August, 2019

M.TECH - GEOINFORMATICS AND EARTH OBSERVATION (2019)

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

Course Code	Type	Course	L	T	P	Cr
19MA601	FC	Foundations of Mathematics	2	0	1	3
19GI601	FC	Introduction To Geostatistics	2	1	0	3
19GI611	SC	Introduction to Earth System	3	0	0	3
19GI612	SC	Fundamentals of Cartography and GIS	2	0	1	3
19GI613	SC	Remote Sensing of Earth Systems	2	1	0	3
19GI602	FC	Python Programming For Earth Science	0	0	1	1
19HU601	HU	Amrita Values Program*				P/F
19HU602	HU	Career Competency I*				P/F
19GI795	P	Live-in-Labs-I - Participatory Design and Modelling	0	0	0	0
Credits						16

*Non-credit course

Second Semester

Course Code	Type	Course	L	T	P	Cr
19GI614	SC	Fundamentals of Earth System Modeling	2	0	1	3
19GI615	SC	Geodetic, Geotechnical and Geophysical Monitoring Methods	3	0	1	4
19GI616	SC	Advanced GIS And Remote Sensing for Earth Science Applications	2	0	1	3
	E	Elective I	2	0	1	3

19GI603	FC	Fundamentals of Digital Signal & Image Processing	2	0	1	3
19GI617	SC	GIS and Society	1	1	0	2
19GI604	FC	IOT for Earth Monitoring System	1	0	0	1
19RM600	SC	Research Methodology	2	0	0	2
19HU603	HU	Career Competency II	0	0	2	1
Credits						22

Third Semester

Course Code	Type	Course	L	T	P	Cr
	E	Elective I	3	0	0	3
	E	Elective II	1	1	0	2
	E	Elective III/ IV	1	1	0	2
19GI796	P	Live-in-Labs II- Lab-to-Field: People Centered Innovation	0	0	0	0
19GI798	P	Dissertation				6
Credits						13

Fourth Semester

Course Code	Type	Course	L	T	P	Cr
19GI797	P	Live-in-Labs III- Social Business: People Centered Innovation	0	0	1	1
19GI799	P	Dissertation				14
Credits						15

Total Credits - 66

LIST OF COURSES

Foundation Core

Course Code	Type	Course	L	T	P	Cr
19MA601	FC	Foundations of Mathematics	2	0	1	3
19GI601	FC	Introduction To Geostatistics	2	1	0	3
19GI602	FC	Python Programming For Earth Science	0	0	1	1
19GI603	FC	Fundamentals of Digital Signal & Image Processing	2	0	1	3
19GI604	FC	IOT for Earth monitoring System	1	0	0	1

Subject Core

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

Electives

Elective I

Course Code	Type	Course	L	T	P	Cr
19GI701	E	Advanced Machine Learning And Data Analytics	2	0	1	3
19GI702	E	Geospatial modelling	2	0	1	3
19GI703	E	Big Data and Applications	2	0	1	3
19GI704	E	GIS Based Urban Planning	2	0	1	3
Elective II						
19GI711	E	Geospatial project management	2	0	0	2
19GI712	E	Climate Change: impacts, adaptation and mitigation.	2	0	0	2
19GI713	E	Environmental Geology and Geohazards	2	0	0	2
Elective III (Practical Oriented Course)						
19GI721	E(POC)	Fluvial Systems and Flood Monitoring Techniques	1	0	1	2
19GI722	E(POC)	Advanced Earth System Modeling	1	0	1	2
19GI723	E(POC)	Vulnerability Assessment & Disaster Risk Reduction	1	0	1	2
19GI724	E(POC)	Techniques For Monitoring Coastal Changes and Coastland Management	1	0	1	2
19GI725	E(POC)	Resilience : Community Engagement	1	0	1	2

Elective IV (Industry and field work Oriented course)						
19GI731	E(IOC)	Environmental Impact Assessment and Management [EIA and EIM]	1	0	1	2
19GI732	E(IOC)	Smart Community/City: Concepts and Planning Framework	1	0	1	2
19GI733	E(IOC)	Landslide Fieldworks And Laboratory Simulations	1	0	1	2
19GI734	E(IOC)	Hyperspectral Imaging and Interpretation	1	0	1	2

Syllabus for Foundation courses

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

Part I: Linear Algebra

Determinants- Row Reduction and Cofactor Expansions, Cramer's rule. 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, LU and LDU Decomposition methods, 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; Orthogonalizations and Least Squares, Parallel Matrix Computations, Unsymmetric Eigenvalue problem, Symmetric Eigenvalue problem, Iterative methods for linear systems, Lanczos methods.

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:

1. Sernesi, Edoardo. *Linear algebra: a geometric approach*. Routledge, 2019.
2. Howard Anton, Chris Rorres, "Elementary Linear Algebra - Applications Version", 11th, 2014
3. Fisz, Marek, and Robert Bartoszyński. *Probability theory and mathematical statistics*. Vol. 3. J. wiley, 2018.
4. Vijay K Rohatgi and A K Saleh, "An Introduction to Probability and Statistics", 2nd, John Wiley & Sons, 2011.
5. Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for

Engineers", 4th, John Wiley & Sons, 2007.
6. Sheldon M. Ross, "A First Course in Probability", 8th, Pearson Prentice Hall, 2010.

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; Thevariogram calculation, interpretation, linking variogrambehaviour 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:

1. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical machine learning tools and techniques*. Morgan Kaufmann.
2. Islam, T., Srivastava, P. K., Gupta, M., Zhu, X., & Mukherjee, S. (Eds.). (2014). *Computational intelligence techniques in earth and environmental sciences*. Springer Netherlands.
3. Wackernagel, H. (2013). *Multivariate geostatistics: an introduction with applications*. Springer Science & Business Media.
4. Chun, Y., & Griffith, D. A. (2013). *Spatial statistics and geostatistics: theory and applications for geographic information science and technology*. Sage.

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

Introduction to Python programming. Python Programming Environment, Python Expressions, Strings, Functions, Function Arguments, Lists, List Methods, Control Flow. Basic Object Oriented Programming concepts.

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:

1. ArsheepBahga, Vijay Madisetti, “internet of Things: A Hands-On Approach”, Universities Press
2. Mark Lutz, “Learning Python: Powerful Object-Oriented Programming: 5th Edition”, O’REILLY, 2013
3. Simon Monk, “Programming Arduino – Getting started with Sketches”, McGraw Hill, 2012.
4. Donald Norris, “The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black”, Copyright Material, Edition 1, 2015

19GI603FUNDAMENTALS OF DIGITAL SIGNAL & IMAGE PROCESSING 2-0-1-3

Basics of Signals and Systems: Definitions, Properties and classification of Signals and Systems, Sampling, Reconstruction, Quantization, Discrete-Time Systems, Power Spectral Analysis.
Digital Filters and Transfer Functions: DFT/FFT Algorithms, FIR Filter Design, Adaptive Filtering.
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:

1. Jensen, J. R. (2015). *Introductory digital image processing: a remote sensing perspective*. Prentice Hall Press.
2. Remote Sensing of the Environment, J.R. Jensen, 2nd Ed. (@ Labyrinth)

3. Canty, M. J. (2014). *Image analysis, classification and change detection in remote sensing: with algorithms for ENVI/IDL and Python*. Crc Press.
4. Antoniou, A. (2016). *Digital signal processing*. McGraw-Hill.
5. Elliott, D. F. (2013). *Handbook of digital signal processing: engineering applications*. Elsevier.
6. Uncini, A. (2015). *Fundamentals of adaptive signal processing*. Cham: Springer International Publishing.

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:

1. ArshdeepBahga, Vijay Madisetti, , Internet of things: a hands-on approach, CreateSpace Independent Publishing Platform, 2013.
2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011
3. Dr. OvidiuVermesan, Dr Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013
4. Olivier Hersent, David Boswarthick, Omar Elloumi The internet of things: key applications and protocols, Wiley, 2012

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: Endogenetic and Exogenetic.

climaticand tectonic factors and rejuvenation of landforms. Geodynamics: Introduction to Geodynamics and Diastrophic movements – Epeirogenic and orogenic mountain building, Structural geology: Folds, Faults, Joints and Unconformities. Earthquakes and Seismic zonation. Plate Tectonics, Continental Drift, Concept of Isostasy. Types of weathering, soil formation/ profiles and mass wasting. Agents of erosion and deposition.Fluvial systems and concepts of gradation, Sea level changes and coastal evolution.Applied Geomorphology landscape development and environmental planning.

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; ElNino; 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:

1. Concept of a coupled Land-Atmosphere-Ocean as a whole system.
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:

1. Chandrashekhar, A. "Basics of Atmospheric Sciences." *Basics of Atmospheric Science* 280 (2010).

2. Huggett, R. (2016). *Fundamentals of geomorphology*. Routledge.

3. Masselink, G., & Hughes, M. G. (2014). *An introduction to coastal processes and geomorphology*. Routledge.

4. Summerfield, M. A. (2014). *Global geomorphology*.

5. Allen, P. A., 1997, Earth surface processes: Oxford, U.K., Blackwell Science, 404 p. Benn, D. I., and Evans, D. J. A., 1998, Glaciers and glaciation: New York, John Wiley and Sons, 734 p

6. Malone, T. (Ed.). (2016). *Compendium of meteorology*. Springe+r.

7. Wallace, J. M., & Hobbs, P. V. (2006). Atmospheric science: an introductory survey (Vol. 92). Elsevier.

19GI612 FUNDAMENTALS OF CARTOGRAPHY AND GIS 2-0-1-3

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:

1. Harvey, F. (2015). *A primer of GIS: Fundamental geographic and cartographic concepts*. Guilford Publications.
2. Heywood, D. I., Cornelius, S. C., & Carver, S. J. (2011). An introdu----ction to geographical information systems. Pearson Prentice Hall.

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

Introduction and Satellite Orbits: History of Satellite remote sensing. Orbits and Navigation: Newton's Laws. Keplerian Orbits. Orbit Perturbations. Meteorological Satellite Orbits. Satellite Positioning, Tracking and Navigation. Space-Time Sampling.Launch Vehicles and Profiles. Satellite Orbits: Geostationary Operational Environmental Satellites (GOES) and Polar Operational Environmental Satellites (POES)

Radiative Transfer: Electromagnetic spectrum, radiation laws, The Radiative Transfer Equation, interaction with atmosphere, Gaseous Absorption. Scattering.interaction with surfaces, Surface Reflection. Solar Radiation.

Satellite sensors and image interpretation: Satellite Instrumentation: Operational Polar-Orbiting Satellites. Operational Geostationary Satellites.Other Satellite Instruments.Visible and Infrared Imaging.Spectrometers.Data products; Passive microwave radiometry. Instruments and data products; Active microwave remote sensing: introduction to radars, SAR, data products,

Remote sensing of the environment: Deriving the parameters from remote sensing: Temperature, rainfall, trace gases, soil moisture, altimetry; Sea Surface temperature, sea level height

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:

1. Barrett, E. C. (2013). *Introduction to environmental remote sensing*. Routledge.
2. Chuvieco, Emilio. (2016) Fundamentals of satellite remote sensing: An environmental approach. CRC press.
3. Lillesand, T., Kiefer, R. W., &Chipman, J. (2015). *Remote sensing and image interpretation*. John Wiley & Sons.
4. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to remote sensing*. Guilford Press.

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.
Numerical methods - solving system of linear equations, solution of nonlinear equations, iterative methods, convergence, accuracy.Numerical differentiation and integration.Solution of ordinary differential equations, stability, convergence, accuracy, Runge-Kutta methods, applications to example problems. Solution of partial differential equations, discretisation, finite difference methods, Explicit and implicit scheme, advection equation, staggered grids, application to example problems, spectral method, introduction to finite element methods, Galerkin method, shape functions and discretisation.
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:

1. Samarskii, A. A., &Mikhailov, A. P. (2014).*Principles of mathematical modelling: Ideas, methods, examples*. CRC Press.
2. Slingerland, Rudy, and Lee Kump. Mathematical Modeling of Earth's Dynamical Systems: A Primer. Princeton University Press, 2011
3. ANDREW. ROOD GETTELMAN (RICHARD B.). DEMYSTIFYING CLIMATE MODELS: A Users Guide to Earth System Models. SPRINGER, 2018.
4. Durran, Dale R. Numerical methods for wave equations in geophysical fluid dynamics. Vol 32. Springer Science & Business Media, 2013.

5. Hamming, Richard. Numerical methods for scientists and engineers. Courier Corporation, 2012.
6. Chapra, Steven C., and Raymond P. Canale. Numerical methods for engineers. Boston: McGraw-Hill Higher Education,, 2010.
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 instrumentsinfluence 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

Geotechnical investigations: Physiochemical behaviour of soil, Theory of Plasticity, Geotechnical Exploration & Measurement Technique, Geotechnical Laboratory methods, Finite Element Methods in Geotechnical Engineering, Flow through Porous Media , Ground Improvement Techniques, Environmental Geotechnology

Geophysical monitoring Methods:Gravity survey, Magnetic survey, Electrical resistivity tomography, Seismic Survey, Radiometric survey, Induced Polarity (IP) Survey, Electromagnetic (EM) Survey. Geoscience data integration and interpretation.

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:

1. Ghilani, Charles D. Elementary Surveying : an Introduction to Geomatics . 15th ed. New York: Pearson, 2018.
2. James K. Mitchell and Kenichi Soga: Fundamentals of Soil Behavior
3. David M Potts. And Lidija, Zdravkovic, Finite Element Analysis in Geotechnical Engineering, Vol 1 & 2. Thomas Telford, London.
4. M. Hvorsler, Subsurface exploration and sampling of soil for Civil Engg. Purpose.
5. 1. J.E. Bowles, ‘Physical and Geotechnical Properties of Soils’, 2nd Edition, Mc. Graw Hill, New York.

19GI616ADVANCED GIS AND REMOTE SENSING FOR EARTH SCIENCE APPLICATIONS 2-0-1-3

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:

1. Wang, G., &Weng, Q. (Eds.). (2013). *Remote sensing of natural resources*. CRC Press.
2. Srivastava, P. K., Mukherjee, S., Gupta, M., & Islam, T. (Eds.). (2014). *Remote sensing applications in environmental research*. Basel, Switzerland: Springer.
3. Bonham-Carter, G. F. (2014). *Geographic information systems for geoscientists: modelling with GIS* (Vol. 13). Elsevier.
4. Quattrochi, D. A., Wentz, E., Lam, N. S. N., & Emerson, C. W. (Eds.). (2017). *Integrating Scale in Remote Sensing and GIS*. CRC Press.
5. Thenkabail, P. S., & Lyon, J. G. (2016). *Hyperspectral remote sensing of vegetation*. CRC press.

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.
2. Clarke, G., Ballas, D., Franklin, R. S., &Newing, A. (2017). *GIS and the social sciences: Theory and applications*. Routledge.
3. Gubrium, A., & Harper, K. (2016). *Participatory visual and digital methods*. Routledge.

19RM600 RESEARCH METHODOLOGY 2-0-0-2

Unit I:

Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research,Research Questions, Research design, Approaches to Research, Quantitative vs. Qualitative Approach,Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. ConfirmatoryResearch, Experimental vs Theoretical Research, Importance of reasoning in research.

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 SystemsAnalysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, FieldExperiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical DataAnalysis: 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:

Intellectual property rights (IPR) - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct.Plagiarism, Unscientific practices in thesis work, Ethics in science

TEXT BOOKS/ REFERENCES:

1. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8thEdition, McGraw-Hill, 2011
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers
3. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.
4. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6th Edition July 2012

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:

1. Kelleher, J. D., Mac Namee, B., &D'arcy, A. (2015). *Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies*. MIT Press.
2. Aggarwal, C. C. (Ed.). (2014). *Data classification: algorithms and applications*. CRC press.

3. Joshua Chapmann; Machine Learning: Fundamental Algorithms for Supervised and Unsupervised Learning With Real-world Applications

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:

1. Reddy, GP Obi. "Spatial Data Management, Analysis, and Modeling in GIS: Principles and Applications." *Geospatial Technologies in Land Resources Mapping, Monitoring and Management*. Springer, Cham, 2018. 127-142.
2. Abdelbaki, Chérifa, et al. "Contribution of GIS and Hydraulic Modeling to the Management of Water Distribution Network." *Geospatial Challenges in the 21st Century*. Springer, Cham, 2019. 125-150.
3. Kumar, Pavan, et al., eds. *Applications and Challenges of Geospatial Technology: Potential and Future Trends*. Springer, 2018.

19GI703 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.

Data Analytics - Theory and Methods - Supervised learning, Linear/Logistic Regression, Decision trees, Naïve Bayes, Unsupervised learning - K-means clustering - Association rules - Unstructured Data Analytics - Technologies and tools - Text mining - Web mining. Data Communication with Information Visualization - Effective Information Visualization - Visual Encoding - Perception of Visual Cues - Data Scales - Visualizing Time Series Data - Visualizing through stories and interpretable summaries.

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:

1. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", First Edition, O'Reily Media, 2012.
2. Cathy O'Neil and Rachel Schutt, “Doing Data Science Straight Talk from the Frontline", First Edition, O'Reily Media, 2013.
3. Chris Eaton, et al, “Understanding Big Data”, McGraw-Hill, 2012.
4. Henrique C. M. Andrade, BugraGedik and Deepak S. Turaga, "Fundamentals of Stream Processing: Application Design, Systems and Analytics", Cambridge University Press, 2014.

19GI704 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:

1. Scholten, H. J., & Stillwell, J. (Eds.). (2013). *Geographical information systems for urban and regional planning* (Vol. 17). Springer Science & Business Media.
2. Black, J. (2018). *Urban transport planning: Theory and practice*. Routledge.
3. deRoo, G. (2017). *Integrating city planning and environmental improvement: Practicable strategies for sustainable urban development*.Routledge.
4. Foot, D. (2017).*Operational urban models: an introduction*. Routledge.
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:

1. Croswell, Peter L. 2011. The GIS Management Handbook.. Des Plaines, IL, Kessey Dewitt Publications in association with URISA.
2. peerreviewd 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:

1. IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp
2. IPCC, 2014: Climate-resilient pathways: adaptation, mitigation, and sustainable development. chapter In: Climate Change (2014)

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

nature-dominated system. Concept of biodiversity and Geodiversity.Mobility of elements.Impact assessment of water availability, quality and contamination of surface water and groundwater.Introduction to medical geology.Atmosphere and air pollution.Soil contamination due to urbanization, industrialization and mining.Basic tenets of environmental laws.Distribution, magnitude and intensity of earthquakes.Geotectonic and seismic hazard assessment.Preparation of seismic hazard maps.Impact of seismic hazards on long and short term environmental conditions. Mechanism of landslides, causes of major floods, cyclones and storms. Deforestation and land degradation. Dryland environments: Droughts and Desertification

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
Real-Time Flood Monitoring Using Wireless Sensor Networks, Flood monitoring and warning: case studies, Requirements for a Flood Monitoring System, monitoring Sensors, Design of the Real-Time Flood Monitoring System

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:

1. Adams, T. E., & Pagano, T. C. (Eds.). (2016). *Flood Forecasting: A Global Perspective*. Academic Press.
2. Costa, J. E., & O'Connor, J. E. (1995). Geomorphically effective floods. *Natural and anthropogenic influences in fluvial geomorphology*, *89*, 45-56.
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:

1. Maraun, Douglas, and Martin Widmann. *Statistical downscaling and bias correction for climate research*. Cambridge University Press, 2018.
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

TEXT BOOKS/REFERENCES:

GIZ, 2014: *A Framework for Climate Change Vulnerability Assessments*, Published by Deutsche GesellschaftfürInternationaleZusammenarbeit (GIZ) GmbH, India Project on Climate Change Adaptation in Rural Areas of India (CCA RAI

UNDP, 2010: *Mapping climate change vulnerability*,http://www.adaptationcommunity.net/?wpfb_dl=58

19GI724 TECHNIQUES 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

TEXT BOOKS/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:

1. Paton, D., & Johnston, D. (2017). *Disaster resilience: an integrated approach*. Charles C Thomas Publisher.
2. Whitmarsh, L., Lorenzoni, I., & O'Neill, S. (2012). *Engaging the public with climate change: Behaviour change and communication*. Routledge.
3. Peer reviewed journal papers

19GI731 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

19GI732 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:

1. Deakin, M. (Ed.). (2013). *Smart cities: governing, modelling and analysing the transition*. Routledge.
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 l;ab based landslide modeling

TEXT BOOKS/REFERENCES:

1. Raj Hari Sharma (2010) Numerical model and flume experiments of single- and two-layered hillslope flow related to slope failure Landslides, 2010, Volume 7, Number 4, Page 425

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

3. S.P. Pradhan, V. Vishal and TN Singh [Eds.] 2018. Landslides: Theory, Practice and Modelling. Springer Nature 2019.

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

Hyperspectral Image Display and Basic Analysis, Pre-processing of Hyperspectral Data, Reducing High Dimensionality of Hyperspectral Imagery and Endmember Selection, Thematic Information Extraction from Hyperspectral Imagery, Unsupervised Hyperspectral Image Classification Using a Neuron-fuzzy System, Hyperspectral Applications: Soil, Mineral & Rock, Urban Area and Water, Vegetation Mapping in the Kissimmee River Floodplain and Coastal Everglades Using Hyperspectral Imagery, Combining Object-based Texture Measures with a Neural Network for Vegetation Mapping in the Everglades from Hyperspectral Imagery, Mapping Individual Tree Species in an Urban Forest Using Airborne LiDAR and Hyperspectral Imagery, Benthic Habitat Mapping in the Florida Keys Using Hyperspectral Imagery

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:

1. Sun, D. W. (Ed.). (2010). *Hyperspectral imaging for food quality analysis and control*. Elsevier.

2. Borengasser, M., Hungate, W. S., & Watkins, R. (2007). *Hyperspectral remote sensing: principles and applications*. CRC press.

3. Peer reviewed journal papers

19GI795 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

19GI796 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

19GI797 LIVE-IN-LABS III: SOCIAL BUSINESS: PEOPLE CENTERED INNOVATION 0-0-1-1

Prototype Development & Evaluation- Model Building, Training on Relevant Simulation Software, Software Simulation of Prototype Iteration (Incorporating HCD)' Real Time Prototype Development, Prototype Presentation. Prototype Review. Evaluating Implementation Challenges-Space, Budget, Feasibility, External Factors.
Field Implementation, Generating Community Awareness, Research Paper Writing-Structure, Writing Skills, Data Compilation, Deliverables