M.TECH - GEOINFORMATICS AND EARTH OBSERVATION

AMRITA CENTRE FOR WIRELESS NETWORKS AND APPLICATIONS

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

Course Code	Type	Course	L T P	Cr
23MA603	FC	Foundations of Mathematics	2 1 0	3
23GE601	SC	Introduction to Earth System	3 0 1	4
23GE602	SC	Fundamentals of GIS and geostatistics	3 0 1	4
23GE603	SC	Principles of remote sensing	2 0 1	3
23GE604	SC	Geodetic surveying and monitoring methods	2 0 1	3
23GE681	FC	Advanced computer programming	0 0 1	1
22AVP103		Mastery Over Mind	1 0 2	2
22ADM501		Glimpses of Indian Culture	2 0 1	P/F
23HU601	HU	Career Competency I*	0 0 3	P/F
		credits		**20**

*Non-credit course

Second Semester

Course Code	Type	Course	L T P	Cr
23GE611	SC	Advanced Remote Sensing	3 0 1	4
23GE612	SC	Advanced GIS & geospatial modelling	2 0 1	3
23GE613	FC	Applied machine learning	3 0 1	4
23GE614	FC	Geotechnical and IoT monitoring methods	2 0 1	3
23RM703	SC	Research Methodology	2 0 0	2
	E	Elective I	2 0 1	3
23GE682	P	Live-in-Labs I		P/F
23HU611	HU	Career Competency II	0 0 3	1
		Credits		**20**

Third Semester

Course Code	Type	Course	L T P	Cr
	E	Elective II	2 0 1	3
23GE781	P	Live-in-Labs II	0 0 0	0
23GE798	P	Dissertation- Phase I		10
		Credits		13

Fourth Semester

Course Code	Type	Course	L T P	Cr
23GE782	P	Live-in-Labs III	0 0 1	1
23GE799	P	Dissertation- Phase II		16
		Credits		17

Total Credits - 70

LIST OF COURSES

Foundation Core

Course Code	Type	Course	L T P	Cr
23MA603	FC	Foundations of Mathematics	2 1 0	3
23GE602	FC	Fundamentals of GIS and geostatistics	3 0 1	4
23GE681	FC	Advanced computer programming	0 0 1	1
23GE613	FC	Applied Machine Learning	3 0 1	4
23GE614	FC	Geotechnical and IoT monitoring methods	2 0 1	3

Subject Core

Course Code	Type	Course	L T P	Cr
23GE601	SC	Introduction to Earth System	3 0 1	4
23GE603	SC	Principles of Remote Sensing	2 0 1	3
23GE611	SC	Advanced Remote Sensing	3 0 1	4
23GE612	SC	Advanced GIS & geospatial modelling	2 0 1	3
23GE604	SC	Geodetic surveying and monitoring methods	2 0 1	3
23RM703	SC	Research Methodology	2 0 0	2

Elective Courses

		Elective I	L T P	Cr
23GE731	E	Climate Change and Sustainability: A Modelling Perspective	2 0 1	3
23GE732	E	Geoelectrical Characterisation And Monitoring Methods	2 0 1	3
23GE733	E	Glaciology and Associated hazards	2 0 1	3
23GE734	E	Smart cities and urban planning	2 0 1	3
		Elective II	L T P	Cr
23GE741	E	Introduction to Deep Learning	2 0 1	3
23GE742	E	Environmental Geology and Geohazards	2 0 1	3
23GE743	E	Sustainable development - Frameworks & Solutions	2 0 1	3
23GE744	E	Vulnerability Assessment & Disaster Risk Reduction	2 0 1	3

Syllabus

(Syllabus for the three subjects will be added later)

23MA603 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:

1. Howard Anton, Chris Rorres, “Elementary Linear Algebra - Applications Version”, 11th, 2014
2. Rice, John A., “Mathematical Statistics and Data Analysis, 3rd Cengage Brook/Cole, 2007

Further References

5. Golub and Loan, "Matrix Computations", 3rd, John Hopkins University Press, 1996.
6. Carl. D. Meyer, "Matrix Analysis and Applied Linear Algebra", SIAM, 2001.
7. Gilbert Strang, "Introduction to Linear Algebra", 4th, Wellesley Cambridge Press, 2009.

23GE601 INTRODUCTION TO EARTH SYSTEM 3-0-1-4

Course Outcomes:

CO1 : Explain basic Geological concepts and identify Geomorphological and Geological phenomena
CO2 : Apply the concepts of regional development and planning
CO3 : Analyze the driving forces behind atmospheric and oceanic circulation systems
CO4 : Apply fundamental physical principles in understanding weather and climate- processes
CO5 : Describe the components of the ecosystem and their interconnections

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. climatic and 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.

State of the atmosphere; Atmospheric composition, structure, Vertical thermal structure of the atmosphere; global wind patterns; Hydrostatic equilibrium; Weather phenomena – Wind, precipitation, Surface weather and vertical structure; Convection, lapse rate, concept of air parcel; atmospheric stability; saturation; lifting condensation level; clouds; Introduction to atmospheric dynamics - equations of motion; atmospheric boundary layer. global hydrologic cycle. Ocean : Distribution of temperature, salinity and density ; Ocean circulation; tides ; waves; coastal processes ; land-atmosphere interaction, ocean-atmosphere interaction. Weather phenomena - Indian monsoon system; El Nino-Southern Oscillation (ENSO); Tropical cyclones; monsoon depressions; other systems. Controls of the climate system; Land-atmosphere-ocean interactions; Carbon cycle ; climatic classifications ; climatic change and variability ; climatic data

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.

Introduction to Human & Social Geography. Planning for Regional Development. Basic concepts and scope of Regional Development. Integrated area development planning (AIDP), considerations for planning of Hilly areas, Drought prone areas/ Deserts, coastal communities. Causes and consequences of regional disparities, medical geography, natural resources utilization patterns and sustainable development.

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*. Springer.

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

8. Bharucha (2005), *Textbook of environmental studies*, Universities Press

9. Understanding the Earth 2017 7th Edition [eds. IG Gass et al.] ELBS edition

23GE602 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.

Spatial statistics: Conventional Analysis (Nongeostatistical), Why Geostatistics, Environmental variables, source of spatial variability, deterministic and scholastic processes. Analysis of discrete and continuous random variables. probability density function; Variances, joint variation, covariance, correlation, regression, different types of error like root mean square; Probability theory: Univariate, bivariate, multivariate statistics, Gaussian Distribution, Central Limit Theorem, Variogram Statistics, Nugget, Higher Dimensions & Statistical Anisotropy, Model-Fitting “Rules of Thumb”. Hands on different R tools like gstat, geoR, etc

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:

1. Islam, T., Srivastava, P. K., Gupta, M., Zhu, X., & Mukherjee, S. (Eds.). (2014). *Computational intelligence techniques in earth and environmental sciences*. Springer Netherlands.
2. Wackernagel, H. (2013). *Multivariate geostatistics: an introduction with applications*. Springer Science & Business Media.
3. Chun, Y., & Griffith, D. A. (2013). *Spatial statistics and geostatistics: theory and applications for geographic information science and technology*. Sage.

23GE603 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 techniques

CO4 : Acquire remote sensing images from common multispectral platforms

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

Introduction, definition, history of satellite remote sensing, Satellite sensors : Orbits and Platforms for Earth observation, sensors and scanners, active and passive sensors.
Electromagnetic spectrum, radiation laws, The Radiative Transfer Equation, interaction with atmosphere, interaction with surfaces, Spectral Response and Spectral Signature, Spectral, Spatial, Temporal and Radiometric resolutions.

Optical imagery : spectral sensitivity, band combinations, Imaging systems, Photogrammetry – geometry of aerial photographs, projections, scale, relief displacement, parallax, stereoscopy, co-ordinate systems, transformations, orientations, triangulation, DEM, DSM, DTM, orthophoto.

Digital image processing – digital image formats, image histograms, Image pre-processing, corrections; image enhancements – contrast enhancement, density slicing, spatial filtering, spectral enhancement, PCA ; Image classification – supervised, unsupervised and hybrid techniques; visual image interpretation.

Thermal Remote Sensing: thermal sensors, thermal image interpretation, emissivity, thermal inertia, applications of thermal remote sensing.

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 multispectral remote sensing images, understanding of various satellite sensors and their applications

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.
5. Elements of Photogrammetry by Paul R. Wolf, McGraw-Hill, Inc
6. Joseph, G. (2005). Fundamentals of remote sensing. Universities Press.

23GE604 GEODETIC SURVEYING AND MONITORING METHODS 2-0-1-3

Course Outcomes (CO)

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

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

Introduction to Geodesy: Basics of Geodesy, its Classification and scope of Geodesy for the Benefit of Society. Georeferencing and Projection: Understanding coordinate system, Datum, Map Projection, Georeferencing, and techniques of spatial data superposition, introduction to PNT (expert lectures) .

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.

Drone: Data acquisition from drone camera, data correction and interpretation. Stereo Photogrammetry, Concept of Orientation and Aerial Triangulation, Digital Terrain Modeling\Digital Elevation Model \Digital Surface Model 3D Feature Extraction, 3D city modeling.

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

1. Ghilani, Charles D. Elementary Surveying : An Introduction to Geomatics . 15th ed. New York: Pearson, 2018.
2. Deng, X. (2015). Geodesy–Introduction to Geodetic Datum and Geodetic Systems.
3. Smith, J. R. (1997). Introduction to geodesy: the history and concepts of modern geodesy (Vol. 1). John Wiley & Sons.
4. Vanicek, P., & Krakiwsky, E. J. (2015). Geodesy: the concepts. Elsevier.
5. Wang, Jian-Guo (2009): Geodetic Surveys, Lecture Notes, Department of Earth and Space Science and Engineering, York University, revised 2011.
6. Anderson, M.J., and E.M. Mikhail, (1998). Surveying: Theory and Practice. McGraw-Hill, (7th Edition).
7. Vaníček P., and E. Krakiwsky (1986). Geodesy: The Concepts. North Holland, Amsterdam (2nd Edition).

SUGGESTED REFERENCES

1. El-Rabbany, A. (2002). Introduction to GPS, the Global Positioning System. Artech House, Boston.
2. Kavanagh, B.F., (2003). Surveying Principles and Applications. Prentice Hall, New Jersey (6th Edition).
3. Leick, A, (1995). GPS Satellite Surveying. John Wiley, New York (2nd Edition).
4. Ghilani, C.D. and Wolf, P.R. (2006), Adjustment Computations: - Spatial Data Analysis, John Wiley & Sons (4th edition), 2006.
5. Mikhail, E.D., and G. Gracie, (1981), Analysis & Adjustment of Survey Measurements, Van Nostrand Reinhold.
6. Wolf, P.R., and C.D. Ghilani, (2002). Elementary Surveying. An Introduction to Geomatics. Prentice Hall, New Jersey (10th Edition).

23GE681 ADVANCED COMPUTER PROGRAMMING 0-0-1-1

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:

1. Downey, A. (2015). *Think Python*. " O'Reilly Media, Inc.".
2. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. O'Reilly Media, Inc.
3. https://www.earthdatascience.org/courses/intro-to-earth-data-science/
4. Lutz, M. (2013). *Learning python: Powerful object-oriented programming*. " O'Reilly Media.

23GE611 ADVANCED REMOTE SENSING 3-0-1-4

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 recertification, 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:

1. Floyd.M.Handerson and Anthony, J.Lewis “Principles and applications of Imaging RADAR”, Manual of Remote sensing, 3rd edition, vol.2, ASPRS, Jhumurley and sons, Inc, 1998.
2. Ian Faulconbridge, Radar Fundamentals, Argos Press, 2002.
3. Philippe Lacomme,Jean clande Marchais,Jean-Philippe Hardarge and Eric Normant, Air and spaceborne radar systems - An introduction, Elsevier publications 2001.
4. Roger J Sullivan, Knovel, Radar foundations for Imaging and Advanced Concepts, SciTech Pub, 2004.
5. Marcus Borengasser and William C., Hungate and Russel Watkins, “Hyper spectral Remote sensing: principles and application” CRC, 2008
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

23GE612 ADVANCED GIS AND GEOSPATIAL MODELLING 2-0-1-3

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

Geospatial Analysis: foundations for analysis of continuous and discrete phenomena. GIS data Models and visualization. Geodatabase and attribute table handling. Spatial Statistical Models and GIS Model Builder. Analysis and modeling with map algebra.

Point Pattern Analysis. Neighborhood operations and buffers. Spatial interpolation and approximation (gridding): Thessian polygon, TIN, Kriging, variogram calculation and interpretation.

Raster distance calculation: cost surfaces, Euclidean and least cost path; Multi-criteria decision making (MCDM). Application of MCDM in different sectors. Network model and spatial optimization model. Site suitability modeling.

Contribution of geospatial tech in different industrial and govt projects and their economic impact. 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:

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.

23GE614 GEOTECHNICAL AND IOT MONITORING METHODS 2-0-1-3

Course Outcomes (CO)

CO1:	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

Geotechnical investigations: Introduction to soil mechanics, basic definitions, origin and formation of soils, soil particle size, soil structure, mechanical analysis of soil, particle size distribution, sieve analysis, Atterbergs parameters, physical and mechanical properties of soils, flow through soils, Darcy's Law, aquifers. Dam structural stability - uplift pressure/seepage pressure, removal mechanisms for seepage water. Soil shear strength, practical applications, and soil stabilizations, advanced techniques (nano-clays) in soil stabilization and remediation measures. Soil conservation measures, climate change on soil geotechnical properties-soil-atmospheric interactions and extreme event patterns, Case studies on IoT based geotechnical solutions.

IoT an overview, General architecture, Applications. Sensors and Sensing technique. Data Acquisition techniques and Daqs. Wireless communication technologies: Near range, medium range and far range communication. Coverage and connectivity: Issues and solutions. Data aggregation and dissemination techniques. Design considerations of energy and latency constrained networks.
Interfacing Geo-technical sensors with Arduino and Raspberry pi, Building networked devices for different applications. 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

1. James K. Mitchell and Kenichi Soga: Fundamentals of Soil Behavior
2. David M Potts. And Lidija, Zdravkovic, Finite Element Analysis in Geotechnical Engineering, Vol 1 & 2. Thomas Telford, London.
3. M. Hvorsler, Subsurface exploration and sampling of soil for Civil Engg. Purpose.
4. 1. J.E. Bowles, 'Physical and Geotechnical Properties of Soils', 2nd Edition, Mc. Graw Hill, New York.

23GE613 APPLIED MACHINE LEARNING 3-0-1-4

Course Outcomes

Learning Outcomes

LO1 To introduce different machine learning paradigms

LO2 To provide understanding of machine learning algorithms to be used on a given dataset for regression/classification problems.

Course Outcomes

CO1 Ability to conduct data analysis and data visualization

CO2 Apply the complete ML pipeline in real-world dataset - Analyse datasets, decide pre-processing steps, visualize data, apply ML models, and infer the meaning based on different performance metrics.

Course contents

Introduction to machine learning and machine learning applications. Data featurization, vectorization, linear algebra and matrix representations.

Supervised learning - linear regression, polynomial regression, logistic regression, Support Vector Machine and ANN. Regularization, tuning, overfitting, underfitting.

Unsupervised learning: Clustering, dimensionality reduction.

Deep Neural networks: multilayer perceptron, transfer learning, edge models. ML model evaluation metrics, MLOps - introduction to converting ML models from test bench to production (saving, loading, using trained models).

Textbooks

1. An Introduction to Statistical Learning by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani (2022)

2. Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media, 2019.

23RM703 RESEARCH METHODOLOGY 2-0-0-2

CO1:	Familiarise with the concepts of research, problem formulation
CO2:	Learn how to conduct a critical review of research literature on a chosen topic
CO3:	Understand the concepts behind data analysis
CO4:	Familiarise with the ethical aspects of research
CO5:	Application of the tools in a practical problem

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 for Elective Courses

23GE732: Geoelectrical Characterisation And Monitoring Methods (BGS offered course)

2 0 1 3

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

23GE734 SMART CITIES AND 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. Agroforestry, Changing Cities by Designing New and Extending Them - Designing Suburbs and Regions. Classifications of Towns and Cities in India. Assessment of urban transformations. Urban growth modeling concepts: Introduction to conventional and new generation models like cellular automata, markov random, 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

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:

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

23GE743 SUSTAINABLE DEVELOPMENT-FRAMEWORKS AND SOLUTIONS 2-0-1-3

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, management and communication strategies for user adoption.

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

1. Franco, I.B. and Tracey, J. (2019), "Community capacity-building for sustainable development: Effectively striving towards achieving local community sustainability targets", International Journal of Sustainability in Higher Education, Vol. 20 No. 4, pp. 691-725
2. Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.
3. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London
4. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. "An introduction to sustainable development." (2012).
5. Sachs, J. D. 2015. The Age of Sustainable Development. Columbia University Press, New York

23GE742 ENVIRONMENTAL GEOLOGY AND GEOHAZARDS 2 0 1 3

Fundamental Principles of Environmental Geology.Geofactor considerations for safe and sustainable development. Soil forming processes, soil 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 overnature-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. Geo-tectonic 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, Fluvial systems and river basin analysis Introduction to Floods, Spatio-temporal distribution of floods, flood mitigation strategies

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

23GE744 VULNERABILITY ASSESSMENT & DISASTER RISK REDUCTION 2-0-1-3

Unit 1: Understand the definitions of risk, vulnerability and indicators of vulnerability, capacity and disasters, and common approaches to vulnerability assessment, methods and tools, and challenges thereof.

· Unit 2: Review National and International disaster risk reduction policies, frameworks, and governance mechanisms by governments and international non-governmental organizations including the National Disaster Management Authority (NDMA) Government of India, the United Nations Sendai Framework for Disaster Risk Reduction, the Paris Agreement, United Nation's Sustainable Development Goals related to climate action etc.

· Unit 3: Critically evaluate the extant literature on multi-disciplinary scientific frameworks and tools for vulnerability identification and assessment including and Social Vulnerability Index (SoVI), Threat and Hazard Identification and Risk Assessment (THIRA), Vulnerability and Capacity Assessments (VCA) and Community Based Disaster Risk Assessment (CBDRA).

· Unit 4: Examine the successes and failures of structural and non-structural disaster risk reduction or mitigation strategies including nature-based solutions (NbS) popularized by national and international agencies through case study analyses, to demonstrate the interconnectedness between community vulnerabilities and protective action implementations.

· Unit 5: Work on a group-based case study project that involves conducting a vulnerability assessment of an identified community or sub-population, reviewing policies and offering an integrated disaster risk reduction solution

TEXT BOOKS/ JOURNAL ARTICLES AND REFERENCES

Unit 1: Definitions and common approaches to Vulnerability Assessment

1. United Nations International Strategy for Disaster Reduction (UNISDR) (2009. UNISDR Terminology of Disaster Risk Reduction. Available at, https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

2. Twigg, J. (2015). Disaster Risk Reduction. Available at http://bvpad.indeci.gob.pe/doc/pdf/esp/doc2601/doc2601-contenido.pdf

3. Ciurean, R. L., Schröter, D., & Glade, T. (2013). Conceptual frameworks of vulnerability assessments for natural disasters reduction. np: INTECH.

4. Moret, W. (2014). Vulnerability assessment methodologies: A review of the literature. Washington, DC: FHI, 360. Available at,

https://www.alnap.org/system/files/content/resource/files/main/Vulnerability%20Assessment%20Literature%20Review.pdf

Unit 2: National and International Disaster Risk Reduction Frameworks and Policies

1. International Federation of Red Cross and Red Crescent Societies. https://www.rcrc-resilience-southeastasia.org/ 2. National Disaster Management Authority, Government of India https://ndma.gov.in/

3. United Nations Office for Disaster Risk Reduction https://www.undrr.org/implementing-sendai-framework/what-sendai-framework

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

Units 3 & 4: Multi-disciplinary scientific frameworks and tools for vulnerability assessment and case study comparisons

1. Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2012). Social vulnerability to environmental hazards. In Hazards vulnerability and environmental justice (pp. 143-160). Routledge.

2. Flax, L. K., Jackson, R. W., & Stein, D. N. (2002). Community vulnerability assessment tool methodology. Natural Hazards Review, 3(4), 163-176.

3. US Federal Emergency Management Agency (2019). 2019 National Threat and Hazard Identification and Risk Assessment (THIRA). Overview and Methodology. Available at, https://www.fema.gov/sites/default/files/2020-06/fema_national-thira-overview-methodology_2019_0.pdf

4. Barnett, J., Lambert, S., & Fry, I. (2008). The hazards of indicators: insights from the environmental vulnerability index. Annals of the Association of American Geographers, 98(1), 102-119.

5. 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). Available at, https://www.giz.de/en/downloads/giz2014-en-cca-rai-vulnerable-assessments-india.pdf

6. Guillard-Gonçalves, C., Cutter, S. L., Emrich, C. T., & Zêzere, J. L. (2015). Application of Social Vulnerability Index (SoVI) and delineation of natural risk zones in Greater Lisbon, Portugal. Journal of Risk Research, 18(5), 651-674UNDP, 2010: Mapping climate change vulnerability.

7. Asian Development Bank (2010). Community Based Climate Vulnerability Assessment and Adaptation Planning: Cooks Island. Available at, https://www.preventionweb.net/files/27076_climatechangeassessmentcoo.pdf

8. Nakagawa, Yuko, and Rajib Shaw. “Social Capital: A Missing Link to Disaster Recovery.” Journal of Mass Emergencies and Disasters 22, no. 1 (2004): 5-34.

9. Chapters 2,4, 5, 6, 9 from Twigg (2015)

10. Chapters 7, 8, 11, 12, 13, 16 from Twigg (2015)

11. Mercer, J., Kelman, I., Taranis, L., & Suchet-Pearson, S. (2010). Framework for integrating indigenous and scientific knowledge for disaster risk reduction. Disasters, 34(1), 214-239. Available to read for free online at, https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1467-7717.2009.01126.x

12. Lindell M., C. Prater, R.W. Perry with W.C. Nicholson (2006). Chapter 6, "Hazard, Vulnerability and Risk Analysis" in Fundamentals of Emergency Management http://training.fema.gov/EMIWeb/edu/fem.asp

13. Schmidtlein, M. C., Deutsch, R. C., Piegorsch, W. W., & Cutter, S. L. (2008). A sensitivity analysis of the social vulnerability index. Risk Analysis: An International Journal, 28(4), 1099-1114.

Youtube Videos

1. 5 EXTREME Natural Disasters Caught on Camera. Available at, https://www.youtube.com/watch?v=d6uJy9WgM4U&ab_channel=Underworld

2. PBS-NOVA. Wake that Shook the World. Available at, https://www.youtube.com/watch?v=o1Ekr0r1XBw&ab_channel=DocLuke (Indian Ocean Tsunami, 2004) 3. Frontline. The Quake. Available at, https://www.pbs.org/wgbh/frontline/film/haiti/

(Haiti Earthquake, 2010)

23GE682 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

23GE781 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

23GE782 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

23HU601	**Career Competency I**	**L-T-P-C: 0-0-3-P/F**

Pre-requisite: An open mind and the urge for self-development, basic English language skills and knowledge of high school level arithmetic.

Course Objectives:

- Help students transit from campus to corporate and enhance their soft skills
- Enable students to understand the importance of goal setting and time management skills
- Support them in developing their problem solving and reasoning skills
- Inspire students to enhance their diction, grammar and verbal reasoning skills

Course Outcomes:

CO1: Soft Skills - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.
CO2: Soft Skills - To make formal and informal presentations with self-confidence.
CO3: Aptitude - To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.
CO4: Aptitude - To analyze, understand and apply suitable techniques to solve questions on logical reasoning and data analysis.
C05: Verbal - To infer the meaning of words and use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.
C06: Verbal - To identify the relationship between words using reasoning skills. To understand and analyze arguments and use inductive/deductive reasoning to arrive at conclusions and communicate ideas/perspectives convincingly.

CO-PO Mapping

PO / CO	PO1	PO2	PO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	1	2	-
CO6	2	2	-

Syllabus

Soft Skills

Introduction to 'campus to corporate transition':

Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.

Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.

Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.

Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals

Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management

Presentation skills: the process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio visual aids, dos and don'ts of effective presentation

Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misspelt words, commonly confused words and wrong form of words in English.

Grammar: Train students to understand the nuances of English Grammar and thereby enable them to spot grammatical errors and punctuation errors in sentences.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions and learn logical reasoning through syllogism questions. Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.

Oral Communication Skills: Aid students in using the gift of the gab to improve their debating skills.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquettes of email writing. Make students practise writing emails especially composing job application emails.

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.
Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.
Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.
Averages: Basics, and Weighted Average.
Time and Work: Basics, Pipes & Cistern, and Work Equivalence.
Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.
Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.
Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.
Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.
Logarithms, Inequalities and Modulus: Basics

References

Soft Skills

Communication and listening skills:

- Andrew J DuRbin , "Applied Psychology: Individual and organizational effectiveness", Pearson-Merril Prentice Hall, 2004
- Michael G Aamodt, "An Applied Approach, 6th edition", Wadsworth Cengage Learning, 2010

Assertiveness skills:

- Robert Bolton, Dorothy Grover Bolton, "People Style at Work..and Beyond: Making Bad Relationships Good and Good", Ridge Associates Inc., 2009
- John Hayes "Interpersonal skills at work", Routledge, 2003
- Nord, W. R., Brief, A. P., Atieh, J. M., & Doherty, E. M., "Meanings of occupational work: A collection of essays (pp. 21- 64)", Lexington, MA: Lexington Books, 1990

Self-perception and self-confidence:

- Mark J Martinko, "Attribution theory: an organizational perspective", St. Lucie, 1995
- Miles Hewstone, "Attribution Theory: Social and Functional Extensions", Blackwell, 1983

Time management:

- Stephen Covey, "The habits of highly effective people", Free press Revised edition, 2004
- Kenneth H Blanchard , "The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy" , Peak Performance Press, 1st edition 2005
- Kenneth H. Blanchard and Spencer Johnson, "The One Minute Manager" , William Morrow, 1984

Verbal

- Erica Meltzer, "The Ultimate Guide to SAT Grammar"
- Green, Sharon, and Ira K. Wolf, "Barron's New GRE", Barron's Educational Series, 2011
- Jeff Kolby, Scott Thornburg & Kathleen Pierce, "Nova's GRE Prep Course"
- Kaplan, "Kaplan New GRE Premier", 2011-2012
- Kaplan's GRE Comprehensive Programme
- Lewis Norman, "Word Power Made Easy", Goyal Publishers, Reprint edition, 1 June 2011
- Manhattan Prep, "GRE Verbal Strategies Effective Strategies Practice from 99th Percentile Instructors"
- Pearson- "A Complete Manual for CAT", 2013
- R.S. Aggarwal, "A Modern Approach to Verbal Reasoning"
- S. Upendran, "Know Your English", Universities Press (India) Limited, 2015
- Sharon Weiner Green, Ira K. Wolf, "Barron's New GRE, 19th edition (Barron's GRE)", 2019
- Wren & Martin, "English Grammar & Composition"

- www.bbc.co.uk/learningenglish
- www.cambridgeenglish.org
- www.englishforeveryone.org
- www.merriam-webster.com

Aptitude

- Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT Common Admission Test", Tata Mc Graw Hills, 5th Edition , 2012
- Arun Sharma, "How to Prepare for Logical Reasoning for the CAT Common Admission Test", Tata Mc Graw Hills, 2nd Edition, 2014
- Arun Sharma, "How to Prepare for Data Interpretation for the CAT Common Admission Test", Tata Mc Graw Hills, 3nd Edition, 2015
- R.S. Aggarwal, "Quantitative Aptitude For Competitive Examinations", S. Chand Publishing, 2015
- R.S. Aggarwal, "A Modern Approach To Verbal & Non-Verbal Reasoning", S. Chand Publishing, Revised -2015
- Sarvesh Verma, "Quantitative Aptitude-Quantum CAT" , Arihant Publications, 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

Evaluation Pattern

Assessment	**Internal**	**External**
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50
Pass / Fail		

*CA - Can be **presentations, speaking activities and tests.**

23HU611	**Career Competency II**	**L-T-P-C: 0-0-3-1**

Pre-requisite: Willingness to learn, team spirit, basic English language and communication skills and knowledge of high school level arithmetic.

Course Objectives:

- Help students to understand the importance of interpersonal skills and team work
- Prepare the students for effective group discussions and interviews participation.
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively by using the correct diction, grammar and verbal reasoning skills

Course Outcomes:

CO1: Soft Skills - To demonstrate good interpersonal skills, solve problems and effectively participate in group discussions.

CO2: Soft Skills - To write technical resume and perform effectively in interviews.

CO3: Aptitude - To identify, investigate and arrive at appropriate strategies to solve questions on arithmetic by managing time effectively.
CO4: Aptitude - To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis by managing time effectively.
C05: Verbal - To be able to use diction that is more refined and appropriate and to be competent in knowledge of grammar to correct/improve sentences
C06: Verbal - To be able to examine, interpret and investigate passages and to be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

CO-PO Mapping

PO / CO	PO1	PO2	PO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	1	2	-
CO6	2	2	-

Syllabus

Soft Skills

Interpersonal skill: ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one's own interpersonal needs, role of effective team work in organizations
Group problem solving: the process, the challenges, the skills and knowledge required for the same.
Conflict management: the concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.)
Team building and working effectively in teams: the concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions.
Interview skills: what is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don'ts of interview, One on one mock interview sessions with each student

Verbal

Vocabulary: Help students understand the usage of words in different contexts. Stress the importance of using refined language through idioms and phrasal verbs.
Grammar: Enable students to identify poorly constructed sentences or incorrect sentences and improvise or correct them.
Reasoning: Facilitate the student to tap her/his reasoning skills through critical reasoning questions and logical ordering of sentences.
Reading Comprehension: Enlighten students on the different strategies involved in tackling reading comprehension questions.
Public Speaking Skills: Empower students to overcome gloss ophobia and speak effectively and confidently before an audience.
Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as

writing strategy, organization, and style.

Aptitude

Sequence and Series: Basics, AP, GP, HP, and Special Series.
Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.
Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.
Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.
Logical Reasoning I: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.
Logical Reasoning II: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmetic Problems and Input - Output Reasoning.
Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.
Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.
Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

References
Soft Skills

Team Building

- Thomas L.Quick, "Successful team building", AMACOM Div American Mgmt Assn, 1992
- **Brian Cole Miller, "Quick Team-Building Activities for Busy Managers: 50 Exercises That Get Results in Just 15 Minutes", AMACOM; 1 edition, 2003.**
- **Patrick Lencioni, "The Five Dysfunctions of a Team: A Leadership Fable", Jossey-Bass, 1st Edition, 2002**

Verbal

- "GMAT Official Guide" by the Graduate Management Admission Council, 2019
- Arun Sharma, "How to Prepare for Verbal Ability And Reading Comprehension For CAT"
- Joern Meissner, "Turbocharge Your GMAT Sentence Correction Study Guide", 2012
- Kaplan, "Kaplan GMAT 2012 & 13"
- Kaplan, "New GMAT Premier", Kaplan Publishing, U.K., 2013
- Manhattan Prep, "Critical Reasoning 6th Edition GMAT"
- Manhattan Prep, "Sentence Correction 6th Edition GMAT"
- Mike Barrett "SAT Prep Black Book The Most Effective SAT Strategies Ever Published"
- Mike Bryon, "Verbal Reasoning Test Workbook Unbeatable Practice for Verbal Ability, English Usage and Interpretation and Judgement Tests"
- www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm
- www.campusgate.co.in

Aptitude

- Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT Common Admission Test", Tata Mc Graw Hills, 5th Edition, 2012
- Arun Sharma, "How to Prepare for Logical Reasoning for the CAT Common Admission Test", Tata Mc Graw Hills, 2nd Edition , 2014
- Arun Sharma, "How to Prepare for Data Interpretation for the CAT Common Admission Test", Tata Mc Graw Hills, 3nd Edition , 2015

- R.S. Aggarwal, "Quantitative Aptitude For Competitive Examinations", S. Chand Publishing , 2015
- R.S. Aggarwal, "A Modern Approach To Verbal & Non-Verbal Reasoning", S. Chand Publishing , Revised -2015
- Sarvesh Verma, "Quantitative Aptitude-Quantum CAT" , Arihant Publications , 2016
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Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

22AVP103	Mastery Over Mind	L-T-P-C: 1-0-2-2

Course Objectives

The course will enable the students to

- Mastery Over Mind (MaOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3)
- It gives an introduction to immediate and long-term benefits of MA OM meditation and equips every attendee to manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- This course will enhance the understanding of experiential learning based on the University's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

Course Outcomes

CO1: To be able to describe what meditation is and to understand its health benefits
CO2: To understand the causes of stress and how meditation improves well-being
CO3: To understand the science of meditation
CO4: To learn and practice MAOM meditation in daily life
CO5: To understand the application of meditation to improve communication and relationships
CO6: To be able to understand the power of meditation in compassion-driven action

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1								1	2	2		2			
CO2			2		2				2	2		2			
CO3					2			2	2	2		2			

CO4			3		3		2	3	2	3		3			
CO5			2		2			2	2	3		3			
CO6			2					2	2	3		3			

Syllabus:

Unit 1: Describe Meditation and Understand its Benefits (CO1)

A: Importance of meditation. How does meditation help to overcome obstacles in life *(Pre-recorded video with Swami Shubhamritananda Puri)*

Reading 1: Why Meditate? (Swami Shubamritananda ji)

Unit 2: Causes of Stress and How Meditation Improves Well-being (CO2)

A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (*Pre-recorded video with Dr. Ram Manohar)*

B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. *(Pre-recorded video with Prof Udhaykumar)*

Reading 1: Mayo Clinic Staff (2022, April 29). *Meditation: A Simple, Fast Way to Reduce Stress.* Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858 (PDF provided)

Reading 2: 'Efficient Action.' Chapter 28 in *Amritam Gamaya* (2022). Mata Amritanandamayi Mission Trust.

Unit 3: The Science of Meditation (CO3)

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method? *(Pre-recorded video with Dr. Shyam Diwakar)*

B: How meditation helps humanity according to what we know from scientific research *(Pre-recorded video with Dr. Shyam Diwakar)*

Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)

Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 4: Practicing MA OM Meditation in Daily Life (CO4)

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 5: Improving Communication and Relationships (CO5)

How meditation and mindfulness influence interpersonal communication. The role ofmeditation in improving relationship quality in the family, at the university and in theworkplace. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves Relationships a Lot. Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways-meditation-improves-relationships-lot

Reading 2: 'Attitude.' Chapter 53 in Amritam Gamaya (2022). Mata AmritanandamayiMission Trust.

Unit 6 Meditation and Compassion-driven Action (CO6)

Understand how meditation can help to motivate compassion-driven action. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocialbehavior: What do we (not) know?. Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamyi Mission Trust.

Text Books/Reference Books:

1. Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
2. The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas

3. Dhyana Yoga-Holy Gita Swami Chinmayanda
4. Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
5. Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
6. Mind: It's Mysteries and control-Swami Sivananda Saraswati
7. Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
8. Books on Amma's teachings like Awaken children, From Amma's Heart etc.
9. The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
10.Allen, Cynthia (2020) The Potential Health Benefits of Meditation
11. Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today
12. Sharma, Hari (2022) Meditation: Process and Effects
13. Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
14. Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: Current Opinion in Psychology

Evaluation Pattern

Assessment	Internal	End Semester
Midterm	20	
Continuous assessment	40	
End Semester/Project		40

•CA – Can be Quizzes, Assignment, Projects, and Reports