

Department of Geology presently runs the Solapur University Approved six month **Certificate Course in Geo-informatics**. (CCGI)

We have Geo-informatics Laboratory well equipped with 15 high configuration desktop computers, its peripherals and software available for GIS studies are IDRISI Taiga, QGIS, ILWIS and GRASS (open source).

The course is of fundamental nature and students completing it learn basic skills over GIS techniques. Intake capacity is 60 and 10+2 science course pass is the basic minimum required qualification. Any science graduate or M A Geography pass students are also qualified to do this course.

It is proposed that one year **Diploma Course in Geo-informatics** to start from next academic year. Intake capacity will be 100. Required qualification will be **Certificate Course in Geo-informatics** pass, M Sc in any science stream, M A Geography with CCGI.

Well equipped GIS Lab



## **SYLLABUS : SEMESTER I**

### **UNIT I**

#### **AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY**

- Introduction: Fundamentals of Aerial Photography: flight planning & execution  
Photogrammetry: Basic concepts of measurements of object height and length
- Stereo Photogrammetry: Stereovision & Stereoscopes, Stereoscopic Parallax & Parallax Equations
- Digital photogrammetry: Model deformation & Rectification, Relief displacement , Vertical exaggeration, Triangulation, Control & Mapping
- Visual interpretation of aerial photographs, Elements of Image Interpretation

### **UNIT II**

#### **FUNDAMENTALS OF REMOTE SENSING**

- Remote Sensing: History, Development, Definition, Concept & Principles
- Electromagnetic Radiation (EMR): Spectrum and its properties, Atmospheric windows, Interaction of EMR with atmosphere & Earth's Surface
- Spectral signatures & Resolutions: Spatial, Spectral, Radiometric and Temporal
- Remote Sensing Systems: Platform, types of platforms & its characteristics
- Sensor classification: Active and Passive, Optical-Mechanical Scanners & Push-broom scanners
- Thermal Infrared: Introduction, Radiation Properties, Kinetic Heat, Temperature, Radiant Energy and Flux, methods of transferring heat
- Thermal properties of terrain: Capacity, Conductivity, Inertia, Infrared
- Microwave: Passive & Active Sensors, RADAR, Scatterometer

### **UNIT III**

#### **INTRODUCTION TO GEOGRAPHICAL INFORMATION SYSTEM (GIS)**

- Basic concepts: Definition and history
- Components of GIS
- Data structure and formats
- Spatial data models - Raster and Vector
- Data base design - editing and topology creation in GIS, Linkage between spatial and non spatial data
- Data inputting in GIS

### **UNIT IV**

#### **GLOBAL POSITIONING SYSTEM (GPS)**

- Fundamentals of GPS and its applications
- Geodesy
- Components of global positioning system
- Factors affecting GPS accuracy

- GPS surveying methods and accuracy
- Reference station, reference equipments and radios

## **PRACTICAL**

### **1. AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY**

- Reading peripheral information.
- Test of Stereo Vision, Orientation of Stereo pair
- Measurement of scale of aerial photograph
- Parallax bar handling and height measurements
- Interpretation of aerial photographs with stereo pair, visual interpretation of physical features ( Settlement, waterbody, forest, agriculture, barren/open land, rocky outcrops and others if present.)

### **2. FUNDAMENTALS OF REMOTE SENSING**

- Introduction to remote sensing data
- Data Downloading
- Introduction to Digital Software ( ERDAS Imagine )
- Data import in ERDAS Imagine
- Generation of FCC
- Geometric correction of satellite data

### **3. INTRODUCTION TO GIS**

- Introduction to GIS software ( ArcGIS)
- Data models : Raster and Vector
- Introduction to SOI topographical Maps: Numbering, Scales, grid reference, signs and symbols and interpretation
- Registration of topographical maps in GIS software
- Onscreen digitization (Database generation)
- Topology creation ( error estimations), Spatial and attribute data input, various measurements, attribute data linking to spatial features.
- Generation of GIS based Maps

### **4. GPS**

- GPS data collection in field
- GPS survey
- Importing GPS data in to google

#### **Reference books**

1. George Joseph, (2004) “Fundamentals of remote sensing”, Universities press (India) Pte Ltd., Hyderabad.
2. Gupta, K. K. Tyagi, (1992): Working with maps, Survey of India Publication, DST, New Delhi

3. Jensen, J.R., (2006) “Remote Sensing of the Environment – An Earth Resources Perspective”, Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi.
4. Leica. A., (2003), GPS Satellite Surveying, John Wiley & Sons, use. New York
5. Lillesand, Thomas M. and Kiefer, Ralph, W., (2007) “Remote Sensing and Image Interpretation”, 4th Edition, John Wiley and Sons, New York
6. N.K.Agrawal , (2004) ,Essentials of GPS, Spatial Network Pvt. Ltd
7. Ramamurthy, K. (1982): Map Interpretation, Rex Printers, Madras
8. Rampal, K.K., (1999) Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi
9. Reeves, Robert G. (1991), “Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
10. Sabins, F.F. Jr., (2007) Edition. ‘Remote Sensing – Principles and Interpretation’, W.H. Freeman & Co.
11. Sathish Gopi , (2000), GPS and Surveying using GPS
12. Singh, R. L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi 2.
13. Tamaskar, B. G., Deshmukh, V. M. (1974): Geographical Interpretation of Indian Topographical Maps, Orient Longman Ltd., Bombay
14. Terry-Karen Steede, (2002), Integrating GIS and the Global Positioning System, ESRI Press
15. Understanding Map Projection (2003-2004): GIS by ESRI, Redlands
16. Vaidyanadhan, R. (1968): Index to a set of sixty Topographic Maps: Illustrating Specified Physiographic Features from India, Council of Scientific and Industrial Research, Ministry of Education, Government of India

## **PROJECT WORK**

## **Appendix – I**

### **REFERENCE BOOKS**

1. Remote Sensing and Image Interpretation by lillesand T.M., Kiefer R.W., Published by John Wiley & Sons Inc., 2000
2. Fundamentals of Remote Sensing by George Josph, University Press (India) Pvt. Ltd, University Press (India) Pvt. Ltd., 2004
3. Textbook on Remote Sensing by Agrawal C.S. Published by Wheeler A.H., 200.
4. Lecture Notes, Module I, Photogrammetry and Remote Sensing, IIRS
5. Principles of Geographic Information System by Burrough P.A. Published by MacDonneli R.A. Published by Oxford University Press, 2000
6. The GIS Book by Korte G.B. Published by Onward Press, 2001
7. Understanding Map Projection, GIS by ESRI, 2003-2004, USA
8. “Geoinformation” Remote Sensing, Photogrammetry and Geographical Information Systems by Gottfried Konecny Published by Taylor & Francis 11 New Fetter Lane, London EC4P 4EE, 2003
9. Remote Sensing And GIS Integration, Theories, Methods and Applications, by Qihao Weng, Published by The McGraw-Hill Companies, Inc.2010.
10. Introduction to Remote Sensing (5<sup>th</sup> Edition) by JB Campbell & RH Wynne (2011), Published by The Guilford Press, Inc., 72 Spring Street, New York, NY 10012
11. Introduction to GPS, The Global Positioning System by Ahmed El-Rabbani published by ARTECH HOUSE, INC. 685 Canton Street Norwood, MA 02062, London
12. Understanding GPS Principles and Applications, Elliott D. Kaplan Christopher J. Hegarty published by ARTECH HOUSE, INC. 685 Canton Street Norwood, MA 02062, London
13. Remote Sensing and GIS, by Basudeb Bhatta ,Published by Oxford University Press,2nd Edition
14. “Introduction to Geographical Information Systems”, by Kang-tsung Chang, Published by Tata McGraw Hill, Third Edition, 2003
15. “Remote Sensing and Geographical Information Systems”, by M. Anji Reddi, Published by B. S. Publications, Second Edition, 2001
16. Remote Sensing and Geographical Information Systems, by A.M. Chandra and S.K. Ghosh, Published by Narosa Publishing House Pvt Ltd.
17. “Geographic Information Systems – An Introduction”, 3rd edition, by Tor Bernhardsen, Published by Wiley Publications
18. “An Introduction to Geographical Information Systems”, 2nd Edition, by Ian Heywood, Sarah Cornelius Published by Pearson Education

## Appendix – II

### CAREER AND JOB OPPORTUNITIES

1. Aspirant students can get admission to advanced courses of geoinformatics in following institutions.
2. Candidates can also seek jobs in private sectors working in the field of civil works, Smart Cities projects as well as urban and municipal areas etc.
3. NGOs, Private companies working on, research and development of Sustainable Agriculture, Forest Resources, Ecosystem Analysis, Geosciences, Human Settlement Analysis, Marine & Atmospheric Sciences, Water Resources,
4. Mobile companies based on GPS tracking system, Web mapping, web GIS and multimedia GIS can appoint these candidates.

This course will be helpful for getting admission to the following advanced courses in geoinformatics.

- Mumbai:**
1. CSRE, IIT, Mumbai,
  2. Khagolam Institute of Geoinformatics,
  3. K J Somaiya college of Science & Commerce,
  4. Rolta Academy
  5. V.J.T.I.
- Pune:**
1. Advanced Computing Training School (ACTS),
  2. All India Institute of Local Self Government
  3. CDAC Pune
  4. Institute of Environment Education and Research, Bharati Vidyapeeth University
  5. Pune University
  6. Sinhgad College of Science
  7. Symbiosis Institute of Geoinformatics
- Hyderabad:**
1. Centre for Environment, Institute of Science and Technology
  2. Geological Survey of India Training Institute(GSITI)
  3. GeoSpace Technologies
  4. Geosys Enterprise Solutions Private Limited
  5. Indian Institute of Surveying and Mapping (Survey of India)
  6. JNT University
  7. Lambodara Technologies
  8. Leonars Techno Services Pvt. Ltd.
  9. National Institute of Rural Development and Panchayati Raj
  10. Osmania University Spatial Solutions
  11. Star Technologies Survey Training Institute

## Appendix – III

### SYLLABUS

- Unit – I Fundamentals of Remote Sensing:** Remote Sensing: Basic Principles, Electromagnetic Remote Sensing, Energy Sources, Energy Interactions with Surface Materials, , Energy Interactions with Earth's Atmosphere, Spectral Reflectance Curves
- Fundamentals of aerial photography:** Scale, resolution, projections, overlaps, geometric characteristics of photographs. **Platforms:** ground based, air borne, space borne, **Orbits:** Geostationary and polar orbiting satellite.
- Visual Image Interpretation:** Information Extraction By human and Computer, Remote sensing Data Products, Image Interpretation, Elements of Image Interpretation
- Unit – II Introduction to digital image processing:** Digital images, Sources of errors: Radiometric and geometric, image rectification, geometric and radiometric corrections
- Image enhancement techniques:** Contrast enhancement, stretching, density slicing, special filtering, edge enhancement, band combination and band ratioing.
- Classification Schemes:** Supervised and Unsupervised classification
- Unit – III Introduction to GIS:** Definition of GIS, Evolution and components of GIS, Geospatial Data, Geographic Coordinate System, Map Projections, Commonly Used Map Projections, UTM grid system, Map Scale
- Data Management, Models and Quality Issues:** Vector Model : Topology, Non topological Vector models, Attribute Data in GIS, Attribute Data Entry, Vector Data Query, Manipulation of Fields and Attribute Data, Raster Data Model : Elements of Raster Data Model, Types of Raster Data, Raster Data Structure, Raster Data Query, Data Compression, Data Conversion, Integration of Raster and Vector data
- Unit – IV GIS Data Exploration Analysis and Visualization:**
- Vector Data Analysis: Buffering, Overlay, Distance Measurement, Pattern Analysis, Map Manipulation Raster Data Analysis: Local Operations, Neighborhood Operations, Zonal Operations, Data Extraction, Data Generalization, Comparison of Vector and Raster Based Data
- Terrain mapping:**
- Terrain Mapping and Analysis: Data for Terrain Mapping and Analysis: DIM, TIN, Terrain Mapping, Slope and Aspect, Surface Curvature, Raster versus TIN
- Unit – V Global Positioning System (GPS):** Concept, Types, Modes of coordinate collection, GPS survey, inputting GPS data into computer

## **PRACTICAL IN GEOINFORMATICS**

### **PRACTICAL IN REMOTE SENSING:**

1. Aerial photographs: Reading peripheral information and measurements of scale of aerial photographs. Interpretation of aerial photographs with stereo-pair. Visual interpretation of physical features, urban, forest, landuse and landcover on digital satellite images of PAN, LISS sensors.
2. Practical in Digital Image Processing: Image data loading in software, Study of histogram and layer information. Linear and non-linear contrast enhancement, band ratioing, edge enhancement, high and low pass filtering. Supervised and Unsupervised classification.

### **PRACTICAL IN GIS:**

1. Introduction to SOI topographical Maps: Numbering, Scales, grid reference, signs and symbols and interpretation. Registration of topomap in GIS software.
2. Spatial and attribute data input, scanning and digitisation editing, topology creation, various measurements, attribute data linking to spatial features.
3. Vector and raster data analysis methods, creation of Digital Elevation Model of terrain. Measurements of slope, aspect and curvature of terrain.

### **PRACTICAL IN GPS:**

1. GPS data collection in the field, GPS survey, importing GPS data to google earth and GIS software.



**Appendix – IV**  
**EXAMINATION PATTERN**

The examination (theory + practical) will be at the end of the course. Following is the distribution of the examination.

Theory:	<b>50</b> Marks
Practical:	<b>30</b> Marks
Project:	<b>20</b> Marks
Total:	<b>100</b> Marks

**Appendix – V**  
**AVAILABLE INFRASTRUCTURE**

1. Software for GIS: IDRISI Taiga, QGIS, ILWIS and GRASS (open source)
2. Computer Systems: 2 systems
3. Books: 4 (digital)

**Appendix – VI**  
**REQUIRED INFRASTRUCTURE**

1. Software:
  - A. ERDAS imagine – For image processing (Remote Sensing)
  - B. ArcGIS – For GIS teaching
2. Instrument: GPS instrument (Garmin make)
3. Books: As listed in Appendix – I
4. Computer systems: 8 systems (at least one for three students)

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- Remote Sensing Systems: Platform, types of platforms & its characteristics.
- Sensor classification: Active and Passive, Optical-Mechanical Scanners & Push-broom scanners
- Thermal Infrared: Introduction, Radiation Properties, Kinetic Heat, Temperature, Radiant Energy and Flux, methods of transferring heat
- Thermal properties of terrain: Capacity, Conductivity, Inertia, Infrared
- Microwave: Passive & Active Sensors, RADAR, Scatterometer

### **UNIT III**

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3. Jensen, J.R., (2006) "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi.
4. Leica. A., (2003), GPS Satellite Surveying, John Wiley & Sons, use. New York
5. Lillesand, Thomas M. and Kiefer, Ralph, W., (2007) "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York
6. N.K.Agrawal , (2004) ,Essentials of GPS, Spatial Network Pvt. Ltd
7. Ramamurthy, K. (1982): Map Interpretation, Rex Printers, Madras
8. Rampal, K.K., (1999) Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi
9. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
10. Sabins, F.F. Jr., (2007) Edition. 'Remote Sensing – Principles and Interpretation', W.H. Freeman & Co.
11. Sathish Gopi , (2000), GPS and Surveying using GPS
12. Singh, R. L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi 2.
13. Tamaskar, B. G., Deshmukh, V. M. (1974): Geographical Interpretation of Indian Topographical Maps, Orient Longman Ltd., Bombay
14. Terry-Karen Steede, (2002), Integrating GIS and the Global Positioning System, ESRI Press
15. Understanding Map Projection (2003-2004): GIS by ESRI, Redlands
16. Vaidyanadhan, R. (1968): Index to a set of sixty Topographic Maps: Illustrating Specified Physiographic Features from India, Council of Scientific and Industrial Research, Ministry of Education, Government of India

## **Semester II**

### **UNIT I**

#### **ADVANCES IN REMOTE SENSING**

- Introduction to digital image processing
- Digital images: Types Sources of errors: Atmospheric, radiometric and geometric.
- Image rectification: geometric correction, radiometric correction, noise removal
- Image enhancement techniques : Contrast enhancement: Linear, non-linear, logarithmic and exponential, Gaussian stretch, density slicing.
- Spatial filtering: low frequency, high frequency, edge enhancement, band rationing and band combination

### **UNIT II**

- Satellite Image Classification
- Digital image classification scheme: Supervised classification: Training sites selection and statistical information extraction, Discriminate functions.
- Classifier : Maximum Likelihood, Euclidian distance, Mahalanobis distance, Parallelopiped.

- Unsupervised classification.
- Classification accuracy assessment and error Matrix

### **Unit III**

#### **Advances in GIS**

- Spatial Analysis : Introduction to Spatial analysis,
- Significance of spatial analysis.
- Overview of tools for analysis
- Spatial analysis - Vector based
- Overlay operations: Point-in-polygon, Line-in-polygon, polygon-in-polygon.
- Single layer operations: Feature identification, extraction, classification manipulation.
- Multilayer operation: Union, intersection, symmetrical difference, update, merge, append and dissolve

### **UNIT IV**

#### **APPLICATIONS OF GIS AND RS TECHNIQUES : Case Studies**

- Agriculture
- Disaster Management
- Water Resource Management
- Natural resource management
- Environmental Management
- Forestry
- Weather
- Biodiversity

#### **Reference Books**

1. Burrough, P. A. and McDonnell, R. A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York
2. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, New Delhi
3. Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi
4. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
5. Lillesand, T. M., Kiefer, R. W. Chipman, J. W.(2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
5. Lo, C. P. Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi
6. Longley, P. A., Goodchild, M. F., Maguire, D. J. Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester
7. Makrewski, J. (1999): GIS Multi-criteria Analysis, John Wiley and Sons, New York

8. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York
9. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
10. Richards, J. A, Jia, X. (1999): Remote Sensing and Digital Image Processing, Springer, Verlag Berlin
11. Sabins, F. F. (1996): Remote Sensing: Principles an Interpretation, W. H. Freeman Company, New York

## **Practical**

### **IMAGE DATA PROCESSING**

- Familiarization with image processing system : Loading of image data, identification of objects on visual display, study of histograms and layer information
- Image enhancement techniques : Linear and non- linear contrast enhancement, Band rationing, edge enhancement, high and low pass filtering, density slicing
- Image registration : Registration of bases map/ topomap, image to map, image to image
- Image Classification : Classification : Supervised, unsupervised and use of different algorithms
- Accuracy analysis : Producer, user accuracy, overall and mapping accuracy, Kappa Coefficient
- Vector layers : Generation of Vector layer, editing and topology building, area and perimeter estimation
- Presentation : Map composition

### **Reference Books**

- ERDAS (2010): ERDAS field Guide, ERDAS incorporation, Norcross, GA, USA
- [http://geospatial.intergraph.com/Libraries/Tech\\_Docs/Erdas\\_Field\\_Guide.sflb.ashx](http://geospatial.intergraph.com/Libraries/Tech_Docs/Erdas_Field_Guide.sflb.ashx)
- Gupta, R. P. (2003): Remote Sensing Geology, Springer, Verlag Berlin

### **Project work**