and the Pacific. Integrated approach to flood disaster management and rural area development. *Water resources journal*. Bangkok, 1991
2. Zalewski, M., 2002. Ecohydrology—the use of ecological and hydrological processes for sustainable management of water resources. Hydrol. Sci. J. 47, 823–832.
3. Leone, A., Shams, S., Chen, D., 2006. An object-oriented and OpenGIS supported hydro-information system (3O-HIS) for upper Mersey river basin management. International Journal of River Basin Management 4 (2), 1-9.

MODULE – II : Optional Elective

2.7 Advanced Techniques in RS & GIS

Sub Module	Subject	Code	Lectures (L)	Tutorials (T) + Practical (P)	Field Work (F)	Library (Li) / Guest Lectures (G)	Total
2.7.1	Advances in Remote Sensing and Image Analysis	ARIA	12	48	10	5	75
2.7.2	Advances in Photogrammetry and Automated feature Extraction	APAF	12	48	10	5	75
2.7.3	GIS customization, Internet GIS & Mobile Mapping	GCIM	12	48	10	5	75
2.7.4	Spatial Decision Modeling & Geo-statistics	SDGS	12	48	10	5	75
	Total		48	192	40	20	300

2.7.1 Advances in Remote Sensing and Image Analysis

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
ARIA 1, 2, 3 & 4	Advanced Classifiers - Introduction To Fuzzy Theory & Fuzzy Classification, Artificial neural Networks and Classification Methods
ARIA 5, 6 & 7 & 8	Spatial Transformation Techniques - Texture Analysis - First Order, Second Order Texture Parameters, Gray Level co- Occurrence Matrix; Image Segmentation methods – thresholding, edge based, region growing etc.; Wavelet transform and its application in RS Image Analysis
ARIA 9, 10, 11 & 12	Hyperspectral Image Analysis - Hyperspectral Remote Sensing, Imaging Spectroscopy, Data processing techniques - N-Dimensional Scatter plots, Spectral Angle Mapping Spectral Mixture Analysis, Spectral Matching and Sub-pixel Classification; Atmospheric Corrections of RS data and Geophysical Parameter retrival

2.7.1 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
ARIA - EX1	Familiarization with **E-cognition** software	4
ARIA - EX1	Fuzzy Classification	6
ARIA - EX1	Neural network Classification	4
ARIA - EX1	Multi resolution segmentation of Image objects	6
ARIA - EX1	Texture Analysis and Texture based segmentation	6
ARIA - EX1	Hyperspectral data import and display (ENVI)	2
ARIA - EX1	MNF Transform Data, End members, and Spectral Unmixing (ENVI) and *n* -Dimensional Visualization (ENVI)	8
ARIA - EX1	Demo on Atmospheric corrections	4
ARIA - EX1	Demo on Atmospheric corrections	4
ARIA - EX1	*Ground Verification*	*10 (Field)*

Suggested Readings

Books

1. Elachi, C. Introduction to the Physics and Techniques of Remote Sensing, Wiley Interscience, 1987.
2. Freek van der Meer, Steven M. de Jong, 2001. Imaging Spectrometry basic Principleas and prospective applications. Kluwer academic publisher, Dordrecht, the Netherlands.
3. Pramod K. Varshney, Manoj K. Arora, 2004. Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data, Springer. ISBN: 3540216685.
4. Richards John A& Xiuping Xia, 2006. Remote Sensing Digital Image Analysis: An Introduction. Birkhäuser
5. Asrar, G., 1989. Introduction in Theory and Application of Optical remote sensing. (Asrar. G. Ed), John Wiley & sons
6. Jensen John R. Introduction to Digital Image Processing: A Remote Sensing Perspective Prentice hall, New Jersey
7. Shunlin Liang, 2005. Quantitative Remote Sensing of Land surfaces. John Wiley & Sons
8. Yu Hen Hu and Jenq_Neng Hwang, Handbook of Neural Network Signal Processing, CRC Press, 2001.
9. Patrick Henry Winston, Artificial Intelligence, AWL, 1999.
10. Adedeji B. Badiru and John Y. Cheung, Fuzzy Engineering Expert System with Neural Network Applications, 2002
11. Gerald Kaiser, 1994. A friendly guide to wavelets. Springer.
12. Anthony K. Hyder, Elisa Shabazian, Edward Waltz, 2002. Multisensor Fusion. Springer

Journal Articles

1. Ball, D.W., Defining Terms, Spectroscopy, 10, 16-18, 1995.
2. Clarke, J.T., G. Ballester, J. Trauger, J Ajello, W. Pryor, K. Tobiska, J.EP. Connerney, G.R. Gladstone,J.H. Waite, Jr., L. Ben Jaffel, J.-C. Gérard, Hubble Space Telescope imaging of Jupiter's UV aurora during the Galileo orbiter mission, J. Geophys. Res., 103, 20,217-20,236, 1998
3. Clark, R. N., S. Vance, K.E. Livo, and R. Green, Mineral Mapping with Imaging Spectroscopy: the Ray Mine, AZ, Summaries of the 7th Annual JPL Airborne Earth Science Workshop, R.O. Green, Ed., JPL Publication 97-21. pp 67-76, Jan 12-14, 1998.
4. Chavez, P.S., Jr. 1988. An improved dark-object subtraction technique for atmospheric scattering correction of multispectral data. Remote Sensing of Environment, 24:459-479
5. Eckhardt, D.W., J.P. Verdin, and G.R. Lyford. 1990. Automated update of an irrigated lands GIS using SOPT HRV imagery. Photogrammetric Engineering and Remote Sensing, 56(11): 1515-1522
6. F. J. Ahern; R. J. Brown J. Cihlar; R. Gauthier; J. Murphy; R. A. Neville; P. M. Teillet, 1987; Review Article Radiometric correction of visible and infrared remote sensing data at the Canada Centre for Remote Sensing; International Journal of Remote Sensing, Volume 8, Issue 9 September 1987 , pages 1349 – 1376
7. Goetz, A. F., G. Vane, J. E. Soloman, and B. N. Rock, Imaging Spectrometry for Earth Remote Sensing. Science, 228, 1147, 1985.
8. Goetz A.F.H.(1992) Imaging spectrometry for earth remote sensing, Imaging spectroscopy: Fundamentals and prospective applications:1-19

9. Goetz, A.F.H. (1992b) Principles of Narrow Band Spectrometry, in The Visible and IR: Instruments and Data Analysis in Imaging Spectroscopy: Fundamentals and Prospective Applications, F. Toselli and J. Bodechtel, Eds., pp. 21-32, Brussels and Luxembourg.
10. Green, Robert O., James E. Conel, Veronique Carrere, Carol J. Bruegge, Jack S. Margolis, Michael Rast, and Gordon Hoover, 1990, Determination of the In-Flight Spectral and Radiometric Characteristics of the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS), in Proceedings of the Second Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) Workshop, JPL Publication 90-54, pp. 15-22, 1990.
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13. Markham B L and Barker J L 1986 Landsat MSS and TM post-calibration dynamic ranges, exoatmospheric reflectances and at-satellite temperatures; In: EOSAT Technical Notes, No. 1, 3{8)
14. Markham B L and Barker J L 1987 Thematic Mapper band- pass solar exoatmospheric irradiances; *Int. J. Remote Sensing* 8(3) 517{523)
15. Merton, R. N., Cochrane, G. R. (1995). Imaging spectroscopy: a new tool for the physical sciences. New Zealand Geographical Society Anniversary Conference. University of Canterbury, Christchurch, New Zealand. 27-31 August 1995.
16. Nassau, Kurt (1980) Gems Made By Man. Chilton Book Co., Radnor, PA, USA.
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20. Smith RB, 2006. Introduction To Hyperspectral Imaging. http://www.microimages.com/getstart/hyprspec.htm.
21. Schott, J. R., C. Salvaggio and W. J. Volchok, 1988. Radiometric scene normalization using pseudo invariant features. Remote Sensing of Environment, 26(1), pp. 1-16.
22. Song, C., Woodcock, C.E., Seto, K.C., Pax Lenney, M., and Macomber, S.A. (2001), Classification and change detection using Landsat TM data: when and how to correct atmospheric effects? Remote Sens. Environ. 75:230-244.
23. Tokola, T., Lofman, S., and Erkkila, A., 1999. Relative calibration of multitemporal landsat data for forest cover change Detection. Remote Sens. Environ. 68:1–11.
24. Tiellet P M, Guindon B and Goodenough D G 1982 On the slope-aspect correction of multispectral scanner data; Canadian J. of Remote Sensing 8(2) 84{106)
25. Vane, G., J.E. Duval, and J.B. Wellman, 1993, Imaging spectroscopy of the earth and other solar system bodies, in Remote Geochemical Analysis: Elemental and Mineralogical Composition (C. M. Pieters, and P.A.J. Englert, eds.), Cambridge University Press, Cambridge, 121-143.
26. Vermote, E. F., Tanre´ , D., Deuze, J. L., Herman, M., and Morcrette, J. J. (1997), Second Simulation of the Satellite approach to atmospheric correction of remotely sensed data.

Signal in the Solar Spectrum (6S), 6S User's Guide Version 2, NSAS Goddard Space Flight Center, Code 923, Green belt MD
27. Vogelmann, J. E. (1988), Detection of forest change in the Green Mountains of Vermont using Multispectral Scannerdata. Int. J. Remote Sens. 9:1187–1200.
28. Xuexia Chen, Lee Vierling and Don Deering, 2005. A simple and effective radiometric correction method to improve landscape change detection across sensors and across time. Remote Sensing of Environment Volume 98, Issue 1, 30 September 2005, Pages 63-79
29. Charalampidis, D., Kasparis, T., 2002. Wavelet-based rotational invariant roughness features for texture classification and segmentation. IEEE Trans. Image Process. 11 (8), 825-837.
30. Di Ruberto, C.; Rodriguez, G.; Vitulano, S. Image segmentation by texture analysis Image Analysis and Processing, 1999. Proceedings. International Conference on Volume, Issue, 1999 Page(s): 376 – 381
31. D. Comanicui and P. Meer, "Mean Shift: A Robust approach toward feature space analysis", IEEE Trans. on PAMI, vol. 24, No: 5, 2002.
32. G.V. Wouver, P.Scheunders and D.V. Dyck, "Statistical texture characterization from discrete wavelet representations", IEEE Trans. on IP, vol.8, pp.592- 598, 1999.
33. J.Chen, T.N. Pappas, A. Mojsilovic, and B. Rogowitz, "Image Segmentation by Spatially adaptive color and texture features", Proceedings of IEEE International Conference on Image Processing (ICIP'03), Barcelona, Spain, Sept. 2003.
34. Gang Hong, Yun Zhang, 2004. The Effects Of Different Types Of Wavelets On Image Fusion. http://www.isprs.org/istanbul2004/comm4/papers/474.pdf
35. H. Li, B. S. Manjunath, S. K. Mitra, Multisensor image fusion using the wavelet transform, Graphical Models and Image Processing, v.57 n.3, p.235-245, May 1995
36. L. J. Chipman, T. M. Orr, L. N. Graham, 1995. Wavelets and image fusion, Proceedings of the 1995 International Conference on Image Processing (Vol. 3)-Volume 3, p.3248, October 23-26, 1995
37. M.Unser, "Texture classification and segmentation using wavelet frames", IEEE Trans. On IP, vol.4, pp. 1549-1560, 1995.
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41. Y.Deng and B.S. Manjunath, "Unsupervised segmentation of color texture regions in images and video", IEEE Trans. on PAMI, vol. 23, pp. 800-810, Aug. 2001.

Websites

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2. www.eoc.csiro.au/hswww/Overview.htm
3. http://www.csr.utexas.edu/projects/rs/hrs/hyper.html
4. http://www.techexpo.com/WWW/opto-knowledge/IS_resources.html
5. www.cas.sc.edu/geog/rslab/Rscc/mod5/5-1/5-1.html
6. http://www.amara.com/IEEEwave/IEEEwavelet.html

2.7.2 Advances in Photogrammetry and Automated feature Extraction

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
APAF 1	Mathematical Concepts in Digital and Satellite Photogrammetry
APAF 2	Collinearity and Coplanarity Conditions
APAF 3	Photogrammetric solution in Satellite Photogrammetry Orbital Parameters; Orbital Modeling & Sensor Modelling and Intersection Data Processing for stereo generation
APAF 4	Alternate Sensor Models - Rational Function Model /Rational Function coefficient
APAF 5	Image Matching Techniques
APAF 6	DEM generation (Regular, Irregular) and Orthorectification
APAF 7	Terrain Analysis and Visualization: 3D Simulation; Inter visibility Analysis; Virtual Reality concepts in Digital Mapping; City models; Derivatives of DEM
APAF 8	Interferrometry technique and DEM Generation
APAF 9	Automatic Feature extraction – Need for Automatic Feature extraction; Point Extraction (Forstner and Morovec Operators); Edge Extraction (Sobel, Prewitt, Robert)
APAF 10	Area extraction (Image Segmentation- Region Growing, Split and Merge) Automatic Extraction of deterministic Objects
APAF 11	Laser Remote Sensing, Lidar Altimetry Principles; Sources of Error and Accuracy , Applications and Processing of LIDAR data
APAF 12	Comparision of DEM generation techniques

2.7.2 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
APAF– EX1	Familiarisation with Digital Photogrammetric Workstation	2
APAF– EX2	DEM and Ortho photo generation from Digital aerial data	6
APAF– EX3	DEM and Ortho photo generation from Satellite Stereo Data	6
APAF– EX4	DEM generation using alternate sensor Model	6
APAF– EX5	Automatic Feature Extraction from satellite imagery (Point & Linear Feature)	4
APAF– EX6	Automatic Feature Extraction from satellite imagery(Polygonal feature)	6
APAF– EX7	Map Updation using ortho rectified satellite/aerial Data	6
APAF– EX8	Viewshed and Inter visibility Analysis	4
APAF– EX9	Lidar data import , display and Processing (ERDAS IMAGINE)	2
APAF– EX10	Filtering and Elevation information (DEM,DSM) generation from Lidar data , Object Height Determination from Lidar Data	2
APAF– EX11	*Field data Collection and verification of updated map.*	10 (Field)

Suggested Readings

Books:

1. Toni Schenk: Digital Photogrammetry, Volume I., TerraScience.
2. Mikhail Edward, bethel James and Mcglone J Chris Introduction to Modern Photogrammetry
3. Kasser Michel and Egles Yves Digital Photogrammetry

Journal Articles

1. Ackermann, F., 1999. Airborne laser scanning – present status and future expectations. *ISPRS Journal of Photogrammetry and Remote Sensing 54 (2-3)*, pp. 164 – 198.

2. Axelson, P., 2000. DEM generation from Laser Scanner Data Using Adaptive TIN-Models. In: *Int. Arch. Of Photogrammetry and Remote Sensing*, Vol. 33, Part B4/1, pp. 110- 117

3. Dowman, I., Dolloff, J., 2000. An evaluation of rational functions for photogrammetric restitution, *IAPRS*, pp. 254-266. Di, K., Ma, R., Li, R., 2003. Rational functions and potential for rigorous sensor model recovery, *PE&RS*, 69(1), pp. 33-41.
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6. Karsten Jacobsen, 2000. State-of-the-art trends in mapping – Past, present and future, INCA workshop 2002, Ahmedabad, India
7. Karsten Jacobsen, 2002. Geometric aspects of the handling of space images, , ISPRS Commission I / Pecora 15 Conference Proceedings, IntArchPhRS (34) Part 1 Com I, pp 89 – 93, Denver 2002
8. Michel Morgan, Klaus Tempfli**,** 2000. Automatic building extraction from airborne laser scanning data, International Archives of Photogrammetry and Remote Sensing. Vol. XXXIII, Part B3. Amsterdam 2000

Website:
www.isprs.org

2.7.3 GIS customization, Internet GIS & Mobile Mapping

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
GCIM 1	GIS customization concepts
GCIM 2 & GCIM 3	Role of Programming languages in GIS Customization
GCIM 4 & GCIM 5	Introduction to VB programming language
GCIM 6 & GCIM 7	Overview of Internet GIS
GCIM 8 & GCIM 9	Client /Server Architecture Application
GCIM 10 & GCIM 11	Fundamentals of Mobile Mapping
GCIM 12	Mobile Mapping application

2.7.3 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
GCIM – EX1	Overview to Visual Basic	**3**
GCIM – EX2	Variables, Procedures & Functions	3
GCIM – EX3	Controlling Program Execution	3
GCIM – EX4	GIS Customization Execution	9
GCIM – EX5	Rendering the features on the map	4
GCIM – EX6	Selecting features & Retrieving the information	4
GCIM – EX7	Web page Design	6
GCIM – EX8	JavaScript Programming	1
GCIM – EX9	Mini-research on programming the web	6
GCIM – EX10	Internet GIS Application	3
GCIM – EX11	Internet GIS development with Open Source& ArcIMS/Other S/Ws	3
GCIM – EX12	Demonstration of Internet GIS Application	3
GCIM – EX13	Field visit for Mobile Mapping	10

Suggested Readings

Books

1. Zong R Peng , Ming H Tsou, 2003 , Internet GIS Distributed Geographic Information Services for the internet and wireless networks., Wiley John & Sons, Inc.
2. Beginning MapServer: Open Source GIS Development (Expert's Voice in Open Source) by Bill Kropla (Author) Apress Publication (August 22, 2005) | ISBN-10: 1590594908 800 pages
3. Spatial Data on the Web by Alterto Belussi, Barbara Catania, Elisco Clementini, Elena Ferrari (Eds.) Springer Publication (2007)
4. Dynamic and Mobile GIS: Investigating Changes in Space and Time **by** Jane Drummond, Roland Billen, Elsa Joao, David Forrest, CRC | ISBN 0849390923 | November 10, 2006 | 310 pages
5. Scott Davis, "GIS for Web Developers: Adding 'Where' to Your Web Applications" Pragmatic Bookshelf (October 9, 2007) ISBN: 0974514098, 176 pages
6. C. V. Tao & J.Li, Advances in Mobile Mapping Technology (ISPRS). Taylor & Francis, ISBN: 0415427231, 2007-05-31, 191 pages
7. International Perspectives on Maps and the Internet Edited by M.P. Peterson (Ed.), Springer Publication (2008)
8. Burrough, Peter. 2001. Principles of Geographical Information Systems. Oxford, England: Oxford University Press.
9. Pressman. 1997. Software Engineering: A Practitioners Approach. New York: McGraw-Hill.
10. Bruce I. Blum 1992 Software Engineering- A holistic View , Oxford, England: Oxford University Press.
11. Tom Flecher, Jim Hunt, 1993, Software engineering and CASE, Bridging the culture gap, McGraw- Hill Inc.
12. David Martin, 1998, Principles of Geographical Information Systems,Routledge
13. Juliano Lopes de, 1997, Active Customization of GIS user interfaces
14. Xyechao Chi, 2004, Arc Objects Customization of routine business process, UC proceedings.
15. S. Pfleeger**.**1991. Software Engineering. New York: Macmillan Inc.
16. Schach. 1996 Classical and Object-Oriented Software Engineering, Oxford, England: Oxford University Press.
17. Environmental Systems Research Institute. 1995. ArcView, the Geographic Information System for Everyone. Redlands , CA.
18. Environmental Systems Research Institute. 1997. Avenue customization and application development for ArcView. White Paper. Redlands, CA.
19. Environmental Systems Research Institute, 2001. ArcObjects developer guide , Redlands, CA.
20. Environmental Systems Research Institute.1996. MapObjects: GIS and Mapping Components. Redlands, CA.
21. Van Vliet, Hans**.**1993 Software Engineering: Principles and Practice. Chichester: John Wiley & Sons
22. Hatcher, G. A., Maher, N. M. and Orange, D. L. 1997 The customization of ArcView as a real-time tool for oceanographic research. Proceedings of the 17th Annual ESRI User Conference, San Diego, CA.

Journal Articles

1. Tomlinson, Roger, and Douglas Smith. 1992. "Assessing Costs and Benefits of Geographical Information Systems: Methodological and Implementation Issues." *International Journal of Geographical Information Systems*, Vol. 6, No. 3, 247-256.
2. Eliana S. 1998. "Cost benefit analysis for Geographical Information Systems-Implementation Justfication" submitted to Bruce Oswald Chair of the NYS GIS Coordinating Body .
3. Ahmed L , Francois P. 2000.The development and customization of GIS based application and web based GIS applications with CASE tool AIGLE. Proceedings of the 8th ACM international symposium on Advances in geographic information systems,Washington , DC
4. *Juliano Lopes de Oliveira, Claudia Bauzer Medeiros, Mariano Ariel Cilia.1997.*Active Customization of GIS user interfaces. University of Birmingham, Birmingham, U.K
5. Carver,S. (2001) Public participation using web-based GIS., *Environmental and Planning B: Planning and Design*, 28, pp. 803-804.
6. Chang, Y.S and Park, H.D. (2004a) Development of a web-based Geographic Information System for the management of borehole and geological data., Computers & Geosciences, 30,pp. 887-897.
7. Chang, Y.S and Park, H.D. (2006) XML web-based development model for Internet GIS applications, *International Journal Geographical Information Science*, 20 (04): 371-399
8. David, J.A., Kerry, T., Ross, A. and Stuart, H. (1998) An exploration of GIS architectures for Internet environments., Computers, Environment and Urban Systems, 22,pp.7-23.
9. Huang, B. (2003) Web-based dynamic and interactive environmental visualization., *Computers, Environment and Urban Systems*, 27,pp. 623-636.
10. Huang, B., Jiang, B, and Lin,H. (2001) An intergration of GIS, virtual reality and the internet for visualization, analysis and exploration of spatial data., *International Journal of Geographical Information Science* ,151pp. 439-456.
11. Huang, B. and Lin,H. (2002) A Java/CGI approach to developing a geographic virtual reality toolkit on the internet ., *Computers & Geosciences*,28pp. 13-19.
12. Huang, B. and Worboys, M.F. (2001) Dynamic modeling and visualization on the internet., *Transactions in GIS*,5, pp. 131-139.
13. Rohrer, R.M and Swing, E. (1997) Web-based information visualization. *IEEE Computer Graphics and Applications*, 17, pp. 63-69.
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2.7.4 Spatial Decision Modeling & Geo-statistics

(L - 12; T+P – 48; F – 10; Li + G –5; Total – 75)

Lecture No.	Topic
SDGS 1	Introduction to spatial decision problems
SDGS 2	GIS and decision support systems
SDGS 3	Principles and components of multi-criteria Decision Making
SDGS 4	Main multi-criteria evaluation methods/ techniques
SDGS 5	Quantitative vs. qualitative multiple-criteria evaluation Techniques
SDGS 6	Practical application on spatial multiple criteria decision Making
SDGS 7 & SDGS 8	Sample design (Applied to spatial data) and probability distribution
SDGS 9	Errors and their propagation
SDGS 10 & SDGS 11	Geo-statistics techniques
SDGS 12	Geo-statistics Application

2.7.4 PRACTICAL + TUTORIAL

CODE	DESCRIPTION	PRACTICAL (HRS)
SDGS – EX1	City Connection Problem – Weighted Sum Approach	3
SDGS – EX2	City Connection Problem – Concordance-Discordance Analysis	3
SDGS – EX3	City Connection Problem – Mixed Method	3
SDGS – EX4	Selection of Best Policy for Irrigation Water Consumption Reduction	3
SDGS – EX5	Search/Evaluate DSS on Internet	3
SDGS – EX6	Spatial MCE – Site selection problem	3
SDGS – EX7	Multi-Criteria Pesticide Evaluation (DSS)	3
SDGS – EX8	Overview of Pattern Analysis, Spatial Autocorrelation, Point Interpolation, Trend Surfaces, Moving Surfaces	6
SDGS – EX9	The experimental variogram; investigating Anisotropy: variogram surface, the bidirectional Variogram	6
SDGS – EX10	Modeling the variogram, Ordinary Kriging	6
SDGS – EX11	Universal Kriging; Co-Kriging	6
SDGS – EX12	Indicator Kriging	3
SDGS – EX13	Demonstration of Case Study on Spatial Decision Modeling and Spatial Data Quality & Uncertainty Handling	3
SDGS – EX14	Field visit for validation of results	10

Suggested Readings

Books

1. Malczewski J. (1999), GIS and Multicriteria Decision Making, New York: Wiley & Sons.
2. Representing GIS by Peter Fisher and David J. Unwin, Wiley Publication (2005)
3. Spatial Modeling in Natural Sciences & Engineering by Jurgen Friedrish, Springer Publication (2004)
4. Open Source GIS: A Grass GIS Approach, Second Edition, Markus Neteler, Helena Mitasova, ISBN:1-4020-8065-4
5. Models in Spatial Analysis, (GIS Series) Edited by Lena Sanders, ISTE Publication (2007)
6. Digital Terrain Modeling by Naser El-Sheimy, Caterina Valeo, Ayman Habib. Artech House Inc. (2005)
7. Fundamentals of Spatial Data Quality Edited by Rodolphe Devillers and Robert Jeansoulin, ISTE Publication (2007)
8. Geo ENV VI – Geostatisitcs for Environmental Application. Springer Publication (2008)
9. International Perspectives on Maps and the Internet Edited by M.P. Peterson (Ed.) Springer Publication, 2008

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2. Hepu Deng, (1999). Multicriteria analysis with fuzzy pairwise comparison. International Journal of Approximate Reasoning. 21, 215-231
3. Janssen (1992). Multiobjective Decision Making for Environmental Management, Kluwer academic Publishers: The Netherlands.
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6. Malczewski J. (1999), GIS and Multicriteria Decision Making, New York: Wiley & Sons.
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14. Gregory E.K., Zbigniewe M., & Anthony G.Y. (2000), Decision Support Systems For Sustainable Development: A Resource Book Of Methods And Applications. London, Etc.: Kluwer Academic Publishers.
15. Hwang C. L. & Yoon K. (1981), Multiple Attribute Decision Making Methods And Applications. Springer-Verlag.
16. Ines Omann (2000), How Can Multi-Criteria Decision Analysis Contribute To Environmental Policy Making? A Case Study On Macro-Sustainability In Germany. 3rd Biennial Conference Of The European Society For Ecological Economics, Vienna, May 3-6.
17. Jean C.P. & Sergio B.R. (2000), Multicriterion Decision In Management: Principles And Practice. Boston, Etc.: Kluwer Academic Publishers.
18. Mendoza G.A and Ravi Prabhu, Forest Ecology and Management. 5913, 1-15, 2002
19. Malczewski J. (1999), GIS and Multicriteria Decision Making, New York: Wiley & Sons.
20. Saaty T. L. (1980), The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. New York: Mcgraw-Hill.
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22. Yang J. B. (2001), Rule And Utility Based Evidential Reasoning Approach For Multiple Attribute Decision Analysis Under Uncertainty. European Journal Of Operational Research, Vol. 131, No.1, Pp.31-61.
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27. Prabhu, Ravi (1999). Criteria and indicators for sustainable forest management: a global overview.In: Prasad, R., Raghavan, S., Phukan, B.R. and Bharti Joshi (eds.) Proceedings of The National Technical Workshop (under Bhopal-India Process of SFM) on Evolving Criteria and Indicators for Sustainable Forest Management in India, 21-22 January, 1999, pp6-19. Indian Institute of Forest Management(IIFM), Bhopal, India.
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Module – III: 3.0 Pilot Project

The stages of pilot project work by topic and activity is presented in Table -1, followed by a detailed list of activities.

Table-1: Activities of Pilot Project Work

Sub-module	Topic	Activity (hours)		
		Practical	Field work	Total
3.1	Project Planning	50	-	50
3.2	Pre-field interpretation & Analysis	25	-	25
3.3	Field data collection		100	100
3.4	Database creation	100	-	100
3.5	Data analysis, Generation of outputs & Report writing	125	-	125
Total		**300**	**100**	**400**

- ***Project Planning:*** Definition of problem, data requirement (Remote sensing, collateral and others), approach, method of analysis and interpretation.

- ***Pre-field interpretation and analysis:*** Preparation of initial version of maps / outputs by interpretation of Remote sensing data following visual /digital analysis also by analysis in GIS environment; Planning for filed data collection etc.

- ***Field data collection:*** Ground truth data collection for modification and finalization of pre-field interpreted maps; Field observations and Instrumental data collection for qualitative /quantitative analysis of Remote sensing and other data.

- ***Database Creation:*** Creation of various data layers by visual / digital / GIS aided analysis or processing of collateral data.

- ***Data analysis, Generation of outputs and Report writing:*** Final interpretation and analysis; generation of maps and outputs of data processings; writing of report including seminar presentation of pilot project work.

Academic performance Evaluation

The examination marks allocation for each subject / activity is shown below-

Subject code	Internal Assessment	External Assessment		Total	Grade
	Theory + Practical+ Assignment	***Theory***	***Practical***		
	Max. Marks	***Max. Marks***	***Max. Marks***	***Max. Marks***	
Semester – I (1.0 Fundamentals of Remote Sensing & GIS)					
Paper 1.1	80	100	60	240	
Paper 1.2	80	100	60	240	
Paper 1.3	80	100	60	240	
Paper 1.4	80	100	60	240	
Paper 1.5	80	100	60	240	
Semester – II (Optional Elective)					
Paper 2....	80	100	60	240	
Paper 2….	80	100	60	240	
Paper 2…	80	100	60	240	
Paper 2…..	80	100	60	240	
3.0 Pilot Project	***Field work; Data collection; Database creation; Data Analysis & Project report***	***Project Seminar***	*Max. Marks*		
	140	-	100	240	
Total	**860**	**900**	**640**	**2400**	

Grade interpretation

A+
75% or above (Equivalent to DISTINCTION)

A
Less than 75% to 60% (Equivalent to FIRST CLASS)

B
Less than 60% to 50% (Equivalent to PASS)

Annexure – I

Minutes of Course Curriculum Revision Meeting of RS & GIS - P. G. Course of CSSTEAP held on September 03, 2007 at Lok Nayak Bhavan, New Delhi

The following members of Course Curriculum Revision Committee attended the meeting:

Dr. R. Krishan, Director, ADRIN	Chairman
Dr. V. K. Dadhwal, Dean, IIRS	Member
Dr. Ajai, GD, MESG, SAC	Member
Dr. I. V. Muralikrishna, Director(R&D), JNTU	Member
Dr. R. Ramachandran DD, ATP&P, ADRIN	Member
Prof. V. V. Rao, Andhra University	Member
Dr. S. K. Saha Course Director, RS & GIS, CSSTEAP	Member Secretary

- Dr. Dr. R. Krishan, Director, ADRIN and Chairman, of the committee welcomed all the members. He briefly mentioned the role of course curriculum revision committee to play for improving the academic profile of P.G. course of RS & GIS of CSSTEAP keeping in view on the latest development in the field / newer applications areas.

- Dr. V. K. Dadhwal, Dean, IIRS and Member, briefed about CSSTEAP and its educational and training philosophy, mode of organization of RS & GIS course, academic arrange with Andhra University, India for recognizing RS & GIS Course of CSSTEAP for awarding M. Tech. degree.

- Dr. S. K.Saha, Course Director & Member Secretary, presented the course structure, modules wise contents of each subjects and mode of organization of course.

- Various issues pertaining to revision of course curriculum such as overall course structure, contents of theory lectures, practical and tutorial exercises, marks allocation, mode of evaluation, use of self learning tools etc. were discussed in detail and suggestions were made by the members.

- **Suggestions / Recommendations**

  - ***Module – 1A (Fundamentals of RS & GIS)***

o The Lecture no. RS 6 covered under *Remote Sensing subject (Code-1.1)*- concept of Radiometric resolution is to be included in the topics covered under "Concept of Resolution in RS "

- The Lectures nos. RS 9, 16, 17 & 18 covered under *Remote Sensing subject (Code-1.1)* are to be combined and combined lectures should covers topics such as Imaging modes & Geometric Errors; Non-sun synchronous satellite; Image Quality & Structures.

- In lecture no. RS 20 covered under Remote Sensing subject (Code-1.1) physical basis of spectral signatures of various objects is to be included.

- The duration of practical EX - RS1 under *Remote Sensing subject (Code-1.1)* is to be reduced from 5 hours to 3 hours.

- The practical exercises EX –RS 3 & EX- RS 7 under *Remote Sensing subject (Code-1.1)* are to be combined and this exercise should cover study on spectral and image characteristics on optical and microwave SAR data for identification / characterization of major earth features.

- The I*mage Interpretation & Analysis subject (Code-1.2)* having total 150 hours of various academic activities is to be divided into two parts (Two Papers) by suitably adjusting the lectures, practical and tutorials topics. Two separate examinations are to be conducted

- The Lecture no. IA 6 covered under I*mage Interpretation & Analysis subject (Code-1.2)* on SLAR is to be deleted and this lecture hour is to be added with IA 7 covering interpretation of SAR Imagery.

- The topics covered in lectures nos. IA 28 - 33 under *image Interpretation & Analysis subject (Code-1.2)* are to be grouped into two major topics viz. (i) Image Transformation including FFT – IA 28 – 31; and (ii) Spectral Indices – IA 32 & 33.

- The topics covered under *Photogrammetry Subject (Code-1.3)* were discussed in details and suggestions were made to make it more concept and practical oriented and also include recent topics. A new content of *Photogrammetry Subject (Code-1.3)* has been worked out and included in ***Annexure - a*** for comments / views by the committee members.

- ***Module – 1B (Recent trends in RS & GIS and Environmental Analysis & Management) (Subject Code – 1.5)***

- The topics covered under this subject are of interdisciplinary in nature and difficult to be assimilated by the student within allotted short period of time. Therefore, suitable evaluation methodology for this subject, combining quiz, seminar presentation / term paper writing on student's choice topic should be adopted instead of formal written and practical examinations

- ***Module –II: Optional Elective (Module – II)***

- Lecture topics on *"Forest encroachment"* and *" Forest fire detection and monitoring"* are to be included in the subject of *Forest Management* (Code 2.2.3) in optional Elective – *Forestry & Ecology (Code – 2.2)*

- *"Environmental Indicator"* topic is to be included in the subject of *Ecosystem Analysis (Code 2.2.4)* in optional Elective – *Forestry & Ecology (Code – 2.2).*

- Topic on *"Coastal Land use / Land Cover"* is to be included in the subject of *Coastal and Marine Ecology" (Code – 2.5.2)* in optional Elective – *Marine Science (Code – 2.5)*

- The Optional Elective *"Advances in RS & GIS" (Code – 2.7)* is to be renamed as *"Advanced Techniques in RS & GIS*".

- The lecture topics covered under *Advances in RS & Image Analysis* subject *(Code – 2.7.1)* in Optional Elective *"Advance Techniques in RS & GIS" (Code – 2.7)* are to be grouped into three major topics viz. *(i) Advanced Classifier, (ii) Spatial Transformation &* *(iii) Hyperspectral Image Analysis.*

- Lectures on topics like Interferometry techniques & DEM generation; Comparison of DEM generation techniques are to be included in subject of *Advances in Photogrammetry & Automated Feature Extraction (Code – 2.7.2)* in Optional Elective *"Advance Techniques in RS & GIS" (Code – 2.7)*

- Existing course curricula of Module –II Optional Electives of other thematic disciplines – Agriculture & Soils; Geoscience; Human Settlement & Urban Analysis and Water Resources does not require revision at present. However Focal Points of Optional Thematic disciplines will look into details and can suggest modifications to cover recent developments in the respective disciplines.

General Suggestions

- Considering current syllabus load, various academic activities and time requirement for the modules, the appropriate duration of the course could be ***10 months*** instead of present duration of 9 months. The committee members felt that the course load and other academic activities are too heavy for 9 months duration. The increased in one month can effectively accommodate English proficiency enhancement classes, remedial classes on mathematics and statistics, loss of academic duration due to time allotted in Module -I for educational excursion.

- Possibility of introduction of Course and Credit System for this course can be explored. Additional ***interdisciplinary subjects*** besides the core and optional elective subjects in Modules –I and II can be offered in Module – II. In

consultation with faculty and Focal Points of RS & GIS course, the feasibility of introduction of this concept will be work out.

- The suggested readings for each subjects in all modules need to be updated and it could be grouped into three categories viz. Text Books; References of research papers & review articles, and Web Links related to the topics of the subject.

Prepared by

Dr. S. K. Saha
Course Director
RS & GIS Course &
Member Secretary

Approved by

Dr. R. Krishnan
Director, ADRIN
Chairman

Annexure –a

1.3 Photogrammetry (L – 20; P+T – 40; F – 10; Li + G – 5; Total: 75 hours)

Lectures

PG 1 & 2	Basics of aerial Photography, Camera, Films, Filters, Film density , Characterstic curves ,Image movement ,Exposure Interval, Resolution.
PG 3	Basic Geometry of aerial Photograph, Central and orthographic projection, Difference between map and aerial photograph , Types of Aerial photographs- wide angle,narrow angle,Horizontal, Vertical, Oblique
PG 4	Scale and Ground Coverage of aerial photograph
PG 5	Relief Displacement in aerial photographs and its characteristics
PG6	Geometry of tilted/oblique photograph, Isocentre, Nadir point, Principle point and Principle plane, Tilt Displacement
PG 7	Stereoscopy and binocular vision, Concept of Depth perception in Monocular and Binocular vision ,Base-eight ratio, stereoscopic exaggeration.
PG 8	Stereoscopes, Stereoscopic parallax, Parallax bar, Floating mark and Parallax Bar formula
PG 9	Use of Parallax bar in height measurement ,Parallax formula
PG10	Stereophotogrammetry, Degrees of freedom in single photograph, Principle of reprojection, stereo restitution
PG 11	Orientation of aerial photograph – Inner, relative and Absolute orientation and Model Deformation in Stereophotogrammetry, Mapping frm stereo aerial photos.
PG 12 & 13	Basics of Analytical Photogrammetry- Collinearity and Coplanarity conditions, Concept of Rotation Matrix
PG 14 - 16	Introductory concepts in Digital Photogrammetry (Digital data input(photogrammetric scanners, Digital Photogrammetric camera), H/W and S/W requirements, Photogrammetric triangulation in DPWS, Stereo view in DPWS,feature extraction on DPWS)
PG 17	Stereo Sensors in Space- tilt across the track, tilt along the track, Single push broom scanners (IRS-1C/1D, SPOT, IKONOS), Three line scanners (MOMS)
PG 18 & 19	Satellite based Digital Photogrammetry (Orbital Parameters, Orbital Modeling, Data Processing for stereo generation)
PG 20	Concept of DEM, DSM and DTM, DEM extraction and Orthoimage generation- Concept of Image Matching, Automatic DEM generation, Orthoimage generation,Digital maps and their characteristics

Practical +Tutorials

CODE	DESCRIPTION	PRACTICAL (HRS)
EX. PG 1	Stereo Test and Determination of photo scale	2
EX. PG 2	Preparation of Base map from toposheet including legend, scale and annotation	3
EX. PG 3	Locating nadir point and principal point on aerial photo and Determination of height from single vertical aerial photograph	3
EX. PG 4	Orientation of Stereo model under mirror stereoscope	8
EX. PG 5	Tracing of details from Stereopair	4
EX. PG 6	Use of parallax bar and determination of heights	8
EX. PG 7	Familiarization with DPWS, Project creation, data input, orientation, generation of DEM and orthoimage.	8
EX. PG 8	Feature extraction of topographic details using DPWS	4
EX. PG 9	Ground data collection and Verification on aerial photo (FIELD EXERCISE)	10