KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES

Panangad, Kochi- 682506, Kerala

M.Sc. Remote Sensing and GIS

Syllabus

2024

M.Sc. Remote Sensing and GIS

About the Course

1. INTRODUCTION

The Master of Science (MSc) in Remote Sensing and Geographic Information Systems (GIS) is an advanced and interdisciplinary program designed to equip students with the knowledge and skills necessary to harness the power of cutting-edge technologies in the field of geospatial analysis. This program delves into the theoretical foundations and practical applications of remote sensing and GIS, offering a comprehensive understanding of how these tools contribute to addressing complex spatial challenges in various industries. Students in this program will explore the latest advancements in satellite and airborne remote sensing, spatial data acquisition, and geospatial analysis techniques. Through a combination of academic rigor and hands-on experience, graduates of the MSc in Remote Sensing and GIS emerge with the expertise to navigate the rapidly evolving landscape of geospatial technology and make meaningful contributions to fields such as Earth and Environmental management science, urban planning, natural resource assessment, and disaster management.

2. OBJECTIVES

The objectives of the Remote Sensing and GIS course are to equip the MSc Graduates with state-of-the-art knowledge in Geospatial Science to meet the growing demands of geospatial industry as well as academia in the country.

3. ELIGIBILTY

A University degree with 55% or 5.5/10.00 or 2.2/4.0 marks (for SC/ST students, relaxation as per the regulation) in any of the following subjects. Bachelor's degree in Physics/ Geophysics / Geology/Geography/Mathematics/Computer Application/ Computer Science/ Physics with Computer Applications/Statistics/Environmental Sciences/Agriculture/ Botany/ Environment and Water Management, Natural Sciences/ Fishery and Life Sciences

or

B.E./ B. Tech in Civil Engineering/Mechanical Engineering/Geo-informatics/Computer Science Engineering/ Agricultural engineering/ Electrical Engineering/ Electronics & Communication Engineering/ Petroleum Engineering/ Aerospace Engineering.

4. ASSESSMENT AND STANDARDS OF PASSING

The evaluation of the students in a course shall be based on his/her performance in various examinations, term papers/assignments/student seminars/records/ case study and project reports. Assignment will be based on both internal and external evaluation.

5. NO. OF SEATS: 15

6. .MODE OF SELECTION

The selection of the candidates will be on the basis of Entrance examination and previous academic performance. Candidates will be considered for admission only if they secure a minimum of 40% marks in the entrance examination. (The minimum mark is 30% for SC/ST candidates). The minimum mark will be subject to revision as per decision of the Admission Committee. The departmental/sponsored candidates can also apply and they should have at least 3 years' experience while applying.

7. PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1. To equip students with a solid foundation in the field of remote sensing and GIS to acquire,process,analyze and interpret spatial data for solving real-world problems and management.

PSO2. To develop a cadre of professionals with multidisciplinary expertise and essential skills, empowering them to apply their knowledge effectively in various disciplines.

PSO3. To provide specialized expertise to government and administrative bodies, enhancing their capacity to effectively manage challenges in areas including urbanization,disaster management,climate change and resource conservation.

PSO4. To foster safe and sustainable communities through capacity-building initiatives that strengthen resilience and preparedness enhances the quality of societal services..

PSO5. To instill core values of social responsibility, ethical practice, and community engagement while promoting research initiatives that enhance the knowledge in geospatial data and analysis.

8. EMPLOYMENT OPPORTUNITIES

Graduates of the MSc in Remote Sensing and GIS are well-positioned for diverse and dynamic employment opportunities across various sectors. The increasing demand for spatial data expertise has opened doors to careers in environmental consulting firms, where professionals contribute to ecological assessments, land-use planning, and natural resource management. Government agencies involved in environmental monitoring, urban development, and disaster response seek individuals with expertise in remote sensing and GIS for roles in policy development and implementation. Private industries, including energy, agriculture, and forestry, actively recruit professionals who can leverage geospatial technologies to optimize operations

and improve decision-making processes. Additionally, research institutions and academia provide opportunities for graduates to engage in cutting-edge research, advancing the field and contributing to the development of new technologies. As the global reliance on spatial data continues to grow, the MSc in Remote Sensing and GIS opens doors to a wide array of rewarding careers at the intersection of technology, environmental science, and decision support systems. National institutes such as ISRO-IIRS, ISRO-SAC, IIT, IISc, IISER, NIT, Central Universities and Research Institutions such as CWRDM, KFRI, NATPAC etc and State Universities are also recruiting MSc in Remote Sensing and GIS graduates frequently.

KERALA UNIVERSITY FOR FISHERIES AND OCEAN STUDIES,
DEPARTMENT OF REMOTE SENSING AND GIS
SCHEME OF EXAMINATION (EFFECT FROM 2020-2021 ONWARDS)

Sl. No.	SUBJECT	No. of Credits	Internal Marks	External Marks	Total
SEMESTER – I					
RS2101	Fundamentals of Remote sensing	C4	50	50	100
RS2102	Geographical Information System & GPS	C4	50	50	100
RS2103	Photogrammetry and Cartography	C4	50	50	100
RS2104	Digital Image Processing	C4	50	50	100
RS2105	Statistical Methods (SME 531 Applied Statistics)	E4	50	50	100
RS2106	Oceanography	E4	50	50	100
RS2107	Practical : Satellite Image Processing and GIS Analysis	P4	50	50	100
SEMESTER – II					
RS2201	Microwave and Hyperspectral Remote Sensing and its Applications	C4	50	50	100
RS2202	Geological Remote Sensing and Techniques	C4	50	50	100
RS2203	Geospatial Techniques for Disaster Management	C4	50	50	100
RS2204	Geospatial Techniques for Coastal and Marine Environments	C4	50	50	100
RS2205	Marine Meteorology	E4	50	50	100
RS2206	Geospatial Techniques for Water Resource Management	E4	50	50	100
RS2207	Practical: Geospatial Technology Applications and Modelling	P4	50	50	100
SEMESTER – III					
RS2301	DBMS, Python and MATLAB	C4	50	50	100
RS2302	LIDAR Remote Sensing and Applications	C4	50	50	100
RS2303	Satellite Meteorology, Agriculture and Forestry	C4	50	50	100
RS2304	Mini Project	C4	50	50	100
RS2305	Coastal Zone Management	E4	50	50	100
RS2306	Marine Survey and GIS	E4	50	50	100
RS2307	Practicals:	P4	50	50	100
SEMESTER – IV					
RS2401	Major Project and Viva-voce		18	---	100

First Semester: 24 Credits Second Semester: 24 Credits
Third Semester: 24 Credits Fourth Semester: 18 Credits **Total** = 90 Credits

SEMESTER - I

RS2101: Fundamentals of Remote Sensing

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List out the fundamental concepts and principles of remote sensing, including energy interactions and its applications	R	1,2
CO2	Describe the characteristics and functions of various remote sensing sensors, platforms, and data acquisition techniques	U	1,2
CO3	Explain the data acquisition process in remote sensing, including reflectance, digital numbers, ground truthing, and the role of detector mechanisms in an ideal remote sensing system	U	1,3
CO4	Classify the applications of land observation satellites and interpret satellite imagery for various uses in urbanization, disaster management, and resource conservation	An	1,3,4
CO5	Inculcate an interest in advanced remote sensing technologies, fostering a desire for further research and skill refinement in the field	U	2,5

COURSE CONTENT

Unit – 1

Introduction to Remote Sensing – Energy sources and Radiation principles, Energy equation, EMR and Spectrum – EMR interaction with Atmosphere – Scattering, Absorption – EMR interaction with Earth surface features reflection, absorption, emission and transmission – Spectral response pattern – Vegetation, Rocks, Soil, Water bodies – Spectral properties and characteristics.

Unit - 2

Types of remote sensing with respect to wavelength regions; active and passive remote sensing, Sensor types characteristics: imaging systems, photographic sensors, characteristics of optical sensors; FOV, IFOV; Sensor resolution - spectral, spatial, radiometric and temporal

Unit – 3

Data acquisition – Procedure, Reflectance and Digital numbers- Intensity-Reference data, Ground truth, Analog to digital conversion, Detector mechanism-Spectro - radiometer-Ideal remote sensing system – Characters of real and successful remote sensing system- Platforms and sensors- orbit types– Resolution

Unit – 4

Land observation satellites, characters and applications, IRS series, LANDSAT series, SPOT, series, Sentinel Missions, High resolution satellites, character and applications, CARTOSAT

series, IKONOS Series, QUICKBIRD series, Weather/Meteorological satellites, INSAT series, NOAA, GOES, NIMBUS Applications, Marine observation satellites OCEANSAT

Unit – 5

Introduction- Active, Passive, Optical Remote sensing, Visible, Infrared, thermal, Sensors and characters. Microwave Remote sensing sensors, Concept of Microwave Remote sensing, SLAR, SAR Scattro meter – Altimeter, Characteristics, Image interpretation characters.

REFERENCES

1. Paul Jude Gibson, Introductory Remote Sensing: Principles and Concepts, Routledge, 11 New Fetter Lane, Landon, UK. 2000. ISBN: 0-415-17024-9
2. M. Anji Reddy, Textbook of Remote Sensing and Geographical Information systems, BS Publications, Hyderabad**.** 2011. ISBN: 81-7800-112-8
3. A.M. Chandra and S.K. Gosh. Remote Sensing and GIS, Narosa Publishing Home, New Delhi 2009.
4. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Remote sensing and image interpretation John Wiley & Sons, 2008
5. George Joseph , Fundamentals of Remote Sensing Universities Press, Hyderabad 2005.
6. Prithvish Nag, M. Kudrat, Digital Remote Sensing, Concept Publishing Company, India, 1998.

RS2102: Geographic Information Systems and GPS

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List the fundamental concepts and components of GIS, including data structures (raster and vector) and types of data (points, lines, polygons)	R	1,2
CO2	Describe the processes for spatial and non-spatial data input, verification, correction, and output, along with data conversion techniques	U	1,2
CO3	Explain interpolation methods, including global and local techniques like Thiessen polygons, trend surface analysis, splines, and kriging	U	1,3
CO4	Classify the methods of three-dimensional modeling (DEM, DTM, DSM, TIN) and GIS applications in modeling, buffering, network modeling, and process models	An	1,3
CO5	Inculcate the basic concepts of GPS, including its history, working principles, coordinate systems, sources of error, and satellite-based navigation systems like GAGAN and GLONASS	U	4,5

COURSE CONTENT

Unit - 1

Definition - Usefulness of GIS - Components of GIS - Data Structure in GIS - Types of Data (Points, Lines and Polygons)- Data Base Structures (Raster Data Structures and Vector data Structures) - Data Conversion, (Vector to Raster and Raster to Vector). Dilution of precision. Introduction to proprietary and open source GIS.

Unit - 2

Spatial Data Input Processes and Devices (Sources of data, - Different Types of Data Entry methods, viz., Manual input, Run length code, Digitization, Automated Scanning, etc. - Vector to Raster conversion - Raster to Vector conversion - Input devices) - Entry of non-spatial data - Linking of Spatial & Non- spatial data - Data Verification (Sources of Errors - Errors due to Natural Variation - Errors during measurement - Errors during entry - Errors during measurement - Errors during Process & Analysis) - Correction (Rubber Sheet Transformation, Bilinear interpolation, Cubic Convolution, etc.) - GIS capabilities for Data correction - Data output (Types of Output, GIS Capabilities for output, Output devices).

Unit- 3

Basic Principles of Interpolation - Methods of Interpolation (Interpolation by Joining Boundaries, viz., Simple vector maps, Thiessen polygon) - Global Methods of Interpolation, Local Interpolation (Trend Surface Analysis) - Local Interpolation (Splines) - Optimal Interpolation (Kriging).

Unit - 4

Need For Three Dimensional Models - Methods of DEM - Products of DTM (Contour Maps, Shaded Relief Map, Maps Related To Slopes, Line Sight Maps, Drainage Analysis, Volume Estimation etc.) Usefulness of DEM/ DTM, DSM, TIN. Role of GIS in modelling- Map Overlaying, Boolean logic models, Index overlay models, fuzzy logic models, process models, Regression models,-Buffering- Network modelling Networking and Dynamic Segmentation- Applications, Minimum Distance Model, Maximum Covering Model (P-median model), Urban Transportation Planning Model. Artificial Intelligence – Expert Systems

Unit - 5

Basic concepts of GPS: History and timeline, overview. GPS coordinate systems: WGS-84, UTM, GPS segments, GPS working principle, source of GPS Errors and biases, Selective availability, GPS satellite signals, code phase v/s carrier phase, GPS positioning types – absolute positioning, differential positioning; Real time DGPS, post processed DGPS, Other satellite based navigational systems: GAGAN, GLONASS, GALILEO. Advantages and disadvantages of GPS surveying, Application of GPS

REFERENCES

1. Principles of Geographical Information System for Land Resource Assessment, P.A. Burrough, Clarendon Press, Oxford, 1986.
2. Geographic Information Systems, T.R. Smith & Piqent, London Press, 1985.
3. Principles of data base systems, J.D. Ullman, Computer Science Press, 1980
4. Santheesh Gopi., Global Positioning System – Principles and Applications, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
5. Seeber, G., Satellite Geodesy, Walter de Gruyter, Berlin, 1993.
6. Alfred Leick, GPS Satellite surveying, John Wiley and Sons, 1995.
7. Hofmann Wellenhof, B. Lichtenegger, H. and Collins, J., Global Positioning System, SorinQer - Verlag, New York, 1994.
8. Otto Huisman and Rolf A. de By (Editors) Principles of Geographical information Systems - An Introductory Text Book, ITC, The Netherlands, 2009. ISBN: 978-90-6164-269-5

RS2103: Photogrammetry and Cartography

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List the definitions, concepts, and branches of photogrammetry, including aerial and satellite photogrammetry, scale determination, and sources of distortion	R	1,2
CO2	Describe stereoscopy, stereophotography, and the processes involved in orthorectification, aero-triangulation, and DTM generation	U	1,3
CO3	Explain the advantages of satellite photogrammetry, including stereoscopic coverage, image acquisition methods, and data processing workflows	U	1,3
CO4	Classify map projections, including cylindrical, conical, azimuthal, and globular projections, and explain their uses and properties	U	1,4
CO5	Summarize the cartographic compilation process, map design, symbolization, and thematic mapping, including map elements and typography	U	2,5

COURSE CONTENT

Unit - 1

Definition and concepts, History of Photogrammetry, Branches of Photogrammetry:- Based on platform (Ground Based, UAV/drone based, Aerial Photogrammetry, Satellite Photogrammetry) Types of aerial photograph (Vertical, low, Oblique), Scale of Photographs, Flight height, Flight planning, Geometric elements of aerial photograph(analog and digital), Scale determination, Source of Distortions and displacement, Relief Displacement, parallax

Unit - 2

Depth perception, steroscopy/ sterovision, viewing sterophotography in analog environment, viewing sterophotography in digital environment, Sterophotogrammetry, Orthorecrification, interior and exterior orientation parameters. DTM generation - Image correlation - Image matching - Digital Orthophoto generation - Automated aero-triangulation - Link between GIS and Digital Photogrammetry.

Unit – 3

Introduction to satellite photogrammetry: Definition, advantage of imaging from space, General workflow, stero coverage (across, along), image acquisition methodology, data processing, mathematical model for satellite sensor modelling, orthorectification, satellites: Cartosat 1, SPOT. .

Unit – 4

History and development of Cartography, Definition, scope and concepts of cartography. Characteristics of Map. Categories of maps. Trends in Cartography. Geodesy, Map projection, classification principles of construction of common projections, cylindrical, conical, azimuthal and globular projections. Properties & uses of projection. The spheroid, Map scale, and co-ordinate system. Plane co-ordinates in UTM system, projection used in Survey of India topographic sheets.

Unit – 5

Compilation process- Generalization- Map Design and Symbolization: Map content, design and implementation- Pattern creation; feature attributes, point, line, areas and volumes; Qualitative and Quantitative symbols. Thematic Mapping-Layout and Display-Map elements- typography and lettering; portraying land surface form

REFERENCES

1. Krauss, J., Photogrammetry, Vol. I IV Edition, Springer –Verlag Publishers, 1993
2. International Archives of Photogrammetry and Remote Sensing, ISPRS, Volume XXIX, B5, Commission 5, 1995 Proceedings of Annual Convention of ASPRS, 1993-96
3. Robinson A. H., Morrison, J. L, Muehrcke, A. C., Kimerling, A. J. and Guptill, S. C., Elements of Cartography. 6th Edition, John Wiley and Sons, 1995.
4. Cromley, R. G., Digital Cartography. Prentice-Hall of India, New Delhi, 1992.
5. Dent, B. D., Cartography – Thematic Map Design. 5th Edition, W C B McGraw-Hill, Boston, 1999.
6. Muller, Advances in Cartography, ISBN: 1851666036, Elsevier Science Publications
7. R.W. Anson and F.J. Ormeling, Basic Cartography for students and Technicians. Vol.., I, II and III Elsevier Applied Science publishers 2nd Edition, 1995.
8. Rampal, K.K., Mapping and Compilation. Concept Publishing Co.,New Delhi, 1993.

RS2104: Digital Image Processing

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List the process of image acquisition, data formats, and the characteristics of satellite data including DN values and data storage	R	1,2
CO2	Explain the causes and sources of image distortion and the methods of geometric and radiometric rectification, including GCPs and resampling techniques	U	1,3
CO3	Describe image enhancement techniques such as contrast manipulation, spatial filtering, and noise removal, with applications of Fourier analysis	Ap	1,4
CO4	Classify image classification techniques, including supervised and unsupervised methods, as well as hybrid classifiers and classification accuracy assessments	Ap	2,3
CO5	Summarize the process of digital image interpretation, pattern recognition, and the use of expert systems, artificial neural networks, and GIS integration	Ap	2,5

COURSE CONTENT

Unit – 1

Image acquisition and format - Satellite data acquisition, DN characters-kernels- storage devices, CC, CDisk, Optical disk.Data retrieval. Export and import, Data formats, BSQ, BIL, BIP, Run length encoding, Image Compression Data products , hard copy, digital products, Image display system, requirement.

Unit - 2

Image distortion and rectification - Introduction-Sensor model, Preprocessing and Post processing Geometric distortion, sources and causes for distortion, rectification, GCP, Resampling, Image registration, transformation,Radiometric distortion, sources and causes, Computation of radiance, Computation of reflectance, cosmetic operations, Noise removal, atmospheric correction.

Unit – 3

Image enhancement - Satellite image statistics, Univariate and multi-variate statistics. Basics of Histogram, noise models, image quality,. contrast manipulation, grey level thresholding, level slicing, contrast stretching- Spatial feature manipulations, spatial filtering, convolution Low pass, high pass, edge enhancement, edge detection, Fourier analysis.

Unit - 4

Image classification - Introduction, Classification techniques, feature extraction, Supervised, training stage, classification stage, scatterogram, minimum distance to mean classifier, Parallelepiped classifier, Gaussian maximum Likelihood classifier,unsupervised classification, Hybrid classifier, classification of mixed pixel-fuzzy classification, output stage, classification accuracy , error matrix.

Unit – 5

Image analysis - Digital Image interpretation ,Pattern recognition, shape analysis, Textural analysis, Decision concepts, fuzzy sets and Evidential reasoning, Change detection, multitemporal data merging, multi sensor image merging-merging image data with ancillary data, Expert system, Artificial Neural Network; Integration with GIS.

REFERENCES

1. M. Anji Reddy, Textbook of Remote Sensing and Geographical Information systems, BS Publications, Hyderabad**.** 2011. ISBN : 81-7800-112-8
2. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman Remote sensing and image interpretation John Wiley & Sons, 2008
3. John R. Jenson "Introducing Digital Image Processing" - Prentice Hall, New Jersey 1986
4. Robert A. Schowengergt, "Techniques for Image Processing and Classification in Remote Sensing"; 1984. ISBN 13: 9780126289800

RS2105: Statistical Methods (SME 531 Applied Statistics)

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List the fundamental concepts of descriptive statistics, including measures of central tendency, dispersion, skewness, and correlation methods.	R	1,3
CO2	Explain the basic concepts of probability and key probability distributions, including binomial, normal, exponential, and others.	U	1,2
CO3	Apply sampling distribution concepts and calculate standard errors, Chi-square, Student's t, and F-distributions in practical scenarios.	Ap	1,4
CO4	Analyze statistical inference methods like point and interval estimation, hypothesis testing, and non-parametric procedures to draw meaningful conclusions.	An	2,3
CO5	Apply time-series analysis techniques, such as trend estimation, seasonal variation, and autocorrelation, to real-world datasets for decision-making.	Ap	1,5

COURSE CONTENT

Unit - 1

Descriptive statistics: Basic Concepts of statistics. Methods of summarization of statistical data Average, Dispersion, Skewness and Kurtosis. Correlation and regression- Linear, Partial and multiple correlation, rank correlation, curve fitting, method of least squares, linear and multiple regression.

Unit – 2

Probability and distributions: Probability _ logical, empirical and subjective theories , random variables and probability distributions. Expectations and moments. Binomial, position Normal ,exponential, weibull, Extreme value , Rayleigh and Log-Normal distributions. (definition and properties only)

Unit – 3

Sampling distribution, standard error, sampling distribution of sample mean, variance and central limit theorem (statements only), Chi-square, Students t and F distributions

Unit - 4

Statistical inference: Point and interval estimation – requisites for a good estimator. Confidence interval for the mean and proportion tests of significance concerning mean, proportions and variance. Non-parametric procedures- chi – square tests, kolmogorove-smirnov test and run test. Analysis of variance – one way and two way classification.

Unit – 5

Applied statistics: Time –series Analysis – components of time – series , Estimation of trend and seasonal variations autocorrelation , Harmonic analysis.

REFERNCES

1. Blackwell, Basic Statistics, 1969
2. Barbar Iiowsky, Susan Dean, Introductory Statistics, 2013
3. Alan Agresti, Christine A. Franklin, Statistics: The art and science of Learning from data, 2006
4. Agresti, Alan, Categorical data analysis, 2013
5. David Houcque, Introduction To Matlab For Engineering Students , 2005

RS2106: Oceanography

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List out and describe the history and major contributions in Marine Sciences	R	1
CO2	Describe the basic structure and earth design in respect of atmosphere and oceans, the inherent processes and their specific roles	U, An	1,2
CO3	Explain various Chemical processes and marine chemistry related sub- systems and their applied linkages to other dominant environments in earth and highlight the prominent features	U, Ap, An	2,3
CO4	To study and understand the biological significance in oceans and issues related to water contamination and resultant impacts	U, E	4,5
CO5	In the major domain of Remote Sensing, Inculcate an ardent desire to pursue advance topics in this course, leading to skill refinement and equip the candidate to seek proficiency	An, E, C	2,5

COURSE CONTENT

Unit - 1

History and development of Marine Sciences; general characteristics of oceans, exploration, survey tools and methods, Navigation and positioning systems.

Unit - 2

Physical Oceanography: Physical properties of seawaters; temperature, salinity, density, T-S diagram, stability, acoustics, optics. Waves-generation, wave transformation, shoreline transformation energy. Currents-Wave generated, thermohaline, turbidity currents (gravity), Coriolis force, large-scale (gyres) oceanic circulation, . Dimensions of Oceans. Water masses. Currents: General characteristics, effects of fields of pressure, gravity and mass. Relative currents, wind currents, upwelling and sinking. Tides: tide-producing forces and tide characteristics. Circulation patterns and currents in the India Ocean. Major currents of the world oceans. Ocean-land-atmospheric interactions: Monsoons, cyclones, anticyclones, Oceanography – Remote sensing techniques.

Unit - 3

Chemical Oceanography: Water and Salts in the Sea, Major Constituents, Simple Gases & CO_2 System, , Trace Elements, Nutrients, Colloid and Particulate chemistry; Marine Biogeochemistry; Dissolved and Particulate Carbon, Radioactive & Stable Isotopes, Organic

Molecules, Drugs from Sea, Anoxic Environments, Exchange at Boundaries, Chemical Evolution of oceans

Unit - 4

Biological Oceanography: The sea as a Biological environment: classification of marine environment; general characters of the populations of the primary biotic divisions (plankton, nekton and benthos). Introduction of plankton; general classification and composition of plankton; floating mechanism of plankton. Collection of plankton; general account of instruments and nets employed; methods of fixation and preservation of plankton; analysis of samples, methods of estimating standing crop of plankton. Plankton in relation to fisheries; general account. Distribution of plankton in space and time; horizontal distribution; neritic and oceanic plankton; geographical distribution; indicator species. distribution of plankton, vertical migration ; seasonal changes in plankton.

Unit - 5

Marine Pollution: Definition by GESAMP, major sources of pollution, dynamics, transport paths and agents. Toxicology: Lethal and sub lethal effects of pollutants on marine organisms, evaluation of toxicity tolerance, bioassay. Enzymatic removal of hazardous organic substances from aqueous effluents. Sewage: composition and fate in the marine environment, toxicity and treatment methods, sewage disposal system. Environmental Impact Assessment Methods of aquaculture activities. Oil pollution: Sources and fate of oil, composition and toxicity of oil, biological effects treatment procedures. Thermal and radioactive pollutants: Source and characteristics, strategies for disposal of RNA and Heated effluents, biological effects and alternative uses of waste dumping, mining and dredging operations, their effects on the organisms and marine environment.

REFERNCES

1. Svedrup H.U, Johnson, M.W. & R.H. Fleming The Oceans, Prentice Hall, 1942
2. Tait, R.V Elements of Marine Ecology, 2nd edition, Butterworths, 1972
3. Pickard. G.L Descriptive physical – Oceanography, Pergamon Press, 1963
4. King, C.A.H., Introduction to Physical and Biological oceanography, ELBS Ltd., London, 1975
5. Angel, M.V Biological Oceanography, Methuen, 1975
6. Nair, N.B. & D.M. Thampy, A Text Book of Marine Biology, Macmillan, 1980
7. Ryamont, J.E.G.,Plankton and productivity in Oceans. Vel. 1: Phytoplankton, Vol.II, Zooplankton, Pergamon Press, 1980
8. Parsons, T.R. Takahashi, M. and B. Hargrave Biological Oceanographic processes, Pergamon 1977
9. Broecker W.S., Chemical Oceanography. 2nd edition Harcout Brace, Jovanovich, 1974
10. Riley O.P. & G.S.Skirrow Chemical Oceanography, 2nd edition, Vols. I-IV, Academic Press, 1975

11. A.M.Chakravarthy Biodegradation and detoxification of Environmental pollutants, CRC Press, 1928
12. O.Kinne: Marine Ecology, Vol.V. Ocean Management 3&4, John Wiley & Sons, 1984
13. Johnston R. (Ed.) : Marine Pollution, Academic Press, 1976
14. Patin. S.A Pollution and Biological resources of the Oceans Butterworth & Co. Ltd., 1982
15. Venugopalan, V.K. Pollution and Toxicology, CAS in Marine Biology, 1991

Hilary B. Moore Marine Ecology, John Wiley & Sons, 1958

RS2107: Practical I: Satellite Image Processing and GIS Analysis

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Apply techniques of aerial photograph interpretation, visual interpretation of multispectral and panchromatic images, and perform image processing tasks like histogram stretching, image rectification, classification, and change detection from multi-temporal imagery.	Ap, An	1, 2, 3
CO2	Utilize GIS software to convert analog data into digital format, manage spatial data through editing and integration, and perform spatial analyses such as clipping, buffering, and advanced analyses like network analysis, culminating in report generation.	Ap, C	1, 2, 4
CO3	Analyze different map projections, prepare UTM grids, update maps using satellite imagery, and apply digital cartographic techniques for base map creation and symbolization.	Ap, C	1, 2, 3
CO4	Collect and process GPS data, including point, line, and area data collection, operate in DGPS mode, and integrate GPS data with GIS for final output preparation and spatial analysis.	Ap, E	1, 3, 4

Remote Sensing

1. Arial photograph interpretation
2. Visual interpretation of multispectral and Panchromatic Image
3. Histogram stretching, linear, non linear stretching, histogram equalization
4. Image rectification
5. Image classification, supervised and unsupervised classifications
6. Image Fusion

7. Stitching of Images
8. Change Detection from Multi-Temporal imagery

Geographical Information System

1. Analog to Digital Conversion – Scanning methods
2. Introduction to GIS software
3. GIS Entities and Feature Data Base– Point features, Line features, and Polygon features
4. Data Editing-Removal of errors – Overshoot & Undershoot, Snapping
5. Data Collection and Integration, Non-spatial data attachment working with tables
6. Dissolving and Merging
7. Clipping, Intersection and Union
8. Buffering techniques
9. Spatial and Attribute query and Analysis
10. Contouring and DEM
11. Advanced Analyses – Network analyses
12. Layout Generation and report

Digital Cartography

1. Construction of different types of scales
2. Construction of different types of map projection: Conical projection, Cylindrical Projection, WGS 84
3. Preparation of UTM grid
4. Base Map
5. Designing and Symbolization
6. Analog to Digital Conversion
7. Analysis of Toposheet
8. Updation of maps from Satellite Imagery.

Global Positioning System

1. Introduction to GPS and initial setting
2. Creating codes and attribute table for GPS receiver
3. Point Data collection using GPS with different datum
4. Line data collection using GPS and measurements
5. GPS data collection for area calculation
6. GPS Data collection in DGPS mode.
8. Post processing of the GPS data
9. GPS and GIS integrations output preparation

SEMESTER – II

RS2201: Microwave and Hyperspectral Remote sensing and its applications

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List the basics of microwave remote sensing, including EMR, microwave band designations, and microwave interaction with atmospheric constituents, Earth's surface, and ocean, and describe radiometry and antenna systems.	R, U	1, 2
CO2	Explain the principles of real and synthetic aperture radars, including radar platforms and sensors, system and target parameters, and their applications in agriculture, forestry, hydrology, and geological interpretation.	U, An	1, 3
CO3	Classify the differences between multispectral and hyperspectral remote sensing, and describe spectral signatures, BRDF, and hyperspectral sensors, including their design and specifications.	U	1, 3
CO4	Summarize preprocessing techniques for hyperspectral data, including hyperspectral data cubes, dimensionality issues, principal component analysis, MNF, and atmospheric correction methods.	U, E	1, 2, 3
CO5	Explain the techniques for analyzing hyperspectral data, including derivative spectral analysis, and describe their applications in fields such as mineral exploration, soil mapping, and coastal water quality studies.	U, Ap, E	1, 4, 5

Unit – 1

Basics of microwave remote sensing - Fundamentals – EMR-Electromagnetic Spectrum - Microwave Band Designation Microwave interaction with atmospheric constituents, Earth's surface, vegetation, and ocean. Radiometry & antenna systems - Basics - Theory of Radiometry - Sensors applications in atmosphere, ocean and land. Antenna –Types and Functions of different types of antenna.

Unit - 2

Radar-Real and synthetic aperture radars, - Principles - different platforms and sensors, System parameters, Target parameters, Radar equation measurement and discrimination, Airborne Data products and selection procedure - SEASAT, SIRA, SIRB, ERS , JERS, RADARSAT missions. Radar data processing - Radar grammetry, Image processing, SAR Interferrometry – Polarimetry- Interpretation of microwave data - Physical mechanism and empirical models for scattering and emission, volume scattering. Applications of microwave remote sensing - Geological interpretation of RADAR –sites-default-files, Application in Agriculture -forestry, Hydrology - ice studies – land use mapping and ocean related studies

Unit - 3

Multispectral and hyperspectral remote sensing, Comparison of Multispectral and Hyperspectral Image Data, Spectral Signatures and BRDF in the Visible, Near Infrared and Shortwave Infrared regions of EMR, Hyperspectral Issues. Sensors and hyperspectral imaging devices - Scanner types and characterization - specifications of various sensors Spectrographic imagers-hyperspectral sensors, Design tradeoffs. Data formats and systems, AVIRIS, CASI, NASA Terra Moderate Resolution Imaging Spectrometer (MODIS), Hyperion.

Unit - 4

Preprocessing of hyperspectral data - Hyperspectral Data Cube, Hyperspectral Profiles, Data Redundancy. Problems with Dimensionality, Principal Component, Minimum Noise Fraction (MNF), Atmospheric Correction, Atmospheric Correction Measures, Flat Field Correction, Empirical Line Calibration, Empirical Flat Field Optimized, Reflectance Transformation (EFFORT), Continuum Removal, Spectral Feature Fitting.

Unit - 5

Hyperspectral data analysis - Derivative spectral analysis, techniques for analysis of hyperspectral data, first-order and second- order derivative spectra, Theoretical basis and relevance, Methods of generating derivative spectra, electronic, electromechanical, numerical techniques, case studies. Applications - Applications of Hyperspectral Image Analysis Forestry to Mineral exploration, soil mapping, coastal water quality studies, quantification of biophysical parameters

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3. Robert M. Haralick and Simmonett, Image processing for remote sensing 1983
4. Robert N. Colwell. Manual of Remote Sensing Volume 1, Americal Society of Photo - grammetry 1983
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8. Jensen, J. R.. Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall, 2nd Edition, 1996
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11. Pramod K. Varshney and Manoj K. Arora, “Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data”, Springer publication, 2004

RS2202: Geological Remote sensing and Techniques

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Describe the spectral properties of rocks and minerals across the visible, NIR, MIR, SWIR, TIR, and microwave regions, and list the reflectance properties from laboratory and field studies.	R, U	1, 2
CO2	Explain the significance of geological structures, and classify geological features such as folds, faults, and lineaments using photo interpretation and digital image processing techniques.	U, An	1, 3
CO3	Classify different rock types (igneous, sedimentary, metamorphic) and summarize the methods for lithological mapping using remote sensing techniques, focusing on digital image processing and image character recognition.	U, AP	1, 3
CO4	Explain the geomorphological mapping process, including the interpretation of various landforms such as tectonic, fluvial, volcanic, and coastal, and emphasize the importance of ground truth data in geological fieldwork.	U, Ap	1, 4
CO5	Summarize geological survey techniques including geophysical, seismic, magnetic, and electrical resistivity methods, and describe the integration of GIS data for comprehensive geological analysis.	U, Ap, E	1, 3, 4

Unit – 1

Spectral properties of rocks and minerals - Reflectance Properties of Rocks, minerals in visible, NIR, MIR, SWIR, TIR and Microwave regions Laboratory spectroscopy - laboratory and field spectral data comparative studies, Spectral reflection curves for important Rocks, Minerals.

Unit - 2

Geological structure and applications - Significance of Geological structures, Role of aerial photographs, Photo interpretation characters of photographs and satellite images, structural mapping, Fold, fault, Lineaments, Direction circular features. Intrusive rocks, rock exposure, Fractures and Joints, Rose diagram. Digital image processing for structural mapping.

Unit - 3

Lithological mapping - Introduction on Igneous rocks, sedimentary rocks, metamorphic rocks, mapping of regional scale lithological units, Image Characters of igneous rocks, sedimentary and metamorphic rocks, examples. Digital image processing of various rock types, resolution and Scale of lithological mapping and advantages.

Unit - 4

Geomorphological mapping - Significance of landform, Geomorphological guide, interpretation and image/photo characters, Tectonic landforms, Fluvial landforms, Denudational landforms,

Volcanic landforms- Aeolian landforms, Coastal landforms. Importance of ground truth and geological field data collection.

Unit - 5

Geological survey techniques and data integration - Geophysical survey, surface investigation, subsurface investigation, Gravity survey, Seismic survey, refraction methods, reflection methods, applications, Magnetic survey and Electrical resistivity survey, self potential methods, potential drop methods, resistivity values, data interpretation, Curve fitting, GIS data generation , integration and analysis.

REFERENCES

1. John J. Qu , Wei Gao, Menas Kafatos , Robert E. Murphy, Vincent V. Salomonson, Earth Science Satellite Remote Sensing,Springer 2007
2. Gupta, R.P Remote sensing Geology, Springer, 2003.
3. Jean-yves scanvk, Aerospatial Remote Sensing in Geology, A.A. Balakarma,Netherlands, 1997
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RS2203: Geospatial techniques for disaster management

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Describe the basic concepts and principles of hydrological and geological disasters, and summarize the roles of government and NGOs in disaster management.	R, U	1, 2
CO2	Explain the principles and components of disaster prediction and mitigation, including legislation and policy frameworks, and evaluate the effectiveness of public awareness and training programs.	U, E	1, 3
CO3	Analyze the implications of constructing disaster-resistant structures such as dams and cyclone shelters, and summarize strategies for reconstruction after disasters.	An, U	1, 3
CO4	Apply remote sensing techniques for monitoring and analyzing disaster impacts, including risk and damage assessments, and discuss the importance of land use planning for sustainable development.	Ap, U	1, 4
CO5	Evaluate the role of GIS in disaster management, including vulnerability analysis of infrastructure, planning for relief operations, and the integration of GIS applications in disaster management plans.	E, An	1, 4, 5

Unit - 1

Hydrological & geological disasters - Basic concepts and principles - Hydrological and geological disasters, Role of Government administration, NGO's - International disaster assistance - Sharing techno - logy and technical expertise.

Unit - 2

Prediction & mitigation - Needs and approach towards prevention - Principles and components of mitigation - Disaster legislation and policy - Cost effective analysis - Utilisation of resources - Training - Education - Public awareness - Roles of media.

Unit - 3

Cyclones & floods - Dams, Bridges, Hospitals, Industrial structures, Disaster resistant structures - Low cost housing for disaster prone areas - Cyclone shelter projects and their implications - Reconstruction after disasters.

Unit - 4

Remote sensing monitoring & analysis - Remote Sensing Application - Risk assessment - Damage assessment – Land use planning and regulation for sustainable development - Use of Internet - Communication Network -Warning system - Post disaster review – Case studies.

Unit - 5

Role of GIS in disasters - Vulnerability analysis of infrastructure and settlements - Pre-disaster and post disaster planning for relief operations - Potential of GIS application in development planning and Disaster management plan - Case studies.

REFERENCES

1. Bell, F.G. Geological Hazards: Their assessment, avoidance and mitigation. E & FN SPON Routledge, London. 1999.
2. David Alexander, Natural Disasters, UCL Press, London, Research Press, New Delhi, 1993.
3. Nick Carter. W. Disaster Management -A Disaster Manager's Handbook. Asian Development Bank, Philippines. 199.
4. Mitigating Natural Disasters, Phenomena, Effects and options, A Manual for policy makers and planners, United Nations. New York, 1991.

George G. Penelis and Andras J. Kappos -Earthquake Resistant concrete Structures. E & FN SPAN, London, 1997

RS2204: Geospatial techniques for coastal and marine environment

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Describe the origin and importance of oceans and coastal processes, including sedimentation and circulation dynamics.	R, U	1, 2
CO2	Explain the physical and chemical properties of seawater, including salinity, temperature, and the effects of sea level rise on coastal zones.	U, E	1, 3
CO3	Identify and classify various sensors used for coastal and ocean applications, analyzing their specific uses in studying chlorophyll production and sea surface temperature.	C, An	1, 4
CO4	Analyze the applications of remote sensing and GIS in coastal studies, including coastal regulation, erosion, and wetland mapping, while summarizing the significance of thematic databases.	An, U	1, 4
CO5	Evaluate the role of remote sensing and GIS in ocean studies, including tsunami impact assessment, ocean circulation, and the effects of global warming on marine environments.	E, An	1, 4, 5

Unit - 1

Oceans and coasts - Introduction- origin- ocean importance, boundaries, continental margins and ocean basin, shelves, slopes, canyon, and rises, deep ocean basins, ridges, seamounts, abyssal plain, sedimentation processes- Coastal processes circulation, current Measurement, Waves, Surface waves, reflection, diffraction and refraction, wave generated currents, Tides, sediment drift.

Unit - 2

Seawater physical and chemical properties - Water molecules, salinity, components, sources, concentration, mixing, dissolved gases, acid –base balance, Study of physical properties of sea water and parameters –heat and temperature, thermostatic effects, density, ocean surface conditions- refraction, light and sound, –sea level rise – coastal zone

Unit - 3

Sensors for coastal and ocean applications - Use of Microwave data - SeaWiFS, OCR, CZCs studies –chlorophyll production index -sea surface temperature (SST) sensors -NIMBUS, RADARSAT, CASI - MESSR, OCTS ATSR - Sensors OCEANSAT ATSR on ERS TOPEX/Poseidon satellite.

Unit - 4

RS and GIS applications in coastal studies - Role of remote sensing, advantages, resolutions, scale parameters, regional studies, coastal regulation zone mapping, Issues, Coastal Hydrodynamic, Coastal erosion and protection, salt water intrusion studies, Estuaries and their impact on coastal process wetland mapping, Thematic data base generation in GIS and analysis, mangroves and coastal zone management.

Unit - 5

RS and GIS applications in ocean studies - Tsunami impact assessment, wave dynamics, ocean resources ocean circulation studies, seal level changes and impact, Tide dynamics, wave dynamics, Plankton and marine plant studies, Changes in marine communities, -open ocean, sea ice studies, Global warming applications.

REFERENCES

1. Tang, Danling Remote sensing of the changing ocean, Springer, 2011
2. Seelye Martin, An Introduction to Ocean Remote Sensing University of Washington Cambridge, ISBN:9780521802802 2004
3. Deepak, A. Remote Sensing of atmospheres and oceans. Academic press, San Francisco, 1986.re (SST), - Mangroves coral reefs mapping
4. Michael Hord, R. Remote Sensing methods and application, John Wiley and Sons, New York, 1986
5. Alasdair J. Edwards, Remote Sensing Hand book for Tropical Coastal Management, UNESCO Publication 2000.

RS2205: Marine Meteorology

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	List and describe the scales of weather systems and analyze meteorological elements using synoptic charts, including wind and pressure analysis.	R, U	1, 2
CO2	Explain the parameters involved in tropical cyclone genesis and analyze the life cycle, wind field, and storm surge characteristics of cyclones.	U, An	1, 3
CO3	Summarize the onset and phases of the monsoon in South Asia, including the influences of various atmospheric and oceanic factors.	U, R	1, 4

CO4	Analyze the interactions between the ocean and atmosphere, including the impact of sea surface temperature and the El Niño Southern Oscillation on climate.	An, E	1, 4, 5
CO5	Evaluate short-range weather forecasting techniques and interpret numerical model outputs to predict weather elements effectively.	E, An	1, 5

Unit - 1

Introduction: Scales of weather systems (Meso, Synoptic and Planetary scales) – Network of observatories - Surface, upper air and special observations (satellite, radar, aircraft etc.) – Map projections - Representation and analysis of fields of meteorological elements on synoptic charts - Wind and pressure analysis – Isobars on level surface and contours on constant pressure surface – Isotherms, thickness field - Geostrophic, gradient and thermal winds – Jet streams - - Streamline and isotach analysis. – ITCZ – Subtropical Anticyclones – Trade winds – Hadley and Walker circulations **–** Subtropical Jetstream – Easterly waves – Convective clouds – thunderstorms – Synoptic conditions favorable for thunderstorm - Hail storm, Tornado, Squall - clouds associated with ITCZ

Unit - 2

Tropical cyclone: Cyclone Genesis Parameters - Intensification of Cyclones – T-number – Movement of cyclones – Land fall – Cyclone- Life cycle, Surface wind field– Vertical structure in wind, temperature – Eye, Wall Cloud and Spiral cloud bands - - Storm surge

Unit - 3

Monsoon onset over south Asia- Active and Break monsoon phases – Monsoon trough – Cross equatorial Low Level Jetstream – Tibetan Anticyclone – Tropical Easterly Jetstream – Monsoon depression – Mid Tropospheric Cyclone – Offshore troughs/vortices– Intra-seasonal variability of Monsoon and role of ocean – Tropospheric Biennial Oscillation – Monsoon and the Indian ocean – Somali upwelling – Summer monsoons of Africa and Australia

Unit - 4

Ocean – Atmosphere Interaction**:** Atmospheric boundary layer over the ocean – Wind stress and its curl – Sea Surface Temperature – Air-sea temperature difference - Oceanic Mixed Layer – coastal and open ocean upwelling – Sensible and Latent heat fluxes – short and long wave radioactive fluxes– Coupling of Ocean and Atmosphere – El Nino Southern Oscillation – Indian ocean Dipole – relation between SST and convection, ocean and Climate.

Unit - 5

Short range weather forecasting: Persistence, climatology and tearing - Prediction of individual weather elements - Prediction of visibility- sea waves and swell – Interpretation and use of numerical model outputs in weather forecasting

REFERENCES

1. G C Asnami , 2 volumes, Tropical Meteorology, 1993
2. R A Houze jr, Cloud Dynamics 1993

3. R.A.Anthes, Tropical Cyclones, their evolution, structure and effects, 1982
4. Monsoon – 2 volumes (2012) by India Meteorological Department
5. D B Shaw, Meteorology of the Tropical Ocean, 1978
6. B. W. Atkinson, Mesoscale Atmospheric Circulations 1981
7. G.S. Philander , El Nino, La Nina and the Southern Oscillation, 1990
8. John Wallace and Peter Hobbs, Atmospheric Science – an introductory survey, 2006

RS2206: Geospatial techniques for water resource management

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Describe the components of the hydrological cycle and estimate various hydrological parameters such as rainfall, runoff, and evapotranspiration.	R, U	1, 2
CO2	Identify watershed characteristics, types, and drainage patterns, and apply GIS for watershed analysis.	U, An	1, 3
CO3	Analyze hydrological studies for mapping and monitoring, including drought zonation and flood mapping, utilizing remote sensing techniques.	An, E	1, 4
CO4	Assess groundwater resources by identifying aquifer types and potential zones, and apply GIS for hydrogeological mapping.	E, An	1, 4
CO5	Evaluate surface water resources through the mapping and monitoring of water bodies, sedimentation control, and the application of GIS in surface water studies.	E, An	1, 5

Unit - 1

Hydrological components - Hydrological cycle, Estimation of various components of hydrological cycle, rainfall, runoff, evaporation, transpiration, evapotranspiration, crop evapotranspiration, depression and interception loss, infiltration and percolation losses.

Unit - 2

Watershed characters - Watershed, types, divide, catchment, command area, stream types, influent, effluent, ephemeral, non perennial. Drainage network, different pattern, morphometric analysis, linear, area, relief aspects. GIS applications for watershed analysis

Unit - 3

Hydrological studies - Hydrological aspects- mapping and monitoring, management Mapping of snow covered area and glacial outburst, soil moisture estimation, Optical and microwave remote sensing techniques , drought zonations, Agricultural, meteorological and hydrological, flood mapping pre and post flood area estimation and control measures –GIS applications for hydrological disaster studies

Unit - 4

Ground water resources applications - Types of Aquifers formations confined and unconfined aquifers Assessment of Groundwater potential zones and Groundwater mapping. Site selection for recharge structures- Hydrogeological Mapping GIS applications to ground water studies

Unit - 5

Surface water resources applications - Surface water bodies, lakes, reservoirs, ponds, rivers , channels ,mapping change detection , Water harvesting structures, in-situ and Ex-situ , Mapping and monitoring of catchment and command area, Water logging and salt affected area mapping, Reservoir Sedimentation, sedimentation control. GIS applications to surface water studies

REFERENCES

1. H.M. Raghunath. Hydrology – Principles – Analysis – Design. New Age International Publishers, New Delhi. 2006
2. Ramasamy, SM ., Remote sensing in water resources Rawat publications, New Delhi ,2005
3. V.V.N. Murty. Land and Water Management Engineering, Kalyani Publishers, New Delhi – 2002.
4. C.S. Agarwal and P.K. Garg. Text Book on Remote Sensing in Natural Resources, Monitoring and Management.2000. Wheeler publishing Co & Ltd., New Delhi.

RS2207: Practical: Geospatial Technology Applications and Modelling

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Demonstrate proficiency in using geospatial software (e.g., ERDAS IMAGINE, ArcGIS) for data analysis and interpretation.	R,U	1,2
CO2	Apply image processing techniques, including contrast enhancement and filtering methods, for effective analysis of satellite images.	An, E	1,3
CO3	Conduct supervised and unsupervised classification of satellite imagery for land use/land cover mapping.	An, E	1,4
CO4	Utilize GIS techniques for natural disaster management, including mapping flood-prone areas and assessing risks.	An, E	1,5
CO5	Integrate hydrological modeling and terrain analysis in GIS for effective water resources management.	C	1,5

1. Introduction to ERDAS IMAGINE/ ENVIS/ GEOMEDIA/ ESRI-ArcGIS etc.
2. Study of the marginal information given on the C.D. Rom/Digital data
3. Import / Export of files using ERDAS IMAGINE Geo-reference of the toposheet and imageries
4. Display, Analysis and interpretation of black & white images and FCC
5. Study of various contrast enhancement techniques
6. Low Pass Filter: Compression of the high frequency component & enhancement of the low frequency component
7. High Pass Filter: Compression of the low frequency component and enhancement of the high frequency component
8. Sub-setting of area of interest from the satellite image
9. Principal Component Analysis
10. Resolution Merging
11. Unsupervised Classification
12. Supervised Classification
13. Map composition

Disaster Management

1. Flood prone area mapping using satellite images and ancillary data.
2. Forest fire risk mapping using satellite images and GIS.
3. Landslide mapping and risk evaluation.
4. Multivariate analysis and application of Geoinformatics model for landslide hazard zonation
5. Drought prone area mapping using satellite images
6. Spatial variation of climatic data using GIS techniques for drought prediction

7. Terrain mapping in coastal region for coastal hazards prediction
8. Multiple hazard mapping using satellite images and modeling risk in GIS.

GIS Modelling and Applications

1. Satellite image based hydro-geomorphological interpretation for ground water targeting. Open cast mining impacts on land resources using satellite images.
2. Mapping flood hazards in a region using satellite images
3. Mapping landslide hazards in a region using satellite images
4. Urban sprawl mapping of a township using satellite images
5. Utility-facility mapping for regional development analysis in GIS
6. Application of Geoinformatics for identification of waste disposal sites.
7. Digital terrain models for selection of dam site and road infrastructure.

Water Resources Management

1. Delineation of river catchments on satellite image- topographical sheets and their codification as per Watershed Atlas of India.
2. Evaluation of various drainage morphometric parameters for watershed characterization.
3. Hydro-geomorphological mapping for ground water exploration in alluvial terrain.
4. Hydro-geomorphological mapping for ground water exploration in hard rock terrain
5. Flood inundation mapping in alluvial plain areas using satellite images
6. Locating surface water harvesting structures like check dams, de-siltation tanks, and nullah bunds etc. using satellite image
8. Location of high dams and tunnels in hard rock terrain for large irrigation projects
9. Creation of flow direction, flow length, flow accumulation in a watershed based on
10. contours using Arc-View GIS
11. Study of snow covered areas for evaluation of its water resources using satellite images.
12. Rainfall run-off modeling using Geoinformatics approach.

Natural Resource Management

1. LU-LC mapping at level I and Level II using 1:50,000 satellite image.
2. Forest Types Mapping using satellite images.
3. Delineating on satellite image various surface water resources and identify potential sites for WR conservation.
4. Delineation of surface mining zones and impact on land resources of the area using satellite image
5. NDVI and density slicing of digital satellite data for forest density classification.
6. Supervised classification for mapping agriculture and forest resources.
7. Soil erosion modeling using Geoinformatics approach
8. Natural resource mapping and change detection study using temporal satellite data

SEMESTER - III

RS2301- DBMS, Python and MATLAB

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Understand the fundamental concepts of databases and DBMS types, including relational, object-oriented, and geographic databases, and demonstrate the ability to create E-R diagrams for spatial data	R, U	1, 2
CO2	Apply file organization techniques and normalization processes in database design, utilizing SQL for data manipulation and query execution in GIS applications.	U, An	1, 3
CO3	Demonstrate proficiency in Python programming, including syntax, control structures, functions, and file handling, to solve basic data processing problems.	U, An	1, 4
CO4	Utilize MATLAB for numerical methods, data visualization, and graphic creation, applying techniques for 2D and 3D data representation relevant to remote sensing applications.	R, U	1, 4
CO5	Evaluate and analyze geospatial data through MATLAB, utilizing statistical tools and numerical methods for effective remote sensing data analysis and modeling.	E, An	1, 5

Unit - 1

Data, Database, Database Management System, Types of DBMS - Hierarchical, Network, Relational Models. Object-Oriented Database - Distributed Databases - Geographic Databases. E-R Model, E-R diagram for spatial data. RDBMS Software - PostGIS, Oracle Spatial, MySQL for GIS.

Unit – 2

File, File Organization - Sequential, Heap File, Hash File, B+ Tree, Clustered. Advantages and disadvantages in GIS applications. Normalization - First, Second, Third, Boyce-Codd, Fourth, and Fifth normal forms. SQL - SQL datatypes, SQL commands - DDL, DML, DCL, TCL. Basic statements in SQL, complex queries in SQL for spatial data, Column Modifiers, Operators in SQL, Functions in SQL, Privilege Commands. MySQL, PostgreSQL/PostGIS, Oracle Spatial for GIS data management.

Unit – 3

Introduction to Python - Python syntax and data types - variables, control structures - if-else, loops. Functions - defining functions, arguments, return values. File handling - reading, writing, appending files (CSV, JSON). Basic data structures - lists, dictionaries, tuples - operations and usage. Numpy - array creation, basic array operations.

Unit - 4

Matrices and arrays, array creation, matrix and array operations, Built-in functions - scalar functions, vector functions, matrix functions. Line plots - 2D and 3D plots. M-files - Script and functions. Basic MATLAB data structures, file I/O, string handling, code efficiency, and analysis, MATLAB debugger.

Unit - 5

Introduction to numerical methods in Remote Sensing. Linear algebra, numerical integration, differentiation, solving systems of ODEs for geospatial modeling. Data visualization in MATLAB: Basic statistical tools for remote sensing, 2D and 3D data visualization. Graphics in MATLAB: Creating mesh and surface plots, plotting remote sensing image data.

REFERENCES

1. Rudra pratap, MATLAB, A Quick Introduction for Scientists and Engineers, 1996
2. Remez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, Fourth Edition, Published by Pearson Education (Singapore) Pvt. Ltd.. 2004.
3. Bipin C. Desai, An Introduction to Database Systems, Galgotia Publications PVT LTD First edit 1993
4. Michael Abbey and Michael J Corey, ORACLE 8 -A Beginner's Guide, Tata Mc.Graw Hill, 1998
5. C.J. Date, An Introduction to Database Systems, Addison Wesley, sixth edition, 1995

RS2302: LIDAR Remote Sensing and Applications

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Explain the principles of LIDAR technology, including its history, components, and types of LIDAR systems, as well as the interaction of laser energy with Earth's surface features.	R, U	1, 2
CO2	Describe the various LIDAR remote sensing platforms, including airborne, terrestrial, and spaceborne systems, as well as their historical development and specific applications.	U, An	1, 3
CO3	Implement georeferencing and calibration techniques for LIDAR data, including understanding geodesy, datums, map projections, and rectifying data errors and anomalies	An, E	1, 4
CO4	Conduct automated classification and processing of LIDAR data, including noise removal, layer extraction, hydrologic enforcement, and the generation of terrain data products.	An, E	1, 4
CO5	Analyze and apply LIDAR data in various applications, such as topographic mapping, flood inundation analysis, forestry metrics, and corridor mapping, utilizing appropriate software and quality control procedures.	E, An	1, 5

Unit - 1

LIDAR system design - Introduction to Lasers and LIDAR – Definitions - History of Lidar Development - LIDAR System Components - LIDAR sensors single-return, multireturn, waveform, photon-counting, Characteristics of LIDAR Data - interaction of laser energy with earth surface features - LIDAR Systems

Unit - 2

LIDAR remote sensing platforms - Introduction to the LIDAR remote sensing platform - Historical development of LIDAR remote sensing platforms Airborne platforms, Laser Scanning, Fixed- Wing Platforms, Rotary-Wing Platforms - Terrestrial, airborne, and spacebar types – Space borne platforms – orbits- Bathymetric Mapping

Unit - 3

Georeferencing and calibration of LIDAR data - Geodesy, Datums, Map projections and Coordinate Systems – Direct Georeferencing Technology - Boresight Calibration - LIDAR Data Preprocessing - Project Coverage Verification - Review LIDAR Data against Field Control - LIDAR data errors and rectifications, - processes calibration of LIDAR data - artifacts and anomalies - LIDAR Error Budget.

Unit - 4

Automated classification - Noise Removal and other sensor-related artifacts - Layer Extraction - Automated Filtering -. Manual Editing and Product Generation – Surface Editing - Hydrologic

Enforcement – Lidargrammetry - Terrain Data Products, definitions, DEM, DSM -TIN, Breaklines, Contours, Specifications, Terrain Products from LIDAR - Quality Assurance, Control, and Accuracy Assessment.

Unit - 5

LIDAR Applications - Topographic Mapping, , flood inundation analysis, line-of-sight analysis – Forestry, various types of LIDAR sensors-, vegetation metric calculations - specific application software - corridor mapping system, data processing and quality control procedures.

REFERENCES

1. Jie shan charles K Toth,Topographic Laser Ranging and Scanning Principles and Processing, Second Edition, 2008
2. Floyd M. Henderson; Principles & Applications of Imaging Radar, John Wiley & Sons, New York, 1998.
3. Alexay Bunkin & Konstantin Volia.K, - Laser Remote Sensing of the Ocean Methods & Publications. John & Wiley & Sons, New York, 2001.
4. Raymond M. Measures; Laser Remote Sensing: Fundamentals and Applications, John Wiley & Sons, New York, 1984.
5. Robert M. Haralick and Simmonett, Image processing for remote sensing 1983.
6. Cracknell, Arthur P.; Hayes, Ladson. Introduction to Remote Sensing (2 ed.). London: Taylor and Francis 2007.

RS2303: Satellite Meteorology, Agriculture and Forestry

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Explain the fundamentals of remote sensing in meteorology, including the characteristics and orbits of meteorological satellites such as TIROS, NIMBUS, NOAA, SEASAT, GOES, METEOSAT, and INSAT, and their roles in collecting meteorological, agricultural, and oceanographic data.	R, U	1, 2
CO2	Analyze cloud classification techniques and satellite remote sensing systems for rainfall monitoring, and interpret meteorological satellite images for weather systems and cyclones, including techniques for estimating soil moisture and evapotranspiration.	An, U	1, 3
CO3	Assess the spectral characteristics of leaves and vegetation using various indices (NDVI, TVI, SVI, PCA), and apply remote sensing techniques for vegetation classification, biomass estimation, and carbon assimilation studies in forests.	E, An	1, 4
CO4	Apply remote sensing methods to agricultural applications, including crop identification, acreage estimation, production forecasting, pest and disease monitoring, and assessing crop water availability and utilization in command areas.	E, An	1, 5
CO5	Utilize remote sensing techniques for soil applications, such as conducting soil surveys, land use classification, monitoring water logging and soil erosion, and implementing wasteland development strategies.	E, An	1, 5

Unit - 1

Fundamentals of Remote Sensing in Meteorology, Meteorological satellite characteristics and their orbits, TIROS, NIMBUS, NOAA, TIROS N, SEASAT, GOES, METEOSAT, INSAT. Role of LANDSAT, SPOT and IRS in collecting meteorological, agricultural and oceanographic data. Measurement of Earth and Atmospheric energy and Radiation budget parameters from satellites. Atmospheric temperature retrieval techniques and surface radiation studies. Wind measuring techniques from satellite data.

Unit - 2

Cloud classification techniques. Satellite Remote Sensing System of use in rainfall monitoring and monitoring methods: Cloud indexing method, Life-history method and Bio-spectral methods. Interpretation of Satellite meteorological images for weather systems and cyclones. Remote Sensing techniques for estimation of soil moisture and evapotranspiration. Spectral behavior of different crops and vegetation in VIS, NIR, MIR, TIR and Microwave regions.

Unit - 3

Spectral characteristics of leaf - Structure of leaf - Spectral behavior of leaf – Vegetation indices – NDVI, TVI, SVI, PCA – Vegetation classification and mapping - Estimation of Leaf area index, Biomass estimation – Estimation of terrestrial carbon assimilation in forests - case studies. Forest mapping - Forest type and density mapping and forest stock mapping using RS technique -factors for degradation of forests – deforestation/afforestation/. Change detection in forests - case studies. Biodiversity characterization mapping - Forestry – Forest taxonomy – Linnaeus classification – Biodiversity characterization – Forest fire risk zonation – wildlife habitats suitability analysis - case studies.

Unit - 4

Agricultural applications - Identification of crops -acreage estimation -production forecasting - pests and disease attacks through remote sensing -crop stress detection due to flood and drought - catchments and command area monitoring. Water management in command areas - monitoring, assessing crop water availability, demand and utilization pattern through Remote Sensing.

Unit - 5

Soil applications - Soil survey and land use classification - water logging - characters of saline, alkali soils - soil erosion – types – Estimation of soil loss from USLE using Remote sensing and GIS - Wasteland development.

REFERENCES

1. Steven, M.D and clark, J.A., "Applications of Remote Sensing in Agriculture", Butterworths, London 1990.
2. Remote Sensing Applications Group, Space Applications Centre, Crop Average and production Estimation (CAPE): An Anthology from January 1986 - June 1996. (Publications in Journals, Seminars I Symposium proceedings), Ahmedabad, August 1996.
3. Negi, S.S., A Handbook of forestry. International Book distributors, Dehradun, 1986. Space Applications Centre, Manual of procedure for Forest mapping and Damage Detection using satellite data, Ahmedabad, 1990

RS2304: Mini Project

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Identify and define a relevant research problem in the field of remote sensing and GIS based on personal interest and existing literature.	R, U	1,2
CO2	Utilize remote sensing data products and GIS software to analyze spatial data related to the identified problem.	An, E	1,3
CO3	Apply various parameters and methodologies to assess the impact of environmental or societal factors on the selected study area	An, E	1,4
CO4	Create innovative solutions and recommendations based on the analysis to address the identified problem within the study area.	E, An, C	1,5
CO5	Interpret and present research findings effectively through maps, visualizations, and written reports.	An, E, C	1,5

RS2305: Coastal Zone Management

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Describe the fundamental concepts of marine and coastal zone management, including coastal environments, processes, and the significance of Integrated Coastal Zone Management (ICZM), as well as local and international challenges related to policy and legislation.	R, U	1, 2
CO2	Analyze the principles and applications of remote sensing in environmental management, including the use of non-photographic imaging systems, in situ data collection, and the interpretation of remote sensing data for environmental resources mapping.	An, U	1, 3
CO3	Evaluate climate policy and economic assessments related to coastal ecosystem services, including the impact of climate change on coastal health and cultural heritage, and develop strategies for adaptation and mitigation of these impacts.	E, An	1, 4
CO4	Assess the impacts of climate change on marine ecosystems and coastal economies, exploring policies and technological options for mitigation and adaptation, as well as implications for socio-economic factors in coastal communities.	E, An	1, 5
CO5	Develop a comprehensive understanding of coastal disaster risk management (DRM), including risk assessment, disaster preparedness planning, early warning systems, and the integration of indigenous knowledge systems into DRM practices.	E, An	1, 5

Unit - 1

Marine and Coastal Zone Management: Coastal environments, processes and management strategies. Climate change and sea-level rise, Coastal biota as environmental proxies. The Indian coastlines. Defining the coastal zone. Importance of the coastal zone and the need for management. Environmental consideration and coastal dynamics. Preparation of action plans and implementations. Coastal Zone Management Framework and coastal management planning process. Expectations of Integrated Coastal Zone Management (ICZM). Local and international constraints/challenges of ICZM, policy, legislation and institutional framework.

Unit - 2

Remote Sensing in Environmental Management Remote Sensing (Non-Photographic Imaging Systems) - principles and scope. The remote sensing process- remote sensing of the environment, in situ data collection, remote sensing data collection. Characteristics of major imaging sensor

systems – the remote sensing systems. Elements of Image Interpretation. Interaction characteristics of electromagnetic radiation with: vegetation, soils, water and human settlements. Application of remote sensing data for environmental resources mapping and degradation assessment. Field visit for ground truth survey. Aerial photography and platforms; geometric properties of aerial photographs; Photo-interpretation; application of photo-interpretation for drainage pattern, relief, land use and vegetation mapping. Using Google Earth image for data collection.

Unit - 3

Climate policy and economic assessments and Implications on coastal ecosystem services - Analysis, projections, models and evaluation of climate change impact and extremes on coastal ecosystems. Adaptation and mitigation strategies for hydrological and hydrogeological risks. Adaptation and mitigation strategies for the management of coastal resources. Translation of the interactions between climate and the processes concerning coastal ecosystems into economic values. Planning and evaluation of strategies for adaptation and mitigation policies. Assessment of the impacts of climate extremes and climate change on coastal public health. Implications of climate change on cultural heritage preservation, analysis and assessment of the vulnerability of cultural heritage related to climate change and potential strategies for adaptation and mitigation.

Unit - 4

Climate Change Impacts, Adaptation and Mitigation.Climate change- science and policy. Current and possible future global climatic changes. Bio-physical and social impacts of climate change on marine ecosystem. Social and biophysical vulnerabilities to climate change - Mitigation and adaptation to climate change. Policies and measures for minimizing the impacts of climate change. Climate change and global/national coastal economies. Mitigation-technological options, policies, and socio-economic impacts of mitigation measures. Climate change and coastal responses. Carbon financing (REDD, CDM, PES).

Unit – 5

Planning for Coastal Disaster Preparedness and Management. Coastal Disaster Risk Management (DRM) - Introduction and definitions. Theories, observations, and models of the dynamics of atmospheric and oceanic fluids - climate change, rapid environmental changes. Coastal Disaster Risk Management Framework, Disasters and vulnerability analysis. Environmental profiling for risk assessment. PRA Tools and field mapping. Hazard monitoring and evaluation. Mainstreaming Disaster Risk Management into development: (institutional and legal arrangements for disaster risk management). Disaster Risk Reduction and building resilient coastal communities. Forecasts and projections of mesoscale processes and extreme events. Establishment of Early Warning System for DRM. Indigenous Knowledge Systems for EWS. Planning for Coastal Disaster Risk Management. Community Centered Human Resource Management. Vulnerable groups focused DRR (gender, child, disabled,etc). Marine

Environmental Policy and Law .Definitions of terminologies. Concept, evolution, purpose and structure of Marine Environmental Law. International Agreements, Conventions and Treaties in Marine Environmental Law. Environmental Law and International action on Management of coastal resources. International Agreements and covenants on transboundary Resource Management. The institutionalization of Marine Environmental Policy, planning and management. Legislation on coastal environmental policy, planning and development. Case studies of contemporary and emerging coastal environmental legal issues.

REFERENCES

1. Parimal sharma, Global Indian Publication Ltd, , Coastal Zone Management, 2009
2. Rajib Shaw, R. R. Krishnamurthy, Communities and Coastal Zone Management, 2008
3. Erlend Moskness, Einar Dahl, Integrated Coastal Zone Management, 2009
4. John R Clerk, Coastal Zone Management Handbook, 1995
5. Peter W French, Coastal and Esturine Management, 1997

RS2306: Marine Surveys and GIS

COURSE OUTCOMES

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Define and classify key geodetic concepts, including the geometry of ellipsoids, coordinate systems, geoid, deflection of vertical, and height systems, along with basic geodetic computations.	R, U	1, 2
CO2	Explain the principles of control surveying, including the parameters of survey measurements and the use of optical, electro-optical, and electronic systems such as Total Stations.	R, U	1, 3
CO3	Analyze satellite positioning systems such as GPS and GLONASS, distinguishing between static and kinematic GPS surveys, and evaluating software applications for horizontal and vertical controls.	An, U	1, 4
CO4	Describe the theory of tides and the methodologies for processing land and marine survey datum, including the use of tide gauges and tidal datum calculations.	R, U	1, 5
CO5	Evaluate various acoustic positioning and sounding techniques, including calibration and maintenance of equipment, and apply methods for reducing soundings and plotting data using GPS.	E, An	1, 5

Unit – 1

Geodesy: Definition and classification - geometry of ellipsoid – various co-ordinate systems – spherical excess – geoid and deflection of vertical, various height systems – rectangular and polar coordinates. Geodetic computation.

Unit - 2

Control Surveying: Basic parameters of survey measurements – time, distance and angles – use of optical systems, electro-optical systems and electronic systems – Total station.

Unit - 3

Satellite systems – GPS, Differential GPS, GLONASS – static and kinematics GPS surveys – software modules – applications of GPS. Horizontal and vertical controls – methods.

Unit - 4

Tides: Theory of Tides – tidal datum – tide gauges – processing land and marine survey datum.

Unit – 5

Soundings: Acoustic Positioning, long, short and ultra short base line systems – constructions, basic measurements, calibration and maintenance. Sounding boat, lead lines, echo sounding – different methods, sensors (bathymetric, geophysical and physical) – single beam, multi-beam echo sounder – side scan sonar, sub-bottom profiler, magnetometer, sound velocity profiler, current meters. Locating sounding – use of GPS – reduction of sounding and plotting.

REFERNCES

1. Thomas Ask, 2nd edition, Handbook of Marine surveying, 1998
2. Satheesh Gopi, R. Sathikumal, N. Madhu, 1st edition, Advanced surveying, Total Station, GIS and Remote Sensing, 2007
3. S. K Duggal, Surveying, 2013
4. Kang tsung chang, Introduction to GIS, 2001

RS2307: DBMS, Python & MATLAB Practical

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Apply SQL commands for creating, altering, managing, and querying databases using DDL, DML, and DCL, along with utilizing SQL functions for data aggregation, mathematical calculations, and time management.	E	1, 2,3
CO2	Utilize MATLAB to create various plots, such as XY plots, scatter diagrams, bubble plots, contour plots, and vector plots, demonstrating the ability to visualize complex data effectively.	E, C	2, 3,4
CO3	Demonstrate basic Python syntax, control structures, and file handling techniques for reading and writing data, showing proficiency in Python-based data manipulation.	E	1, 4
CO4	Visualize and analyze data using Python libraries such as Matplotlib, creating plots such as line and scatter plots for basic data interpretation and exploration.	An, C	3, 4
CO5	Develop hands-on experience in practical data management and analysis using DBMS, MATLAB, and Python to address geospatial and database-related problems.	E, Ap	2, 5

Database management system

- SQL Commands:
    - DDL (Data Definition Language): Creating, altering, and dropping tables.
    - DML (Data Manipulation Language): Inserting, updating, deleting, and retrieving records.
    - DCL (Data Control Language): Granting and revoking permissions.
- SQL Functions:
    - Aggregation Functions: AVG, SUM.
    - Mathematical Functions: ABSOLUTE, ROUND, CUBEROOT, LOG.
    - Date/Time Functions: TIMESTAMP.

MATLAB

- XY Plot: Basic 2D line plots.
- Scatter Diagram: Creating scatter plots for visualizing data points.
- Geo Show (Bubble Plot): Visualizing geographical data with bubble sizes representing additional information.
- Contour Plots: Representing three-dimensional data in two dimensions using contour lines.
- Vector Plots: Displaying vector fields to visualize direction and magnitude.

Python (Basics)

- Introduction to Python Syntax:
  - Basic data types (integers, floats, strings, lists).
  - Control structures (if-else statements, loops).
- File Handling:
  - Reading from and writing to text files.
- Basic Data Visualization:
  - Using libraries like Matplotlib to create simple plots.
  - Creating line plots and scatter plots with sample datasets.
  -

RS2401: Major Project and Viva-voce

CO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO
CO1	Identify and articulate a significant research problem related to remote sensing and GIS in collaboration with a government research institution.	R, U	1, 2
CO2	Design a comprehensive research methodology to investigate the chosen problem, utilizing appropriate remote sensing data products and GIS technologies.	An, E	1, 3
CO3	Assess various environmental and spatial parameters to analyze the identified problem critically.	An, E	1, 4
CO4	Synthesize research findings to create innovative solutions and actionable recommendations that address the identified problem.	E, An, C	1, 5
CO5	Present research outcomes effectively through a well-structured viva-voce, utilizing maps, visualizations, and written reports to communicate findings to the scientific community.	An, E, C	1, 5

ABBREVIATIONS

R- remember, U-Understand, Ap-Apply, An –Analyze, E- Evaluate, C-Create