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 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.

*Programme Outcomes (PO)*

PO1: An ability to independently carry out research/investigation and develop to solve practical problems

PO2: An Ability to write and present a substantial technical report / document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than requirements in appropriate bachelor program

PO4 Understanding of how the basic theories can be applied to solve practical problems.

PO5 Ability to bridge the gap from research to community needs.

**Programme Specific Outcomes (PSO)**

PSO1: Course aims to develop a critical understanding of spatial planning based on academic discourses, the international development agenda and candidates’ own experiences

PSO2: Mastering GIS and remote sensing based software packages and other technologies to analyse and solve earth science related resource utilisation and environmental issues.

PSO3: Understanding the earth system processes, problems and solutions.

PSO4 Mathematical and statistical description of earth observations.

PSO5: In a digital workflow environment, one will learn to combine remote sensing data with laboratory and field measurements, and to extract information from these data and gain insight to analyze, predict and monitor for sustainable applications.
## CURRICULUM
### First Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L</th>
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<td>21MA616</td>
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Credits 18

*Non-credit course

## Second Semester

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Total Credits - 69
## LIST OF COURSES

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<td>Geoelectrical Characterisation And Monitoring Methods</td>
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<td>HYDROSAT: Observing the Water Cycle from Space</td>
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<td>Climate Change: impacts, adaptation and mitigation</td>
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## Syllabus

**21MA616 FOUNDATIONS OF MATHEMATICS** 2-1-0-3

**Course Outcomes**

**CO1**: Understand the concepts of linearity, vector spaces and subspaces, inner products, orthogonality and bases  
**CO2**: understand geometry of linear systems of equations, kernel and range of a matrix  
**CO3**: understand representations of linear maps, diagonalization and singular value decomposition  
**CO4**: Understand the description and quantification of randomness in experiments. Learn to compute probabilities from such models.  
**CO5**: Learn to use discrete and continuous probability distributions. Train the associated computations of descriptors including mean, variance and of event probabilities.  
**CO6**: Understand the concepts of independence, conditional distributions, covariance and correlation.
Part I: Linear Algebra

Determinants- Row Reduction and Cofactor Expansions, Row picture, Column picture, Vector Spaces- Euclidean space, General (real) Vector Spaces, Subspaces, Linear Independence, Dimension, Row, Column and Null spaces.

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

Linear Transformations: Kernel and Range, Inverse Transformations, Matrices of Linear Transformations, Change of Basis, Similarity; Orthogonalization and Least Squares, Eigenvalues and Eigenvectors,

Iterative methods for linear systems

Skills Acquired: Mathematical representation of physical systems in array & equations

TEXT BOOKS/REFERENCES:


Further References


21GE601 INTRODUCTION TO EARTH SYSTEM 3-0-1-4

Course Outcomes:

CO1 : Understand the concept of a coupled Land-Atmosphere-Ocean as a whole system.
CO2 : Explain basic Geology and identify Geomorphological and Geological phenomena
CO3 : Understanding of landscape evolution and environmental planning
CO4 : Describe the composition of atmosphere, Atmospheric parameters, dynamics and thermodynamics
CO5 : Summarize the fundamentals of Oceanography
CO6 : Outline the various aspects of climate change, biosphere and ecosystem components

Atmosphere and 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;
大气稳定; 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.

Concept of an ecosystem : understanding ecosystem, ecosystem degradation, resource utilization.
structure and functions of an ecosystem; producers, consumers and decomposers; energy and
matter flow in the ecosystem: water cycle, carbon cycle, oxygen cycle, nitrogen cycle, energy
cycle; food chains, food web and ecological pyramids; forest ecosystems; grassland ecosystems;
desert ecosystems; aquatic ecosystems

Climate change: Climate change history geological evidence; 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.

**TEXT BOOKS/REFERENCES:**

1. Chandrashekhar, A. "Basics of Atmospheric Sciences." *Basics of Atmospheric Science*
   280 (2010).
3. Masselink, G., & Hughes, M. G. (2014). *An introduction to coastal processes and
   geomorphology*. Routledge.
   92). Elsevier.

**21GE602  FUNDAMENTALS OF GIS AND GEOSTATISTICS  3-0-1-4**

**Course Outcomes**

**CO1** : Understanding of spatial data, its types and how to handle it.
**CO2**: Map generation and its understanding in a GIS software (including open source software)
**CO3** : Fundamentals of spatial statistics and introduction to R software
**CO4** : Time series analysis in geospatial datasets

Cartography & GIS: Intro to Geographic Information Systems (GIS) and their applications; Vector
and Raster data operations. Spatial phenomena and its distribution, diversity of representation forms, map types, scale, projections, coordinate system. Concepts of map making: Data Posting, symbolizations, typography; Contour Map; primary and derivative map, features and resolution. Map making ArcGIS, digitization.

Google earth: Exporting vector and raster maps to KML; Reading KML files through R, obtaining data via google service, export of maps to google earth.


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.

Skills acquired: Practical knowledge of GIS softwares, statistical and time series analysis of geospatial data using R

TEXT BOOKS/REFERENCES:


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**21GE603 PRINCIPLES OF REMOTE SENSING 2-0-1-3**

**CO1**: Define the concepts of remote sensing and applications

**CO2**: Describe electromagnetic spectrum and the interactions with various media

**CO3**: Detail the various sensors and image acquisition

**CO4**: Acquire remote sensing images from common multispectral platforms

**CO5**: Apply the basics of image processing to remote sensing images


Satellite sensors: Orbits and Platforms for earth observation, sensors and scanners, spectral sensitivity,

Active and passive microwave remote sensing: basics of RADAR and LIDAR, radiometry, spectrometers, image restorations and atmospheric corrections, Thermal imagery: basic theory, blackbodies and emissivity, processing of thermal data.

Commonly used multi-spectral remote sensing satellite systems: LANDSAT, SPOT, ENVISAT, RADARSAT, IRS, IKONOS, SENTINEL Family, RISAT, RESOURCESAT etc

Skills acquired: Acquire and perform basic processing of remote sensing images, understanding of various satellite sensors and their applications

TEXT BOOKS/REFERENCES:

21GE604 GEODETIC SURVEYING AND MONITORING METHODS 2-0-1-3

Course Outcomes (CO)

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<thead>
<tr>
<th>CO1:</th>
<th>Introduction and foundation of Geodetic survey</th>
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<tr>
<td>CO2:</td>
<td>To learn technological enhancements in Geodetic monitoring</td>
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<tr>
<td>CO3:</td>
<td>Introduction and application of modern Geodetic survey equipment: total station, DGPS, EDM, Drones etc.</td>
</tr>
<tr>
<td>CO4</td>
<td>Application of satellite Geodetic survey: gravimetry and altimetry</td>
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</table>

Familiarization with high precision surveying instrument systems. Become capable of applying geodetic theory in high precision monitoring networks.

**Measurements Methods**: Distance, angle measurements, errors and uncertainties and impact on designing the survey plan, use of Compass, EDM, Ultrasonic Methods, VLBI, Global Positioning System (GPS-DGPS) Monitoring and Improvements

**Basic Surveying**: Surveying principles, equipment, errors sources, and setting ground control points (GCP), Topographical surveying using total station, GNSS and Space Exploration, Integrated Geodetic Measurements.

**Geometrical and Gravimetric observations**: Satellite gravimetry from Gravity Recovery and Climate Experiment (GRACE) and GRACE follow-on (GRACE-FO). Satellite altimetry: Concept of data acquisition and correction, applications and limitations, hands on different missions like Jason series, envisat, SARAL-altika, etc.

**Exploratory data analysis**: ground based radiometer data acquisition, sampling design, Developing skills in data collection, processing, analysis and interpretation via advanced and complex calculations and computer programming. DEM generation from contour data.


Case studies of smart city applications, disaster management etc

**Skills acquired**: Theoretical and practical knowledge of acquiring and processing data from surveying equipments, GNSS, geometrical, gravimetric, radiometric and drone based observations

**TEXT BOOKS/REFERENCES:**

**Geodesy**

**SUGGESTED REFERENCES**
Course Outcomes

CO1 : Understand the fundamentals of Python programming language
CO2 : Learn the concepts of object oriented programming in Python
CO3 : Execute Python scripts for simple data analysis
CO4 : Utilise data frames for data analysis
CO5 : Create simple visualisations and graphs for data analysis

Introduction to Python, variables, data types, objects and object oriented programming, classes, inheritance, lists and indices, loops, conditional statements, functions, script files, loading and using modules

Numpy arrays, Data analysis using pandas, plotting using Matplotlib, programming with spatial data

Skills acquired: Basics of python programming

TEXT BOOKS/REFERENCES:


COURSE OUTCOMES:

On completion of this course, the student shall be able to

1. Understand concepts of Radar systems and its application
2. Gain knowledge in the principles of Lidar data and interpretation
3. Understand the various application domains of hyperspectral remote sensing
4. Gain exposure various image processing techniques

Image processing : Image registration – definition principle and procedure - Fundamental of image rectification, interpolation- intensity interpolation- Radiometric & geometric correction of remotely sensed data. Basic statistical concept in DIP and use of probability methods in DIP- Image enhancement
techniques - an overview - Contrast enhancement - linear and nonlinear, histogram equalisation and density slicing Spatial filtering and edge enhancement, Multi image manipulation – addition, subtraction and band rationing - Enhancement by using colours – advantages, types of colour enhancements

**RADAR Techniques:** SAR Interferometry (InSAR, DInSAR) and Polarimetry: [fundamental concept, methodology, processing, application], SAR Systems and Image Acquisition Modes, SAR data processing and backscatter image generation, Advance techniques of SAR Remote Sensing, Application of SAR imagery in the field of defence and security; Fundamentals of RADAR, SAR Interferometry, and SAR imagery; Introduction to SAR sensors and platforms, SAR geometrical and radiometric effects, enhancements of a SAR image, basic SAR imagery ordering, interpretation of SAR imagery, SAR signatures, change detection using amplitude and interferometry coherence map, SAR interferometry ordering, coherence maps, DEM generation, interferogram and displacement maps SAR interferometry applications in the field of security and defence; Applications of RADAR - soil response – vegetation response- water and ice response- urban area response

**LiDAR:** Measurements using LiDAR and its applications: temporal and spatial coverage, Impact of Errors, Information extraction from LiDAR data, Principles of LiDAR, LiDAR sensors and platforms, LiDAR data view, processing, and analysis, LiDAR applications: topographic mapping, vegetation characterization, and 3-D modeling of urban infrastructure, Basic skills of LiDAR needed to leverage the commercial LiDAR sources, Software packages (ArcGIS LAS Dataset; FUSION/LDV; PointVue LE; LAStools) for LiDAR data displaying, processing, and analyzing. LiDAR data applications

**Hyper-spectral Remote Sensing:** Hyper-spectral Imaging: Hyper spectral concepts, data collection systems, calibration techniques, data processing techniques; preprocessing, N-dimensional scatter-plots, Special angle mapping, Spectral mixture analysis, Spectral Matching, Mixture tuned matched filtering, Classification techniques, airborne and space-borne hyperspectral sensors, applications. High resolution hyperspectral satellite systems: Sensors, orbit characteristics, description of satellite systems, data processing aspects, applications.

**Skills acquired:** Theoretical and practical knowledge of acquiring and processing RADAR, LIDAR and hyperspectral data.

**REFERENCES:**
6. Pinliang Dong and QiChen., Lidar remote sensing and applications ISBN 9781138747241 Published December 12, 2017 by CRC Press220 Pages 40 Color & 143 B/W Illustrations
Course Outcomes

CO1: Exploring different geospatial data types and statistical methods

CO2: GIS techniques in GIS software and model builder (ArcGIS/Q-GIS)

CO3: Point pattern analysis and spatial interpolation

CO4: Geospatial multi-criteria decision making and site suitability analysis

CO5: Network analysis


Contribution of geospatial tech in different industrial and govt projects. Legal and policy aspects. Guest lectures: sharing of real time applications from invited talks

Note: software flexibility (ARCGIS/QGIS)

Skills acquired: Experience on working with geospatial data for societal benefit using GIS software

TEXT BOOKS/REFERENCES:


21GE614 GEOTECHNICAL AND IOT MONITORING METHODS 2-0-1-3

Course Outcomes (CO)

| COI | To provide an introduction to geotechnical engineering and soil mechanics and an understanding of the scope of these subjects |
| CO2: | To familiarize the student with basic terms and concepts in soil mechanics |
| CO3: | Provide the theoretical basis for understanding geophysical measurements and observations |
| CO4: | To be able to choose appropriate geophysical techniques to address problems relevant to society, such as natural hazards, resource exploration and management, and environmental issues |
| CO9: | Ability to understand and work with geophysical modelling and inversion software to translate field measurements into subsurface properties |

IoT an overview, General architecture, Applications, Internet, LAN and WAN, Sensors and Sensing technique, Data Acquisition techniques and Daqs, Wireless communication: Near range, medium range and far range communication,


Real-word case study: Geotechnical instruments deployment in real-world, challenging factors, Interfacing Geo-technical sensors with Arduino and Raspberry pi, Building networked devices, using wireless networking protocols, data summarization, data analysis. Real-world case study Landslide monitoring sites in Munnar and Sikkim, IoT in disaster management

Skills acquired: Use of IoT systems for Earth monitoring, hands-on experience working with real-world deployment and data

Geotechnical

21GE613 MACHINE LEARNING 2-0-1-3

Course Outcomes

<p>| CO1: | An understanding of ML and its wide application in real-world |
| CO2: | Understanding supervised learning, |
| CO3: | Implementation and interpretation of regression |</p>
<table>
<thead>
<tr>
<th>CO4:</th>
<th>Able to understand the logic behind a machine learning algorithm. Students able to understand how the optimal solution is arrived by a ML algorithm</th>
</tr>
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<tbody>
<tr>
<td>CO5:</td>
<td>Understanding and implementation of linear models, SVM algorithm.</td>
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<tr>
<td>CO6:</td>
<td>Understanding and implementation of neural networks</td>
</tr>
</tbody>
</table>

Introduction to Machine learning: Supervised and unsupervised classification, land use land cover change, change detection, accuracy assessment

some basic concepts in machine learning; Cluster analysis- K means algorithm, cluster evaluation; KNN classifier-feature weight, non parametric model, misclassification rate; Model evaluation- Cross validation, Hold one out, Leave one out, m-fold cross validation;

Linear Regression model; Logistic Regression; Bayesian decision theory, Parametric methods, multivariate methods

Dimensionality reduction, Support Vector Machine, decision trees, multilayer Perceptrons, assessing and comparing classification algorithms, combining multiple learners, and reinforcement learning.

**Skills acquired**: Application of machine learning concepts in geospatial data

**TEXT BOOKS/ REFERENCES:**

**21RM620 RESEARCH METHODOLOGY**

<p>| CO1: | Familiarise with the concepts of research, problem formulation |</p>
<table>
<thead>
<tr>
<th>CO2:</th>
<th>Learn how to conduct a critical review of research literature on a chosen topic</th>
</tr>
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<tbody>
<tr>
<td>CO3:</td>
<td>Understand the concepts behind data analysis</td>
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<tr>
<td>CO4:</td>
<td>Familiarise with the ethical aspects of research</td>
</tr>
<tr>
<td>CO5:</td>
<td>Application of the tools in a practical problem</td>
</tr>
</tbody>
</table>

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


**TEXT BOOKS/ REFERENCES:**

_Syllabus for Elective Courses_
Course Outcomes

CO1: Explain the importance of numerical modelling for studying Earth system
CO2: Construct computer programs for solving nonlinear equations
CO3: Solve first order Ordinary differential equation
CO4: Understand the concepts of numerical integration and differentiation
CO5: Know how the numerical schemes and grids influence the model
CO6: Apply numerical methods to simulate heat conduction, advection and diffusion in simple systems


Modelling the components of Earth System, Expert lectures

Skills acquired: Working with numerical models for Earth system components

TEXT BOOKS/REFERENCES:

21GE703: Geoelectrical Characterisation And Monitoring Methods (BGS offered course)

Course Description
Electrical Resistivity Tomography (ERT) method: geophysical method applied to the characterisation and monitoring of the near-surface. ERT surveys can be applied to the geological, hydrological and engineering investigation of the subsurface in 2D or 3D. It allows the characterisation of e.g. landslides, karst landscapes, wetlands, earth dams, landfills, mine tailings, archeological sites, etc. Applied as a monitoring tool, it provides critical information related to changes in moisture content or changes in temperature in the ground.

**Learning Objectives:**

1. Training in ERT field campaign planning
2. Learning techniques of ERT data acquisition and processing
3. Insights of ERT data interpretation through data from real world deployments
4. ERT surveys, lab experiment and time-lapse experiences
5. Establish a solid scientific foundation for the students in the field of Electrical Resistivity.
6. Develop a coherent understanding of ERT applications to several of the world's problems (such as Landslides, ground water quality etc.) from a scientific perspective.

Skills acquired: experience in ERT measurement, data interpretation and applications

**21GE701 BIG DATA AND APPLICATIONS 2-0-1-3**

Introduction: Large databases and their evolution, Introduction to Data Science - Why Big Data? - Problems solved by Data Science - Data Science Process - Exploratory Data Analytics. Data Preparation: data munging - scraping - sampling - cleaning. Exploring and Analysis of Data - descriptive and inferential statistics, sampling, experimental design, parametric and non-parametric tests of difference, ordinary least squares regression, and general linear models; Data 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.


Skills acquired: Ability to apply the concepts of big data analytics in practical applications

**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:

21GE711 SMART CITIES AND URBAN PLANNING  2-0-1-3


Class Project: case studies

Skills acquired : Knowledge in using GIS techniques in city planning and development

Learning Outcomes:
1. concepts of urbanization and urban growth
2. GIS based Urban studies
3. Introduction to urban growth modeling
4. Models like cellular automata, markov random, agent based model
5. Python scripting examples for urban applications

TEXT BOOKS/REFERENCES:
5. Peer reviewed journal papers
Course Outcomes:

CO1: Hydrological states from satellite observations: surface water, soil moisture and groundwater
CO2: Hydrological cycle from satellite observations: precipitation, evapotranspiration and runoff.
CO3: Hands on GRACE gravity field data for hydrological mass variation studies
CO4: Hands on satellite remote sensing datasets for surface water level estimation
CO5: Automate the analysis of hydrological observation by integrating different datasets.

The course will educate on how to work with the state of the art satellite data which provides important information on the status and spatio-temporal changes of water resources worldwide. Different satellite data can be used to monitor the water cycle or hydrologic states of a region, like optical remote sensing, microwave, gravimetry, altimetry. Hands-on in these satellite data acquisition and data-analysis. Specifically, explore water balance equation with Gravity Recovery and Climate Experiment (GRACE) gravity field data for hydrological mass variation along with the combination of other sensors like the upcoming Surface Water Ocean Topography (SWOT) mission. Integrated use of different satellite altimetry datasets like Jason 1 or 2, Envisat, Saral-Altika, etc for surface water level estimation. Different soil moisture datasets like Soil Moisture and Ocean Salinity (SMOS), Soil Moisture Active Passive (SMAP) etc, precipitation data like Tropical Rainfall Measuring (TRMM), Global Precipitation Measurement (GPM), along with Clouds and the Earth’s Radiant Energy System (CERES) and Moderate Resolution Imaging Spectroradiometer (MODIS) etc will be explored. Different algorithms for quantifying the hydrological cycle components.

TEXT BOOKS/REFERENCES


21GE713 CLIMATE CHANGE: IMPACTS, ADAPTATION AND MITIGATION. 2-0-1-3

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:

21GE714 SUSTAINABLE DEVELOPMENT-FRAMEWORKS AND SOLUTIONS

Introduction to Sustainable Development: Glimpse into History and Current practices - Broad introduction to SD - its importance, need, impact and implications; definition coined; evolution of SD perspectives (MDGs AND SDGs) over the years; recent debates; 1987 Brundtland Commission and outcome; later UN summits (Rio summit, etc.) and outcome. Ecosystem & Sustainability: Fundamentals of ecology - types of ecosystems & interrelationships, factors influencing sustainability of ecosystems, ecosystem restoration - developmental needs. Introduction to sustainability & its factors, requirements for sustainability: food security and agriculture, renewable resources - water and energy, non-renewable resources, factors and trade-offs, sustainability conflicts, a conceptual framework for linking sustainability and sustainable development.

Dimensions to Sustainable Development - society, environment, culture and economy; current challenges - natural, political, socio-economic imbalance; sustainable development initiatives and policies of various countries : global, regional, national, local; needs of present and future generation - political, economic, environmental.

Gauging Sustainable Development - Sustainability and development indicators and SDGs, UN’s outlook of sustainable development and efforts, UN SDGs - structure, governance and partnerships; communities / society: ensuring resilience and primary needs in society; biosphere: development within planetary boundaries; strengthening institutions for sustainability; shaping a sustainable economy.

Frameworks of Sustainability - Analytical frameworks in sustainability studies, sustainability metrics: criteria and indicators; the significance of quantitative and qualitative assessments of sustainability; current metrics and limitations; metrics for mapping and measuring sustainable development; application of the metrics in real scenarios

Critical Perspectives on Sustainable Development: Resource management and implications on sustainable
development, implications for valuation, risk assessment; integrated decision-making processes: requirements of information, information flow, data analytics, learning from historical data, multicriteria decisions, multi level decisions, participatory decisions ; translating impact chains to information flows - impact of governance and policies

Case Studies & Projects on Rural Sustainable Development (Indian village perspectives) - Village resources (broad perspectives); current challenges and thematic areas; village social hierarchy; village economy; needs of present and future generation; conflicts - sustainability and rural culture & tradition; road to achieving sustainable development goals - bridging conflicts and way forward

Text Books/Reference Materials


21GE721 ENVIRONMENTAL GEOLOGY AND GEOHAZARDS 1-0-1-2


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. Weathering and 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 work

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

21GE723 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 Flood modeling premier
3. Monitoring system design for flood monitoring

TEXT BOOKS/REFERENCES:
3. peer reviewed literature.

21GE724 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

TEXT BOOKS/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)
21GE725  ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT
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

21GE681 LIVE-IN-LABS I: PARTICIPATORY DESIGN AND MODELLING
0-0-0-0

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

21GE781  LIVE-IN-LABS III: 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

21GE782  LIVE-IN-LABS IV: SOCIAL BUSINESS: PEOPLE CENTERED INNOVATION 0-0-1-1