Program Description

Evolution of healthy Smart City and Smart Community based research has increased the demand for spatial assessment and earth system observations. These needs are further enhanced due to climate change impacts. Domain knowledge about the monitoring phenomenon plays a key role in designing systems that minimize the impact of natural hazards and reducing disaster risk. To achieve this we developed a multidisciplinary curriculum that introduces to a wide spectrum of geospatial data analysis for multi-hazard risk assessment and disaster risk reduction. This program aims to provide the students with an opportunity to acquire detailed systematic knowledge and critical understanding of spatial environment related processes. The program also introduces state of the art technologies for data collection and analysis, as well as the ability to independently develop innovative solutions to complex problems in the areas of natural and man-made environment. The students will learn to become a valuable part in the national and global efforts in improved understanding of climate change mitigation and adaptation, geohazards evaluation, disaster risk reduction, disaster preparedness, Smart City and environmental planning and sustainable development, etc.
### CURRICULUM

#### First Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19MA601</td>
<td>FC</td>
<td>Foundations of Mathematics</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI601</td>
<td>FC</td>
<td>Introduction To Geostatistics</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19GI611</td>
<td>SC</td>
<td>Introduction to Earth System</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19GI612</td>
<td>SC</td>
<td>Fundamentals of Cartography and GIS</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI613</td>
<td>SC</td>
<td>Remote Sensing of Earth Systems</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19GI602</td>
<td>FC</td>
<td>Python Programming For Earth Science</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>19HU601</td>
<td>HU</td>
<td>Amrita Values Program*</td>
<td></td>
<td></td>
<td></td>
<td>P/F</td>
</tr>
<tr>
<td>19HU602</td>
<td>HU</td>
<td>Career Competency I*</td>
<td></td>
<td></td>
<td></td>
<td>P/F</td>
</tr>
<tr>
<td>19GI795</td>
<td>P</td>
<td>Live-in-Labs-I - Participatory Design and Modelling</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Credits 16

*Non-credit course

### Second Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19GI614</td>
<td>SC</td>
<td>Fundamentals of Earth System Modeling</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI615</td>
<td>SC</td>
<td>Geodetic, Geotechnical and Geophysical Monitoring Methods</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>19GI616</td>
<td>SC</td>
<td>Advanced GIS And Remote Sensing for Earth Science Applications</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Elective I</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Course Code</td>
<td>Type</td>
<td>Course</td>
<td>L</td>
<td>T</td>
<td>P</td>
<td>Cr</td>
</tr>
<tr>
<td>-------------</td>
<td>------</td>
<td>---------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>19GI603</td>
<td>FC</td>
<td>Fundamentals of Digital Signal &amp; Image Processing</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI617</td>
<td>SC</td>
<td>GIS and Society</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>19GI604</td>
<td>FC</td>
<td>IOT for Earth Monitoring System</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>19RM600</td>
<td>SC</td>
<td>Research Methodology</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>19HU603</td>
<td>HU</td>
<td>Career Competency II</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**Credits**  
22

### Third Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>E</td>
<td>Elective I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>Elective II</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>Elective III/ IV</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>19GI796</td>
<td>P</td>
<td>Live-in-Labs II- Lab-to-Field: People Centered Innovation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19GI798</td>
<td>P</td>
<td>Dissertation</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

**Credits**  
13

### Fourth Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19GI797</td>
<td>P</td>
<td>Live-in-Labs III- Social Business: People Centered Innovation</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>19GI799</td>
<td>P</td>
<td>Dissertation</td>
<td></td>
<td></td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

**Credits**  
15

**Total Credits - 66**
# LIST OF COURSES

## Foundation Core

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19MA601</td>
<td>FC</td>
<td>Foundations of Mathematics</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI601</td>
<td>FC</td>
<td>Introduction To Geostatistics</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19GI602</td>
<td>FC</td>
<td>Python Programming For Earth Science</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>19GI603</td>
<td>FC</td>
<td>Fundamentals of Digital Signal &amp; Image Processing</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI604</td>
<td>FC</td>
<td>IOT for Earth monitoring System</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

## Subject Core

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19GI611</td>
<td>SC</td>
<td>Introduction to Earth System</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19GI612</td>
<td>SC</td>
<td>Fundamentals of Cartography and GIS</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI613</td>
<td>SC</td>
<td>Remote Sensing of Earth Systems</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19GI614</td>
<td>SC</td>
<td>Fundamentals of Earth System Modelling</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI615</td>
<td>SC</td>
<td>Geodetic, Geotechnical and Geophysical Monitoring Methods</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>19GI616</td>
<td>SC</td>
<td>Advanced GIS And Remote Sensing for EarthScience Applications</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI617</td>
<td>SC</td>
<td>GIS and Society</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>19RM600</td>
<td>SC</td>
<td>Research Learning and Problem Formulation</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
## Electives

### Elective I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19GI701</td>
<td>E</td>
<td>Advanced Machine Learning And Data Analytics</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI702</td>
<td>E</td>
<td>Geospatial modelling</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI703</td>
<td>E</td>
<td>Big Data and Applications</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>19GI704</td>
<td>E</td>
<td>GIS Based Urban Planning</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

### Elective II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19GI711</td>
<td>E</td>
<td>Geospatial project management</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>19GI712</td>
<td>E</td>
<td>Climate Change: impacts, adaptation and mitigation.</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>19GI713</td>
<td>E</td>
<td>Environmental Geology and Geohazards</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

### Elective III (Practical Oriented Course)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>19GI721</td>
<td>E(POC)</td>
<td>Fluvial Systems and Flood Monitoring Techniques</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>19GI722</td>
<td>E(POC)</td>
<td>Advanced Earth System Modeling</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>19GI723</td>
<td>E(POC)</td>
<td>Vulnerability Assessment &amp; Disaster Risk Reduction</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>19GI724</td>
<td>E(POC)</td>
<td>Techniques For Monitoring Coastal Changes and Coastland Management</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>19GI725</td>
<td>E(POC)</td>
<td>Resilience : Community Engagement</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Course Code</td>
<td>Code</td>
<td>Course Title</td>
<td>Credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------</td>
<td>------------------------------------------------------------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19GI731</td>
<td>E(IOC)</td>
<td>Environmental Impact Assessment and Management [EIA and EIM]</td>
<td>1 0 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19GI732</td>
<td>E(IOC)</td>
<td>Smart Community/City: Concepts and Planning Framework</td>
<td>1 0 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19GI733</td>
<td>E(IOC)</td>
<td>Landslide Fieldworks And Laboratory Simulations</td>
<td>1 0 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19GI734</td>
<td>E(IOC)</td>
<td>Hyperspectral Imaging and Interpretation</td>
<td>1 0 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Syllabus for Foundation courses

19MA601 FOUNDATIONS OF MATHEMATICS 2-0-1-3

Part I: Linear Algebra


Inner products: Norms, Orthogonal Bases and Gram-Schmidt Orthogonalization; Matrix Multiplication Problems, Matrix Analysis, Gauss Elimination Technique, LU and LDU Decomposition methods, Diagonalization of a Matrix, Singular value decomposition, Dimensionality Reduction, Principal Component Analysis.


Part II: Probability Theory

Introduction to Probability, Conditional Probability, Bayes’ theorem; Random Variables, Analysis of discrete and continuous random variables, Probability Distributions, Distribution Functions, Mean and Variance of random variables, Standard Discrete and Continuous Distributions and their properties; Analysis of Joint Probability Distributions of discrete and continuous random variables, Two or more random variables, Joint, Marginal and Conditional Probability Distributions, independence of random variables, Covariance and correlation, Linear functions of random variables, several functions of random variables, Convergence of random variables, Law of Large Numbers, Central Limit Theorem.

learning outcomes:
1. concepts of row and columns, and linear independence
2. Matrix operations: products, orthogonality
3. Linear transformations
4. Probability theory and basic statistics.

TEXT BOOKS/REFERENCES:
19GI601 INTRODUCTION TO GEOSTATISTICS 2-1-0-3

Fundamental Concepts Background on statistics and its importance, Data in Earth science

Spatial statistics: Basic introduction to geostatistics with the emphasis on concepts rather than mathematics. Regionalized (or spatial) variables. Quantifying the criteria for estimation sources of errors in estimation; The variogram calculation, interpretation, linking variogram behaviour with physical causes (geology, sampling). Variances, covariances, Global reserve/resource estimation. Optimal estimation and introduction to kriging.

Time series analysis: Examples of time series; Purposes of analysis; Components (trend, cycle, seasonal, irregular); Stationarity and autocorrelation; Approaches to time series analysis; Simple descriptive methods: smoothing, decomposition; Regression; Introduction to forecasting.

Learning Outcomes:
1. Importance of spatial statistics for Earth science
2. The concept of spatial statistics
3. Variogram/ Homogeneity and heterogeneity
4. Optimal estimation and introduction to kriging
5. Time series analysis

TEXT BOOKS/REFERENCES:

19GI602 PYTHON PROGRAMMING FOR EARTH SCIENCE 0-0-1-1


pandas, Data mining, Time series analysis with python, Statistical analysis and intro to machine learning with python, SciPy, Spatial analysis with python, intro to QGIS python console,
Learning Outcomes:
1. Basic programming
2. Nimpy, Pandas and data mining
3. SciPy, statistical analysis
4. Spatial analysis

TEXT BOOKS/REFERENCES:

19GI603 FUNDAMENTALS OF DIGITAL SIGNAL & IMAGE PROCESSING  2-0-1-3

Introduction to Digital Image Processing; Image Preprocessing; Image Enhancement; Image Classification; Image Fusion and Change Detection. Resolution, Sampling and Contrast Enhancement; Stretching, Filtering; Transformations & Principal Component Analysis; satellite Image classification & Information Extraction; Supervised & Unsupervised Classification and interpretations

GRASS GIS: Introduction installation; GRASS tutorial for satellite Image classification

Learning Outcomes:
1. fundamentals of signals and systems
2. DFT/FFT
3. Filters
4. intro. to supervised and unsupervised Image classification
5. Familiarization with GRASS GIS

TEXT BOOKS/REFERENCES:

**19GI604 IOT FOR EARTH MONITORING SYSTEM 1-0-0-1**

Module 1: IOT an overview, General architecture, Applications, Internet, LAN and WAN
Module 2: Earth Observation remote sensing approach: satellite imaging, Aerial photography, Drones etc..
Module 3: IOT in disaster management: flood, events, landslides, drought, forest fire etc..
Module 4: Sensors and Sensing technique
Module 5: Data Acquisition techniques and Daqs
Module 6: Wireless communication: Near range, medium range and far range communication

- Handson session on IOT

Learning Outcomes:
1. IOT basics and earth science applications: remote sensing approach
2. IOT and Disaster Management
3. Sensor and data acquisition
4. Wireless communication introduction

**TEXT BOOKS/REFERENCES:**

**Syllabus for Core Subject Courses**

**19GI611 INTRODUCTION TO EARTH SYSTEM 3-0-0-3**

Basic Geology and Geomorphology: Nature and scope of Geology; fundamental concepts - stratigraphy and structures; recent trends in Geomorphology. Approaches to geomorphology - static, dynamic, environmental and applied; Landforms: Endogenic and Exogenic.

Atmosphere and Ocean: Ocean: Ocean currents; coastal oceanography; Sea Surface temperature Atmosphere: atmospheric composition, structure; Pressure, temperature, humidity; vertical structure of the atmosphere; Global wind systems. Land-Atmosphere interaction; Ocean-atmosphere interaction; coastal erosion and deposition; Atmospheric Radiation: electromagnetic radiations; Radiation laws; Earth’s heat budget; scattering; albedo; Hydrostatic equation; hypsometric equation and sea level pressure; Convection, lapse rate, concept of air parcel; atmospheric stability; saturation; lifting condensation level; clouds; Introduction to atmospheric dynamics; equations of motion; atmospheric boundary layer. Tropical weather systems: Indian monsoon system; El Nino; Tropical cyclones-genesis, structure and climatology: monsoon depressions; other systems.

Climate change: Climate change history geological evidences; Greenhouse effect: Global CO2; Stratospheric ozone; evidence for climate change; extreme weather events; climate change mitigation; climate policy; disaster risk reduction; towards a climate resilient community.

Learning Outcomes:
2. Basic Geology and Geomorphology and Geological phenomena
3. Composition of atmosphere Atmospheric parameters, dynamics and thermodynamics
4. Intro to Oceanography
5. Greenhouse gases and climate change

TEXT BOOKS/REFERENCES:
Fundamentals of cartography: Spatial phenomena and its distribution, diversity of representation forms, map types, and spatial processes that geographers and other researchers model to understand spatial phenomena. Develop an understanding of the concepts regarding scale, projections, symbolizations, classifications, colors, typography, within the context of effective spatial communication. Concepts of map making, primary and derivative map features and resolution, Google earth as a navigational and mapping tool.

Intro to GIS: Examines in detail of the fundamentals of Geographic Information Systems (GIS) and their applications; Vector data operations; Raster data operations; Map making; Georeferencing and Projection: Understanding Earth, Coordinate System, Map Projection, Transformation, Georeferencing, and techniques of spatial data superposition.

Learning Outcome:
1. Thinking spatially, cartographic map making
2. Concepts of scale, projection, and map elements
3. Intro to GIS
4. Vector and Raster data operations
5. Georeferencing

TEXT BOOKS/REFERENCES:

19GI613 REMOTE SENSING OF EARTH SYSTEMS 2-1-0-3

Application of remote sensing data to real earth science problems. Change detection studies and analyses
Introduction to Hyperspectral Remote Sensing, hyperspectral Sensors and Data Collection

Learning Outputs:
1. Satellite orbits 
2. introduction to electromagnetic radiation and radiative transfer 
3. Satellite sensors Visible and infrared 
4. Microwave remote sensing 
5. deriving earth system parameters 

TEXT BOOKS/REFERENCES: 

19GI614 FUNDAMENTALS OF EARTH SYSTEM MODELLING 2-0-1-3 

Introduction, components of earth system models, overview of modelling processes over land, atmosphere and ocean, timescales, dimensionality, resolution, complexity, hierarchy of earth system models. 


Familiarise with the Community Earth System Model (CESM). 

Learning outcomes: 
1. Components of earth system models, concept of coupled modeling 
2. Introduction to numerical methods 
3. Partial differential equation primer 
4. Implicit and explicit scheme 
5. starting to work with climate models. 

TEXT BOOKS/REFERENCES: 
7. https://www.cesm.ucar.edu/

19GI615 GEODETIC, GEOTECHNICAL AND GEOPHYSICAL MONITORING METHODS 3-0-1-4

Geodetic monitoring: Advanced measurement techniques and analysis methods for geodetic monitoring of natural structures of local to regional scale like landslides, rock falls, volcanoes and tsunamis; testing and calibration of surveying instruments; influence of the atmospheric refraction, design and optimization of geodetic control surveys; several case studies to highlight the application of the presented technologies, Ground Laser Scanning, GNSS Navigation, Topographical Survey.


Learning Outcomes:
1. Sensors and measuring methodology for regional scale natural phenomenon
2. measuring soil parameters
3. Introduction to advanced geophysical sensors and measuring methodology
4. hands-on experience

TEXT BOOKS/REFERENCES:
A review of the basics of spatial modeling and vector and raster spatial data models, attribute data, relational and object-oriented databases and their links to spatial models. Spatial analysis; spatial analysis techniques; GIS based geospatial statistics;

Advanced remote sensing: Introduction to radar systems and data; real aperture and synthetic aperture radar systems, Introduction to hyperspectral imaging; Hyperspectral Image Display and Basic Analysis,

The use of imagery and remotely sensed data in GIS; An introduction to applications for 3D data within GIS; Internet- and intranet-based browser GIS and the incorporation of remotely-served spatial data; The use of GPS and mobile GIS products in collecting and integrating field data An introduction to the development and customization of GIS interfaces and applications.

Applications of remote sensing data: GIS based and other methods, introduction to land use land cover classification, accuracy assessment, urban planning with a basic intro to smart city concept; Disaster management: extreme event detection and vulnerability mapping using GIS, flood, landslide and drought and coastland changes; . Introduction to hyperspectral image application in pattern detection for vegetation

Learning Outcomes:
1. Basics of spatial Modeling
2. Introduction to Radar systems and data
3. hyperspectral data analysis
4. 3D data analysis in GIS
5. Applications of GIS and Remote sensing techniques.

TEXT BOOKS/REFERENCES:


19GI617 GIS AND SOCIETY 1-1-0-2

Geographic Information Systems (GIS) is a multibillion dollar business with applications in a range of disciplines, in public and private sectors. This course is conducted as a seminar based course where the students will read and present their views to understand many aspects regarding the interconnected relationship between the society and GIS, and explores the implications and impacts of such a relationship. The students will give seminars in the research areas of:
GIS and ethics; GIS and democracy; GIS and privacy; Technocratic nature of GIS; Evolution of public participatory GIS; GIS and women empowerment.

This course is organized as a seminar, with weekly readings and reflection papers.

Learning Outcomes:
1. Applications of GIS for society
2. Basic concepts of GIS and its impacts on ethics, democracy, technological advances
3. Public participatory GIS
4. Methods of research presentation

TEXT BOOKS/REFERENCES:
1. Peer reviewed research papers for each week will be provided.

19RM600 RESEARCH METHODOLOGY 2-0-0-2
Unit I:
Unit II:
Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes
Unit III:
Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results
Unit IV:
Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents
Unit V:

TEXT BOOKS/REFERENCES:

Syllabus of Elective I courses

19GI701 ADVANCED MACHINE LEARNING AND DATA ANALYTICS  2-0-1-3

Data Preprocessing, Regression: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, SVR, Decision Tree Regression, Random Forest Regression; Classification: Logistic Regression, K-NN, SVM, Kernel SVM, Naive Bayes, Decision Tree Classification, Random Forest Classification; Clustering: K-Means, Hierarchical Clustering; Association Rule Learning: Apriori, Eclat; Reinforcement Learning: Upper Confidence Bound, Thompson Sampling; Deep Learning: Artificial Neural Networks, Convolutional Neural Networks; Dimensionality Reduction: LDA, Kernel PCA; Model Selection & Boosting: k-fold Cross Validation, Parameter Tuning, Grid Search, XGBoost

Learning Outcomes:
1. Simple and multiple Linear regression
2. Advanced method of regression
3. decision tree classification
4. Deep learning and Artificial neural networks
5. Model selection and Boosting

TEXT BOOKS/REFERENCES:
19GI702 GEOSPATIAL MODELLING 2-0-1-3

Geospatial Analysis: foundations for analysis of continuous and discrete phenomena; neighborhood operations and buffers; analysis and modeling with map algebra cost surfaces and least cost path; spatial interpolation and approximation (gridding)

Terrain Modeling and Analysis (Geomorphometry I-III): terrain and bathymetry mapping; mathematical and digital representations (point clouds, contour, raster, TIN); spatial interpolation of elevation data and topographic analysis

Flow tracing, Watershed Analysis and Landforms: methods for flow routing and flow accumulation; extraction of stream networks; extraction of watershed boundaries and building watershed hierarchies; feature extraction, landforms

Introduction to Modeling of Geospatial Processes: model formulation, input data processing: introduction to GIS-based hydrologic and erosion modeling

Learning Outcomes:
1. Geospatial analysis
2. Terrain modeling and topographic analysis
3. Flow tracing, Watershed Analysis and Landforms
4. GIS-based hydrologic and erosion modeling

TEXT BOOKS/REFERENCES:


19GI703 BIG DATA AND APPLICATIONS 2-0-1-3

storage and management in order to be able to access data - especially big data - quickly and reliably during subsequent analysis - storage, search and retrieval systems for large scale structured and unstructured information systems.


Learning Outcomes:
1. Introduction to Big data analysis
2. Statistical models
3. data storage and management
4. machine learning basics
5. time series data visualization

TEXT BOOKS/REFERENCES:

19G1704 GIS BASED URBAN PLANNING 2-0-1-3

Urbanization: Urban population; built up area measurements; introduction to Urban Geology and Terrain evaluation. GIS based urban planning and design, challenges of urban planning. Growth of smart cities and waste disposal management.Recycling and resource conservation. Urban heat index an introduction.

GIS techniques: Spatial joints; GIS network analyst; GIS spatial analyst; Analyzing Patterns; Mapping Clusters; Measuring Geographic Distributions; and Modeling Spatial Relationships., 3D Analyst, Areal Interpolation/Polygon Apportionment, Techniques of urban simulation, Assessment of urban transformations. Urban growth modeling concepts: Introduction to conventional and new generation models like cellular automata, agent based models and flow dynamics.
Time-Enabled Geospatial Analysis: Python Scripting: write specialized tools, set up iterative models, and customize geoprocessing tools to fit a particular urban project objective. 

Class Project: case studies

Learning Outcomes:
1. concepts of urbanization and urban growth
2. GIS based Urban studies
3. Introduction to urban growth modeling
4. Python scripting examples for urban applications

TEXT BOOKS/REFERENCES:
5. Peer reviewed journal papers

Syllabus for Elective II

19GI711 GEOSPATIAL PROJECT MANAGEMENT 2-0-0-2

Introduction; Geospatial program development; project life cycle, Geospatial organization structure, governance, and coordination; Human resources, scope of a GIS project, Funding, financial management, and collaboration, Geospatial program, legal issues; Management of geospatial program technical elements, Geospatial office operations, service delivery, user support, Geospatial projects and project management, time cost, risk and quality management.

Learning Outcomes:
1. The issues involved in organizing, planning, monitoring and controlling a geospatial technology project
2. Developing project plans and financial budgets, assembling project costs and benefits
3. developing investment appraisal methods and using authorization, monitoring and control processes
4. Discuss the role, significance and impact of people in a project management setting
5. Review current geospatial technology project management methodologies.

TEXT BOOKS/REFERENCES:
2. peerreviewed journal papers.

19GI712 CLIMATE CHANGE: IMPACTS, ADAPTATION AND MITIGATION. 2-0-0-2

Climate change mitigation: Relationships between greenhouse gas emissions and climate change; the sources and sinks for GH gases at the global level; Policy instruments for emission reductions, including carbon taxes, emissions trading schemes and offset projects. Mitigation and sustainable development: how they fit together and the importance of co-benefits; International organizations and governance structures, agreements and reduction targets. Measuring climate change: global and local phenomena; Life Cycle Assessment (LCA) based Industrial ecology techniques; Global Warming Potential (GWP) and other metrics; Climate resilience: What is Community-Driven Climate Resilience Planning? Shifts in Governance to Support Lasting Solutions; Characteristics of Community-Driven Climate Resilience Planning; Defining the Field of Community-Driven Resilience Planning; Critical; GUIDING PRINCIPLES Whole Systems Thinking; Planning Processes as Learning Processes; Emerging opportunities.

Project on Climate change mitigation strategy/ Climate resilience strategy

Learning Outcomes:
1. Human impact of climate change
2. History of Climate change research
3. Measuring climate change
4. Impacts of adaptation, mitigation of climate change on community.

TEXT BOOKS/REFERENCES:

19GI713 ENVIRONMENTAL GEOLOGY AND GEOHAZARDS 2-0-0-2

Fundamental Principles of Environmental Geology. Geofactor considerations for safe and sustainable development. Soil forming processes, soils types, soil degradation and changing land use pattern. Soil erosion and soil conservation Concepts of natural ecosystems on the Earth and their mutual inter-relations and interactions (atmosphere, hydrosphere, lithosphere and biosphere). Environmental changes due to influence of human-dominated environment over

Class projects: Study of seismic and flood prone areas in India, Evaluation of environmental impact of air pollution, contaminated groundwater, landslides, deforestation, cultivation and building construction in specified areas and affected societies.

Learning Outcomes:

1. Fundamental Principles of Environmental Geology
2. Soil forming processes
3. Concepts of natural ecosystems on the Earth and their mutual inter-relations and interactions
4. Air pollution and ground pollution.
5. Geohazards concepts and project

TEXT BOOKS/REFERENCES:
1. Keller E A; Environmental Geology
2. K S Valdiya; Environmental Geology: Ecology, Resource and Hazard Management
3. Alan E Kehew: Geology for Engineers and Environmental Scientists

Syllabus of Elective III (Practical Oriented Course)

19GI721 FLUVIAL SYSTEMS AND FLOOD MONITORING TECHNIQUES 1-0-1-2

Hydraulics, Meteorology and Hydrology, Fluvial systems and river basin analysis
Introduction to Floods, Spatio-temporal distribution of floods, flood mitigation strategies, Structural and non-structural approaches in flood mitigation, Approaches to the reduction of flood impacts, Engineering solutions to flood control.
2D and 3D river flood modeling, Dam break modelling, flood risk maps. Flood Prediction Models

Learning outcome:
1. understanding the fluvial systems, hydromorphology
2. floods and flood dynamics, risk reduction strategies
3. Flood modeling premier
4. Monitoring system design for flood monitoring

TEXT BOOKS/REFERENCES:
3. peer reviewed literature.

**19GI722 ADVANCED EARTH SYSTEM MODELING 1-0-1-2**

Regional scale climate modeling, Statistical and dynamical downscaling methodology. Installing and compiling a regional climate model, land surface schemes, basics of parameterization, working on a case study.

OR
Installing and compiling a soil infiltration model. Running a case study, basics of debris flow models and slope stability.

Learning Outcomes:
1. Understanding the regional downscaling methods of global climate projection
2. Designing a case study modeling experiment
3. analyzing the output from a climate model
4. Hands-on experience with the climate model/landslide modeling

TEXT BOOKS/REFERENCES:
2. User’s manual for different model components will be provided

**19GI723 VULNERABILITY ASSESSMENT & DISASTER RISK REDUCTION 1-0-1-2**

This course will enhance the learning experience by providing a scientific approach to disaster risk reduction efforts and vulnerability assessment framework.

First quarter: understanding the vulnerability, definition, common approaches to vulnerability assessment, methods and tools, Challenges
Second quarter: Students will be learning through some case studies, India and international.
Third quarter: Basic understanding of disasters, disaster risks, and disaster risk reduction. Literature based module
Fourth quarter: Students will be doing a project based vulnerability assessment case study.

Learning Outcomes:
1. Basics of Vulnerability assessment
2. Concept of Disaster Risk reduction
3. Mapping vulnerability
4. Case studies to understand the strategic disaster risk reduction

Textbooks/References:
GIZ, 2014: A Framework for Climate Change Vulnerability Assessments, Published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, India Project on Climate Change Adaptation in Rural Areas of India (CCA RAI)

19GI724 TECHNOQUES FOR MONITORING COASTAL CHANGES AND COASTLAND MANAGEMENT 1-0-1-2

Theory: Change in coastal environment & reconstruction, Coastal changes, mapping of erosion and deposition, GIS based coastal zone management utilizing remote sensing data

Class project: Case studies

Learning outcomes:
1. Understanding the coastal changes
2. Coastal zone management
3. GIS based coastal zone management
4. Project on coastal zone management

Textbooks/References:
1. Peer reviewed journal papers

Syllabus for Elective IV (Industry and field work Oriented course)

19GI725 RESILIENCE: COMMUNITY ENGAGEMENT 1-0-1-2

First half of this project based course will focus on reviewing high impact research papers to understand and explore the concept of resilience in the context of climate change, drawing on literature from other fields and countries there relevance, and considering both local area resilience and, specifically, to identify key components of resilience and that factors may support
or undermine resilience in different contexts. How effective and smart communication will equip the local community to become resilient community. Concept of shared knowledge and adoptability. Second half of the project is field based. Student will visit the fields where disaster stuck and study the effective communication and sharing knowledge by surveys and conducting community engagement events etc. They will also be guided to make a strategic framework for climate resilience.

Learning Outcomes
1. Up to date research on climate change resilience and community engagements
2. How to talk science for the benefit of the community.

TEXT BOOKS/REFERENCES:
3. Peer reviewed journal papers

19G1731 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT
[EIA AND EIM] 1-0-1-2

The course has been designed to do mini projects with Industries and learn directly from Industry experts the application of Remote Sensing and GIS in Environmental Impact Assessment (EIA) studies including Environmental Clearance, Ambient Air Quality Monitoring, Analysis, Air Pollution Modelling, Dispersion of Stack and Fugitive Emissions, Water Quality, Noise and Vibration, Soil Quality, Fertility Status and Microbiological Quality in soil and Soil Erosion, Solid & Hazardous Wastes – Characterization, Classification, TCLP, Socio-Economic Aspects, Risk Assessment and Hazard Management,

Learning Outcomes:
1. Experience in environmental impact assessment

TEXT BOOKS/REFERENCES:
Peer reviewed journal papers

19G1732 SMART CITY AND SMART COMMUNITY: CONCEPTS AND PLANNING FRAMEWORK 1-0-1-2
With the development of computer technology, wearable devices, Internet of Things (IoT) etc, understanding smart community concepts and being able to analyze smart community/city cases is important for urban planners, managers and policymakers. What is a smart city? What is a smart community? Being smart is not just about technology; a city and a smart community enables better service delivery and quality of life for all of its residents. This seminar class will provide hands on experience for interested students in public policy, planning, administration, and others.

Learning Outcomes:
1. To obtain basic knowledge of smart communities;
2. To learn how to analyze and compare existing smart community projects;
3. To learn how to analyze smart community data using GIS and other related software.

TEXT BOOKS/REFERENCES:
2. Peer reviewed journal papers

19GI733 LANDSLIDE FIELDWORK AND LABORATORY SIMULATIONS 1-0-1-2

Landslide types and processes, features and geometry, landslide activity and material mass movement, landslide processes and vulnerability zonation. Spatiotemporal distribution of landslides, Geo-factors contributing to landslide Hazards
Laboratory simulations of a slow-moving landslide mechanisms, Pore pressure generation, changes in soil moisture and movement of rain induced landslides, Seismic monitoring of landslide in laboratory
Field visit to landslide prone areas. Practical landslide field Investigations and data processing

learning Outcomes:
1. Understanding the field based landslide monitoring
2. Understanding the lab based landslide modeling

TEXT BOOKS/REFERENCES:
2. Brian C. McFall (2018) Laboratory experiments on three-dimensional deformable granular landslides on planar and conical slopes

19GI734 HYPERSPECTRAL IMAGING AND INTERPRETATION 1-0-1-2

Learning Outcomes:
1. Advanced analysis experience with hyperspectral image
2. Different applications of hyperspectral analysis
3. Applications for coastal changes, vegetation detection, Urban land use etc

Text Books/References:
3. Peer reviewed journal papers

19GI795 LIVE-IN-LABS I: PARTICIPATORY DESIGN AND MODELLING

AMRITA University has established live-in-labs at 100+ locations, mostly in rural areas spread across the length and breadth of India. Live-in-Labs© is an opportunity for students to live in a village environment so they can study problems first-hand in water, health, education, etc. and work together to devise solutions. Live-In-Labs will provide an experiential learning opportunity where each student can come and spend for 2 weeks to a semester in one of the live in labs based on the area. They will become part of the interdisciplinary team of students and faculty drawn from across the disciplines from all participating universities. The live-in-labs have varied focus areas such as energy, water, healthcare, education, waste management, ICT for billion, skill building etc.

During this process the students will share village life and observe and understand problems encompassing health and hygiene, energy, water, waste, environment, etc., touching the villagers’ lives, and define projects that seek to address these problems, devise solutions, implement, test and eventually demonstrate innovative solutions. One definitive achievement is that they will receive a deeper understanding of challenges faced by emerging developing countries. This gives the wonderful opportunity since emerging countries have the largest opportunity for new ideas, innovative solutions etc.
Identify the problem, Proposal Writing -Proposal Format, Budget Estimation, Proposal Drafts, Proposal re-evaluation, Final Proposal Draft. Advanced Human Centered Design

19G1796  LIVE-IN-LABS II: LAB-TO-FIELD: PEOPLE CENTERED INNOVATION 0-0-0-0

Sustainable Approach to Product Designing, Project Management, Planning, Implementing Evaluation of Implementation, Plan with Domain Experts, Design Optimization

19G1797  LIVE-IN-LABS III: SOCIAL BUSINESS: PEOPLE CENTERED INNOVATION  0-0-1-1