DEPARTMENT OF REMOTE SENSING & GIS
JIS UNIVERSITY

Program: **Master of Science (MSc) Remote Sensing & GIS**
Department: **Remote Sensing & GIS**
Year: **I**

Teaching Scheme					Contact Hours/week			Exam Duration		Relative weightage (%)		
Sl. No.	**Subject code**	**Course Title**	**Max Marks**	**Credit**	**L**	**T**	**P**	**Theory**	**Pract**	**INE**	**MTE**	**ETE**
		Semester I (Autumn)										
1	MRS 101	Remedial Mathematics, Remote Sensing Fundamentals and Launching Vehicles	100	4	4	-	-	3	-	20	30	50
2	MRS 102	Atmospheric and Ocean Sciences	100	4	4	-	-	3	-	20	30	50
3	MRS 103	Fundamentals of GIS, Navigational Satellite and Photogrammetry	100	4	4	-	-	3	-	20	30	50
4	MRS 191	Basic RS and GIS Lab; Image Interpretation and Photogrammetric Lab	100	4	-	-	4	-	3	50	-	50
5		CBCS: Geoinformatics in Environmental Science & Management	100	4	4	-	-	3	-	20	30	50
6		SEMINAR-I	25	1	2	-	-	-	-	25	-	-
7		SKILLX-I	25	1	2	-	-	-	-	25	-	-
		Total	**550**	**22**	**20**	**-**	**4**	-	-	-	-	-
		Semester II (Spring)										
1	MRS 201	Probability & Statistical Concepts in RS	100	4	4	-	-	3	-	20	30	50
2	MRS 202	Spatial decision, Thermal, Microwave and Hyper spectral Remote Sensing	100	4	4	-	-	3	-	20	30	50
3	MRS 203	Computational Method and Digital Cartography	100	4	4	-	-	3	--	20	30	50
4	MRS 291	Lab.1: Advanced RS Lab; Lab.2: Computational lab	100	4	-	-	4	3		20	30	50
5		CBCS: GIS & GNSS and its application	100	4	4	-	-	3	-	20	30	50
6		SEMINAR-II	25	1	2	-	-	-	-	25	-	-
7		SKILLX-II	25	1	2	-	-	-	-	25	-	-
		Total	**550**	**22**	**20**	**-**	**4**	-	-	-	-	-

DEPARTMENT OF REMOTE SENSING & GIS
JIS UNIVERSITY

Program: **Master of Science (MSc) Remote Sensing & GIS**
Department: **Remote Sensing & GIS** **Year II; Sem: IIIrd & 4th**

Teaching Scheme					Contact Hours/week			Exam Duration		Relative weightage (%)		
Sl. No.	Subject code	Course Title	Max Marks	Credit	L	T	P	Theory	Pract	INE	MTE	ETE
Semester III (Autumn)												
1	MRS 301	Image Processing and Geo- informatics	100	4	4	-	-	3	-	20	30	50
2	MRS302	Advanced Remote Sensing	100	4	4	-	-	3	-	20	30	50
3	MRS 303	Earth Science Fundamentals and Application of Geo- informatics	100	4	4	-	-	3	-	20	30	50
4	MRS 304	Resources: Applications of RS & GIS in Resource Management	100	4	4	-	-	3	-	20	30	50
5	MRS 391	Digital Signal and Image Processing Lab & Earth Science and Geology	100	4	-	-	4	-	3	50	-	50
6	MRS 381	SEMINAR	25	1	2	-	-	-	-	25	-	-
7	MRS 382	SKILLX	25	1	2	-	-	-	-	25	-	-
		Total	**550**	**22**	**20**	**-**	**4**	-	-	-	-	-
Semester IV (Spring)												
1	MRS 401/2	ELECTIVE-I Geoinformatics in Water Resource Management	100	4	4	-	-	3	-	20	30	50
2	MRS 402/2	ELECTIVE-II Geoinformatics in Natural Hazards Management	100	4	4	-	-	3	-	20	30	50
3	MRS 491	ELECTIVE-III Advanced Lab	100	4	-	-	4	-	3	50	-	50
4	MRS 492	Dissertation	150	6	-	-	-	-	-	-	-	150
5	MRS 493	Grand Viva	50	2	-	-	-	-	-	-	-	50
6	MRS 481	SEMINAR	25	1	2	-	-	-	-	25	-	-
7	MRS 482	SKILLX	25	1	2	-	-	-	-	25	-	-
		Total	**550**	**22**	**12**	**-**	**4**	-	-	-	-	-

SUMMARY				
Semester	1	2	3	4
Semester-wise total credits	22	22	22	22
Total Credits	**88**			

JIS University

81, Nilgunge Road, Agarpara, Kolkata 700109, West Bengal

M. Sc. in
Remote Sensing& GIS

About the Course

M.Sc. in "Remote Sensing & GIS" is a postgraduate course with duration of 2 years and is divided into four semesters. Out of the four semesters, the first three semesters are devoted to exhaustive course work and the fourth semester has two compulsory elective courses and research project with a mandate to work as a member of a research group in a project in close association with the subject matter experts. This course trains the students to enable them to apply their knowledge and practical training in identification of measures or indicators of system performance and the actions needed to improve or correct performance and relative to the goals of the system. More specifically, it is a field of science and technology. The objective of this course is to equip the students with the required knowledge and practical training to make them proficient at technologies in-vogue and trains them to take up projects relevant to the industrial needs, the R& D activities and self-ct, have introduced new dimensions into the study and understanding of Earth's processes and in improving the quality of life for the people living on it.

Course Summary

- Mode: Full time
- Duration: 2 Years
- Offered by: The University
- In Charge: Dr. Sanhita Banerjee Chattaraj
- Course Coordinator: Prof. A. B. Bhattacharya, Pro Vice-Chancellor

Eligibility Criteria

Eligibility: A candidate who has passed B.Sc. (Hons.) degree of 3 years duration in Electronics/Physics/ Mathematics/Geography/ Geology/ Applied Geology/ Geo Physics/ Geo Informatics/ Oceanography/ Environmental Science and Equivalent degree (OR) B.E./ B. Tech in ECE/EE/Civil/ Geo Informatics/ CSE/ Agriculture Engineering/ Urban & Regional Planning/ IT (OR) B.Sc., Agriculture/ Forestry/ Horticulture (4 years).

Remote Sensing& GIS Course Structure

Semester	Paper's name and code	Modules	Marks Distribution	Credits
Semester- 1	**Core Course-1** (Theory)(MRS-101) Remedial Mathematics, Remote Sensing Fundamentals and Launching Vehicles	Module-1:Remedial Mathematics for RS & GIS	100	4
		Module-2: Fundamentals of Remote Sensing		
		Module-3: Platforms, Sensors and Launching Vehicles		
	Core Course-2 (Theory)(MRS-102) Atmospheric and Ocean Sciences	Module-1: Meteorology	100	4
		Module-2: Climatology		
		Module-3: Oceanography		
	Core Course-3 (Theory)(MRS-103) Fundamentals of GIS, Navigational Satellite and Photogrammetry	Module-1: Fundamentals of Geographic Information System	100	4
		Module-2: Surveying and Global navigational Satellite System		
		Module-3: Aerial Photography & Photogrammetry		
	Core Course-4 (Practical)(MRS-191) Lab.1: Basic RS and GIS Lab; Lab. 2 Image Interpretation and Photogrammetric Lab	Lab.1: Basic RS and GIS Lab	100	4
		Lab. 2 Image Interpretation and Photogrammetric Lab		
	Total	Theory Paper = 3x 100=300	400	16
		Practical Paper=1x100=100		
	CBCS(Physics/Geology/ Chemistry)	Theory +Practical	100	4
	Non –CGPA Courses	Seminar/Other activities(MRS-181)	25	1
		Skillx; NSS/Yoga(MRS-182)	25	1
		Total	50	2
Semester- 2	**Core Course-1** (Theory)(MRS-201) Probability & Statistical Concepts in RS	Module-1: Basic Probability Theory	100	4
		Module-2: Statistical concepts in RS		
		Module-3: Geo-statistics & Statistical applications in GIS		

	Core Course-2 (Theory)(MRS-202) **Spatial decision, Thermal, Microwave and Hyperspectral Remote Sensing**	**Module-1: Spatial decision support system**	**100**	**4**
		Module-2: Thermal and Microwave Remote Sensing		
		Module-3: Hyper spectral Remote Sensing and Lidar		
	Core Course-3 (Theory)(MRS-203) Computational Method and **Digital Cartography**	**Module-1: Computational Method**	**100**	**4**
		Module-2: Digital Cartography		
	Core Course-4 (Practical)(MRS-291) Lab.1: Advanced RS Lab; Lab.2: Computational lab	**Lab.1: Advanced RS Lab**	**100**	**4**
		Lab.2: Computational lab		
	Total	**Theory Paper = 3x 100=300**	**400**	**16**
		Practical Paper=1x100=100		
	CBCS(Physics/Geology/ **Chemistry)**	**Theory +Practical**	**100**	**4**
	Non –CGPA Courses	**Seminar/Other activities(MRS-281)**	**25**	**1**
		Skillx; NSS/Yoga(MRS-282)	**25**	**1**
		Total	**50**	**2**
Semester- 3	Core Course-1(Theory)(MRS-**301)** Image Processing and Geo-**informatics**	**Module-1: Digital Image Processing**	**100**	**4**
		Module-2: Application of Geo-informatics		
	Core Course-2 (Theory)(MRS-302) **Advanced Remote Sensing**	**Module-1: Information Extraction from Satellite Images**	**100**	**4**
		Module-2: GIS Data Analysis		
		Module-3: Geodesy		
	Core Course-3 (Theory)(MRS-303) Earth Science Fundamentals **and Application of Geo-informatics**	**Module-1: Fundamentals of Earth System**	**100**	**4**
		Module-2: Application of Geo-informatics in Earth Science		
	Core Course-4 (Theory)(MRS-304) Resources: Applications of RS **& GIS in Resource Management**	**Module-1: Concepts in Resources**	**100**	**4**
		Module-2: Application of Remote Sensing and GIS in Resource Management		
	Core Course-5 (Practical)(MRS-391)	**Lab.1. Digital Signal and Image Processing Lab**	**100**	**4**

	Lab.1. Digital Signal and Image Processing Lab; Lab.2: Earth Science and Geology Lab	Lab.2: Earth Science and Geology Lab		
	Total	Theory Paper 4 x 100 = 400 Practical Paper=1x100=100	500	20
	Non –CGPA Courses	Seminar/Other activities(MRS-381)	25	1
		Skillx; NSS/Yoga(MRS-382)	25	1
		Total	50	2
Semester- 4	DSE-1. Elective Paper-I MRS-401/1 Geoinformatics in Coastal Zone Management MRS-401/2 Geoinformatics in Water Resources Management	Geoinformatics in Coastal Zone Management/ Geoinformatics in Water Resources Management	100	4
	DSE-2. Elective Paper-II MRS-402/1 Radar Systems & Satellite Techniques MRS-402/2 Geoinformatics in Natural Hazards Management	Radar Systems & Satellite Techniques/ Geoinformatics in Natural Hazards Management	100	4
	DSE-3. ElectivePaper-III (Practical)MRS-491 Advanced Lab	Advanced Lab	100	4
	DSE-4. ElectivePaper-IV (Project) MRS-492 Dissertation	Project: Dissertation (Examination+ Dissertation viva)100+50=150	150	6
	MRS-493 Grand Viva	GrandViva: 50	50	2
	Non –CGPA Courses	Seminar/ Other activities	25	1
		Skillx; NSS/ Yoga (MRS -482)	25	1
		Total	50	2

Total= Sem1 +Sem2 +Sem3 +Sem4	**(Core +CBCS)total= 500+500+500+500=2000**	**20x4=80**
	Non CGPA Courses= 50+50+50+50=200	**4x2=8**
	Total 2200	**88**

Syllabus

http://gsp.humboldt.edu/OLM/Courses/GSP_216_Online/lesson1-2/sci-notation.html

Semester-1

Core Course-1
Remedial Mathematics, Remote Sensing Fundamentals and Launching Vehicles
(60 Lectures) (Theory)(MRS-101)

Module-1: Remedial Mathematics for RS & GIS (20 Lectures)

Limits and continuity: Introduction, Limit of a function, Definition of limit of a function ($\in$ - δ definition), examples.

Differentiation: Partial derivatives, Total differential, Conditions for a function to be a maximumor a minimumat a point, Errorsandapproximation, Successive Differentiation

Differential Equations: Some basic definitions, Order and degree, Equations in separable form, Homogeneous equations, Linear Differential equations, exact equations, application

Vector Algebra: Position vector, scalar product, vector product, geometrical interpretation, gradient of scalar function, divergence and curl of vector function

Matrices and Determinant: Introduction to matrices, Types of matrices, Operation on matrices, Transpose of a matrix, Matrix Multiplication, Determinants, Properties of determinants, Product of determinants, Minors and co-Factors, Adjoint of a square matrix, Singular and non-singular matrices, Inverse of a matrix, Solution of system of linear of equations using matrix method, Cramer's rule, Characteristic equation and roots of a square matrix, Cayley–Hamilton theorem

Simple problems on practical applications of RS & GIS

Module-2: Fundamentals of Remote Sensing (25 Lectures)

Concept and Scope of Remote Sensing: Definitions, Process and Characteristics of Remote Sensing System, Advantages and limitations

Concept of Electromagnetic Radiation (EMR): Wavelength-frequency-energy relationship of EMR, EMR Spectrum and its properties, EMR wavelength regions and their applications, Atmospheric windows, Interaction of EMR with matter, Spectral signatures

Fundamental laws governing the science: Sources of Energy, Radiation laws: Stefan-Boltzmann law, Wien's law, Kirchhoff's law, Black body and Real body, Radiant temperature & Kinetic temperature

(Numerical problems of all above)

Energy Interaction in the atmosphere: Scattering, absorption, transmission, atmospheric windows

Energy Interactions with Earth Surface Features: Spectral Reflectance Curve, Concept of signatures; Remote Sensing Scenario in Indian Context

Module-3: Platforms, Sensors and launching vehicles (15 Lectures)

Introduction: Sensor materials, Sensor System - Framing and Scanning System, Whiskbroom scanners, Push-broom scanners, Side Looking scanner.
Types and Characteristics of Sensor: Imaging and non-imaging sensors, Active and passive sensors, Resolution of Sensors - Spectral, Spatial, Radiometric & Temporal, Scale, Mapping unit, Multi-band concepts and False Color Composites.
Remote Sensor Platforms and Satellite Orbits: Ground, Airborne and Space bore Platforms, Orbital Characteristics – Coverage, Passes, Pointing Accuracy, Geostationary, Sun synchronous and shuttle orbit. Semi synchronous orbit (Molniya orbit) and Quasi-zenith satellite orbit
Satellite Basics: Kepler's laws, Major-Semi major axis & Eccentricity, Velocity, Period (Numerical problems), Historical development, Launch Vehicle, Escape Velocity Payload.
Space Imaging Satellites: Early history of space imaging; Multispectral and Hyper spectral sensors, Radar, Lidar; Specification of some popular satellites – IRS, Landsat and SPOT series; High resolution satellites – IKONOS, Cartosat, Quickbird, OrbView, GeoEye, Pléiades, WorldView; Other latest earth resource satellites.

Reference Books:

1. Remedial Mathematics, Dr. P. K. Sharma, NiraliPrakashan; 1st edition, 2017.
2. Mathematical Methods, Merle C. Potter , Jack Goldberg , Prentice Hall; 2nd edition,1987
3. Mathematical Methods, E. Rukmangadachari, Pearson India, 2009
4. Fundamentals of Remote Sensing, Joseph George, Universities Press, 2005
5. Fundamental of Remote Sensing and GIS, S K Sinha, Ayushman Publication House, 2014
6. Advances in Environmental Remote Sensing: Sensors, Algorithms, and Applications (Remote Sensing Applications Series),QihaoWeng, CRC Press,2017
7. Remote Sensing and Image Interpretation, Lillesand, Wiley; Sixth edition, 2011.
8. Remote Sensing: Principles and Applications, Floyd F. Sabins, Waveland PrInc; 3 edition, 2007

Core Course-2
Atmospheric and Ocean Sciences
(60 Lectures) (Theory)(MRS-102)

Module-1: Meteorology (20 Lectures)

Thermal structure of the atmosphere and its composition, Pressure, Temperature, Wind, Font humidity, moisture variables, virtual temperature, radiation, radiation from sun, solar constant, atmospheric thermodynamics, atmospheric stability, atmospheric scale of motion, boundary layer, meso-scale convective system, severe thunderstorms, tropical cyclones, flood, earthquake, landslide, drought

Module-2: Climatology (20 Lectures)

Elements of climate, climate controls, Earth's radiation balance, latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance, spatial and temporal patterns of climate parameters, Air masses and fronts, SW and NE monsoon, jet stream, tropical and extra tropical cyclone, ENSO, QBO; Classification of climate-Koppen's and Thornthwaite' scheme. Climate change

Module-3: Oceanography (20 Lectures)

Introduction- historical, current and future- Earths structure physiographic of oceans origin and evolution of ocean basins (Continental and oceanic basins) Continental drift, sea floor spreading, plate tectonics shelf and deep sea sedimentation physical, chemical and biological aspects of sea water- Ocean current (circulation)- Waves properties and motion- tidal currents and characteristics- air-water interface / exchange, gas solubility and circulation models

Reference Books:

1. Meteorology for Scientists and Engineers, Roland B. Stull, 3rd edition, Brooks/Cole,2011
2. Atmospheric Science: An Introductory Survey (International Geophysics Series), John M. Wallace, Peter V. Hobbs, Academic Press, 2nd edition, 2000.
3. An Introduction to Dynamic Meteorology, James R. Holton, Gregory J. Hakim, Academic Press; 5 edition, 2012.
4. Understanding Weather and Climate, Edward Aguado, James E. Burt, Pearson; 7 edition, 2014.
5. Basics of Atmospheric Science, Chandrasekar, Prentice Hall India Learning Private Limited, 2010.
6. The Atmosphere and Ocean: A Physical Introduction, Neil C. Wells, Wiley, 3rd Edition, 2012
7. Atmospheric & Oceanic Sciences 3: Introduction to the Oceanic Environment, C. Donald Ahrens, Thomson; 5th edition, 2008.
8. Atmosphere, Ocean and Climate Dynamics: An Introductory Text, John Marshall, R. Alan Plumb, Academic Press; 1 edition, 2007.

Core Course-3
Fundamentals of GIS, Navigational Satellite and Photogrammetry
(60 Lectures) (Theory)(MRS-103)

Module-1: Fundamentals of Geographic Information System (20 Lectures)

Basic Concepts: definition of GIS, Components of GIS, Variables – points, lines, polygon, Functionality of GIS, Areas of GIS application, Advantage and Limitation of GIS
GIS Data: Spatial and Attribute Data, Information Organization and Data Structures -Raster and Vector data structures, Data file and database
Creating GIS Database: GIS Software, file organization and formats, Geo-database, Rectification, Digitization and Map Composition
GIS Data Input: Nature and Source of data, Method of spatial data capture - Primary and Secondary, digitization and scanning method, Techniques and procedure for digitizing, Errors of Digitization, Attribute data capture
Data Editing: Detecting and correcting errors, Re-projection, Transformation and Generalization, Edge matching and Rubber sheeting, Topology, Conversion from Other Digital Sources

Module-2: Surveying and Global navigational Satellite System (20 Lectures)

Validation of Data: Importance of Field Survey, Collection of Ground Truth.
Introduction to conventional field survey techniques: Plane and Geodetic Surveying (Traversing, Triangulation and Leveling), Topographic, Cadastral, Engineering and Hydrographic surveys.
Surveying Instruments: Principles of using Plane Table, Principles of Prismatic Compass, Theodolite traversing, Utility of Total Station
Global Positioning System: Introduction, Satellite constellation, GPS signals and data, Geopositioning, Basic Concepts. NAVSTAR-GPS, GLONASS, GALELIO, Indian Regional Navigational Satellite System (IRNSS), GAGAN, Control Segment, Space Segments, User Segment, GPS Positioning Types-Absolute Positioning, Differential positioning
GPS Surveying Methods and Accuracy: Methods-Static & Rapid Static, Kinematic-Real Time Kinematic Survey- DGPS-GPS Data Processing and Accuracy, Factors Affecting GPS Accuracy
Reference Station: Selection of Reference Station, Reference Station Equipment: GPS receiver, GPS antenna. Radio and its types, Radio Antenna

Module-3: Aerial Photography & Photogrammetry (20 Lectures)

Introduction: Historical Development and Fundamentals of aerial photography, Vertical and Oblique aerial photography, Classification of Aerial Film Cameras, Digital cameras Components of aerial Cameras, digital photography, Camera Calibration, Photogrammetric Applications and Products
Scale, Geometry and Ground Coverage of Aerial Photographs, Area calculation & Flight Planning
Binocular and Stereoscopic vision, Conditions for Stereovision, Photographic overlap Image Parallax, Height determination from stereo pairs - Parallax Equation, Ground Control.
Co-ordinate Systems used in Photogrammetry, Relief distortion and Tilt distortions, Rectification, Ortho Rectification, Height determination from single photograph, Planimetric map compilation, Digital Elevation Model (DEM), Digital orthophotos.
Principles of digital photogrammetry: Hardware & software requirements, Image measurement, Orientation procedure, Epipolar geometry, Aerotriangulation, Block adjustment, Mosaics of DTM &ortho images.

Reference Books:

1. Fundamental of Remote Sensing and GIS, S K Sinha, Ayushman Publication House, 2014
2. Advances in Environmental Remote Sensing: Sensors, Algorithms, and Applications (Remote Sensing Applications Series),QihaoWeng, CRC Press,2017
3. Fundamentals of Geographic Information Systems, Michael N. Demers , Wiley; Fourth edition, 2012.
4. Geographic Information Systems: An Introduction, Tor Bernhardsen, Wiley; Third edition, 2007
5. Digital Cartography, Robert G. Cromley, Prentice Hall ,1991
6. Fundamentals of Cartography, R.P. Misra, Concept Publishing Co; 2nd ed. Edition,2002
7. Elements of Photogrammetry with Applications in GIS, Paul R. Wolf, Bon A. Dewitt, Benjamin E. Wilkinson, McGraw-Hill Education, 2014
8. Digital Photogrammetry-Theory and Applications**,** Linder, Wilfried, Springer-Verlag Berlin Heidelberg,2003

Core Course- 4
Lab.1: Basic RS and GIS Lab; Lab. 2 Image Interpretation and Photogrammetric Lab
(120 periods) (Practical) (MRS-191)

Lab.1: GIS Lab (60 periods)

a. Fundamentals of RS&GIS

1. Visualization Tools Blend, Swipe, Flicker, Conversion: Raster↔Vector↔ASCII and others
2. Managing Geo-database, geometric measurements tools & Changing Projection
3. Digitization: Point, Line, Polygon
4. Managing attribute table and thematic mapping
5. Map composition and representation

b. Surveying & GPS

1. Scale measurement of aerial photographs, Distance and area measurement of themes, Aerial-photo Interpretation for Terrain Evaluation and thematic mapping, Object height measurements by Parallax bar, Aerial photo mosaicking, Stereo plotting with photogrammetric Instruments, Aerial triangulation and photo control.
2. Orthorectification of Air photos [orthobase] Stereo analysis & Anaglyph generation
3. Calculation of distance & area on plane surface, spherical surface and ellipsoidal surface. Coordinate transformation. Determination of orbital period of a satellite, its velocity and distance from the earth's centre.
4. Preparation of Base map from Survey of India Toposheets, Use of India topographical sheets for delineation of different features.
5. Plane table survey for cadastral and large scale Mapping, Theodolite traverse and triangulation, Spirit Leveling, use of Dumpy level, Prismatic Compass, and preparation of a road map
6. Introduction to a GPS and initial setting ,Creating codes and attribute table for GPS receiver, Point Data collection using GPS with different datum, Line data collection using GPS and measurements, GPS data collection for area calculation, Post processing of the GPS data, Creating attribute table in GPS pro software and Export functions, GPS and GIS integrations output preparation

Lab. 2 Image Interpretation and Photogrammetric Lab (60 Periods)

a. Image Interpretation

2. File export import/ translation, Conversion of file formats
3. false color composite and visual identification
4. Image registration / Geo coding, Projection, Creating Region of Interest
5. File sub setting /clipping Mosaic Air photo and Images
6. Feature identification and signature curve generation Image Statistics, Histogram

b. Photogrammetric Lab

1. Introduction: Historical Development and Fundamentals of aerial photography, Vertical and Oblique

aerial photography, Classification of Aerial Film Cameras, Digital cameras Components of aerial Cameras, Camera Calibration, Photogrammetric Applications and Products

2. Scale, Geometry and Ground Coverage of Aerial Photographs, Area calculation & Flight Planning.
3. Binocular and Stereoscopic vision, Conditions for Stereovision, Photographic overlap Image Parallax, Height determination from stereo pairs - Parallax Equation, Ground Control.
4. Co-ordinate Systems used in Photogrammetry, Relief distortion and Tilt distortions, Rectification, Ortho Rectification, Height determination from single photograph, Planimetric map compilation, Digital Elevation Model (DEM), Digital orthophotos.
5. Principles of digital photogrammetry: Hardware & software requirements, Image measurement, Orientation procedure, Epipolar geometry, Aero triangulation, Block adjustment, Mosaics of DTM &ortho images.

Semester-2

Core Course-1
Probability and Statistical Concepts in Remote Sensing
(60 Lectures) (Theory)(MRS-201)

Module-1: Basic Probability Theory (15 Lectures)

Classical and Axiomatic definition of Probability (elementary properties), Conditional probability, Baye's theorem and related problems; Probability Distributions: Definition of random variable; Continuous and discrete random variables; Probability density function, probability mass function for single variable only; Distribution function and its properties (without proof), Examples; Definitions of Expectation, Variance, properties and examples. Some important discrete distributions: Binomial, Poisson. Continuous distributions: Normal; Determination of Mean, Variance and standard deviation of the distributions, Application to RS.

Module-2: Statistical Concepts in RS (25 Lectures)

Meaning, Scope and importance of Statistics, application of Statistics in RS; Collection of data - sampling methods; random and systematic method; source of data - primary and secondary
Organization of data - array, frequency, class intervals, histograms, and distribution, Presentation of Data: Tables, Diagrams, Grouped data and ungrouped data, Geographical data: discrete and continuous series, scales of measurement, Measures of Central Tendency - mean, median, mode, quartiles, Moments, Skewness, Kurtosis, Measures of Dispersion – absolute dispersion, relative dispersion Correlation: meaning, scatter diagram, standard deviation, variance, Measures of correlation – Karl Pearson's method (two variables ungrouped data), Spearman's rank correlation methods.

Descriptive Statistics- Data Visualization-Sampling distribution-Confidence Interval- Hypothesis Testing-Correlation; Simple linear Regression-Method of Least Square-Analysis of variance, Chi-square test, t-test, F-test, Z-test.

Module-3: Geo-statistics & Statistical applications in GIS (20 Lectures)

Mean centre of population and temporal shift, Bi-variate & Multiple correlation and regression, Correlation analysis Scatter Diagram & Residual mapping, T-test, Z-Score, Root Mean Square Error, Principal Component analysis

Surface Modeling: Spatial autocorrelation, Role of Interpolation, Methods of Interpolation – Global and Local Deterministic Methods, Moving Averages, Inverse Distance Interpolation, Optimal Interpolation using Geostatistics, Variogram and its use for Interpolation, Interpolation by Kriging – Ordinary Kriging, Block Kriging, Non-Linear Kriging, Stratified Kriging, Co-Kriging, Universal Kriging, Probabilistic Kriging Factor and cluster analysis.

Reference Books:

1. Probability and Statistics (Schaum's Outline Series),Murray Spiegel, John Schiller, R. Alu Srinivasan, Debasree Goswami , McGraw Hill Education; 3 edition, 2017
2. An Introduction to Probability and Statistics, Vijay K. Rohatgi and A.K. Md. EhsanesSaleh, 2008
3. Statistical Methods, N. G. Das, Mcgraw Hill,2008
4. An Introduction to Probability Theory and its Applications, William Feller, Wiley; Third edition, 2008
5. A First Course in Probability, Sheldon Ross, Pearson Education India; 9 edition, 2013
6. David J. Morin,Probability: For the Enthusiastic Beginner,Create Space Independent Publishing Platform, 2016
7. Edwin Thompson Jaynes, Probability Theory: The Logic of Science,Cambridge University Press, 2003

Core Course-2

Spatial decision, Thermal, Microwave and Hyper spectral Remote Sensing

(60 Lectures) (Theory) (MRS-202)

Module-1: Spatial decision support system (20 Lectures)

GIS and Decision Support Systems: Concept and characteristics of Decision Support Systems (DSS), Spatial Decision Support Systems (SDSS) and GIS; Multicriteria Decision Analysis (MCDA): Elements and Structure of MCDA, Multi objective and Multi attribute analysis; Spatial Multicriteria Decision

Analysis (SMDA): Framework of SMDA, Evaluation Criteria and GIS, Decision Alternatives and Constraints; Criterion Weighting and Decision Rules: Estimation of Weights- Ranking, Rating, Pairwise Comparison and Trade-off analysis method; Decision Rules-Simple Additive Weighting method and Analytic Hierarchy Process

Module-2: Thermal and Microwave Remote Sensing (25 Lectures)

Thermal Remote Sensing: Basic Principles, Physical Laws, Blackbodies and Emissivity, Thermal Infrared Radiation Properties, Thermal Infrared Atmospheric Windows, Interaction of Thermal Radiation with Terrain Elements

Thermal Data Processing: Thermal Energy Detectors, Thermal Radiometers, Thermal Scanners, Interpreting Thermal Scanner imaginary, Geometric Characteristics of Thermal Scanner Imaginary, Geometric and Radiometric Calibration of Thermal data, Applications

Microwave Remote Sensing: Basic Principles, Radar Operation, Polarization, Spatial Resolution, Radar Image Geometry, Relief Displacement, Shadows and Speckle effect, Side Looking Radar System (SLAR) Operation, Synthetic Aperture Radar (SAR), Radar Interferometry

RADAR Environmental Considerations: Surface Roughness Characteristics, Electrical Characteristics, Vegetation and Water response to Microwave energy

Microwave Remote Sensing and its advantages, Active and Passive Microwave Systems, Attenuation of Microwave, Surface Scattering, Volume Scattering, Types of Antenna, Platforms and sensors, Applications

Module-3: Hyper spectral Remote Sensing and Lidar (15 Lectures)

Hyper spectral Remote Sensing: Basic principles of Spectroscopy, Advantages, Hyperspectral sensors and platforms, Sensor specifications

Hyper spectral Data Processing: Geometric and Atmospheric Corrections, End member Collection, Image Classification, Spectro-radiometer

Application of Hyper spectral Data: Application in Agriculture, Water, Soil and Mining

LIDAR: Basic Principles and advantages, Laser and Scanning System, Laser Location, Lidar Antenna Attitude, Types of Lidar returns, Lidar post processing of multiple returns,

Reference Books:

1. Spatial Decision Support Systems: Principles and Practices, RamanathanSugumaran, John DeGroote, CRC Press; 1 edition, 2010
2. Intelligent Spatial Decision Support Systems, Leung**,** Yee, Springer, 1997
3. Thermal Microwave Radiation: Applications for remote sensing (Electromagnetics and Radar), Christian Matzler, Institution of Engineering

and Technology, 2006
4. Fundamentals of Remote Sensing, Joseph George, Universities Press, 2005
5. Lidar Remote Sensing and Applications, Pinliang Dong, Qi Chen, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2018
6. Hyperspectral Remote Sensing : Fundamentals and Practices, RuiliangPu, Taylor & Francis Ltd, 2017

Core Course-3
Computational Method and Digital Cartography
(60 Lectures) (Theory) (MRS-203)

Module-1: Computational Method (40 Lectures)

Python

Introduction: Keywords and Identifiers, Statements & Comments, Python variables, Data types, Type conversion, I/O and Import, Operators, Namespace

Flow Control: Python if …else, python for loop, while loop, break and continue, pass statement, looping technique

Functions: Python function, Argument, Recursion, Anonymous function, python global, local and nonlocal, Global keyword, Modules, package

Datatypes: Python numbers, List, Tuple, String, Set, Dictionary, Nested dictionary, Arrays, Matrix, List Comprehension

File Handling: File operation, Python directory, Python exception, Exception handling, User defined exception

Object & Class: Python OOP, Python class, Python inheritance, Multiple Inheritance, Operator overloading

‘R’ Programming Language

verview: Environmental Setup, Basic Syntax, Data Types, Variable, Operators, Decision Making, Loops, Functions, Strings, Vectors, Lists, matrices, Arrays, factors, Data Frames, Packages, Data reshaping,

R Data Interfaces: CSV Files, Excel Files, Binary Files, XML Files, JSON Files, Web data, Database

R Charts and Graphs: Pie Charts, Bar Charts, Box plots, Histograms, Line graphs, Scatter plots

R Statistics Examples: Mean, median & modes, Linear regression, Multiple regression, Logistic regression, Normal distribution, Binomial distribution, Poissionregression, Analysis of covariance, Time series analysis, Nonlinear least square, Decision tree, Random forest, Survival analysis, Chi square tests

MATLAB

Fundamentals: Syntax, Variables, Vectors and matrices, Structures

Functions: Function handles, Classes and object-oriented programming, Graphics and graphical user interface programming, Interfacing with other languages,

File extensions: Simulink, Simscape, MuPAD

Statistical Analysis Features: Association Discovery, Compliance Tracking, File Storage, Forecasting, Multivariate Analysis, Regression Analysis, Statistical Process Control, Statistical Simulation, Survival Analysis, Time Series

Module-2: Digital Cartography (20 Lectures)

GIS and Digital Cartography: Concept of Digital Cartography, Advantages and Disadvantages of Digital Cartography

Concept of Map Scales: Defining Map, Projection Systems, Categories of maps, Map Scales

Measurement of Geographic Variables: Nominal, Ordinal, Interval and Ratio Scales, Qualitative vs. Quantitative data, Discrete vs. Continuous data.

Digital Mapping: Cartographic Design Issues, Concept of Visual Variables, Map Lettering, Map Compilation, Generalization, Map Composition, Multivariate and Dynamic Mapping, Map Production

Visualization of geospatial data- 2D and 3D visualization;

Reference Books:

1. Python Crash Course, Eric Matthews, No Starch Press; 1 edition, 2015.
2. Head-First Python, Paul Barry, O′Reilly; 2 edition, 2016
3. Python Programming: An Introduction to Computer Science, John Zelle, Franklin, Beedle & Associates Inc; 2nd Revised edition edition, 2010.
4. R Programming for Beginners, SandipRakshit, McGraw Hill Education; First edition, 2017
5. Beginning R: The Statistical Programming Language, Mark Gardener, Wiley, 2013
6. The R Book, Michael J. Crawley, Wiley; Second edition, 2017.
7. Matlab, An Introduction with Applications, Amos Gilat, John Wiley & Sons; 5th edition, 2017.
8. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, RudraPratap, Oxford; Edition edition, 2010.

Core Course-4
RS and Computational Lab (Practical)
(120 periods)(MRS-291)

Lab.1. RSLab (60 periods)

a. Advance Remote Sensing: Data Processing & Applications-I

1. Geometric and Atmospheric Correction
2. Image enhancement and filtering
3. Advanced classification techniques

b. Advance Geographic Information System & Geodesy

1. Geometric and Atmospheric Correction
2. Image enhancement and filtering
3. Advanced classification techniques
4. Accuracy assessment, ground truthing with spectroradiometer
5. Algorithm Liberation, Raster calculation, modeling.

c. Fundamental Statistical Concepts & Geo-Statistics

1. Introduction of Statistical Software: Time series, Charts, Scatter plot with regression line, Histogram, Z-Score, T-test, Correlation, Neighborhood analysis.
2. Principal Component analysis, spatial autocorrelation.
3. IDW and Krigging through GIS softwares
4. Extraction of image statistics

d. Advance Remote Sensing: Data Processing & Applications-II

1. Accuracy assessment, ground truthing with spectroradiometer
2. Algorithm Liberation, Raster calculation, modeling.

Lab.2: Computational Lab (60 periods)

1. Conventional and modern operating system
2. Applications using Python
3. Applications using 'R'
4. Numerical solutions with MATLAB

Semester-3

Core Course-1
Image Processing &Geo-informatics
(60 Lectures)(Theory) (MRS-301)

Module-1: Digital Image Processing (30 Lectures)

Introduction: Definition of digital image, Source of Data, Data Formats, Hardware and Software Consideration for Digital Image Processing, Data loading, Image Restoration, Image Reduction and Magnification
Image Pre-processing: Sources of Error in image data, Image Rectification and Registration, Resampling Techniques, Radiometric corrections
Contrast Manipulation: Gray Level Thresholding, Level Slicing; Contrast Stretching – Linear and Non-linear
Spatial Texture Manipulation: Spatial filtering – Linear, High Boost, Directional and Gradient Filters; Edge Enhancement and Fourieranalysis;
Multi-image Manipulation: Band Ratioing and Differencing, Principal and Canonical Components, Vegetation Components, Image Fusion
Initial Statistics Extraction: Univariate & Multivariate Image Statistics, Band Correlation, Statistical Evaluation of Image Quality Parameters

Module-2: Application of Geo-informatics (30 Lectures)

Introduction: Emergence of Geoinformatics technology in different application areas, Indian satellite missions with focused applications
Areas of Applications: Application in Disaster Management, Water, Soil, Urban Planning, Land use/ Land cover, Environmental Management
Remote Sensing in Water resource evaluation and Watershed Management, Runoff and Soil Loss estimation based on empirical models, Remote Sensing in hydro geomorphological studies for ground water targeting.

Reference Books:

1. Introductory Digital Image Processing, A Remote Sensing Perspective, John R. Jensen, Pearson Series
   Geographic Information Science, 2015
2. The Digital Negative, Raw Image Processing in Light room, Camera Raw, and Photoshop, Jeff Schewe, 2015
3. Digital Image Processing using MATLAB, Arsath Natheem, 2017

4. The Image Processing Handbook, Seventh Edition, John C. Russ, F. Brent Neal, 2015
5. Design for Embedded Image Processing on FPGAs, Donald G. Bailey, 2011
6. Image and Geometry Processing for 3-D Cinematography, RémiRonfard and Gabriel Taubin, 2010
7. Principles of Digital Image Processing, Wilhelm Burger, Mark J. Burge, 2009
8. An Introduction to Geoinformatics, G. S. Srivastava, McGraw Hill Education, 2014
9. Principles of Geoinformatics, R.K. Gupta, Subhash Chander, Jain Brothers; 5Edition edition, 2008

Core Course-2

Advanced Remote Sensing

(60 Lectures)(Theory) (MRS-302)

Module-1: Information Extractionfrom Satellite Images (20 Lectures)

Ground Truthing: Ground Truth Collection for Image Classification, Spectral Signature, Data Calibration, Interpretation of target Properties, Training, Verification.

Thematic Image Classification: Spectral Pattern Recognition, Spatial Pattern Recognition, Temporal Pattern Recognition, Parametric and Non-Parametric classifiers, Hard and Soft Classification System, Advantage and Disadvantages of Different Classifiers

Unsupervised Classification: Isodata, K-mean

Supervised Classification System: Minimum Distance to Mean, Parallelepiped, Maximum Likelihood, Mahalanobis Distance

Advanced Classification Techniques: Hybrid Classification, ANN, Spectral Mixture Analysis, Fuzzy Classifiers, Spectral Angle Mapper, Decision Tree, Support Vector Machine

Accuracy Assessment: Reference Data, Sampling techniques, Error of Commission and Omission, Error Matrix, Kappa Statistics

Change Detection Analysis

Module-2: GIS Data Analysis (20 Lectures)

Data Storage: Vector and Raster data model, Digital coding and storing of Point, Line and Polygon, Spaghetti Model, Topological Model, Quad tree, Conversion between Raster and Vector

Database Modeling: Hierarchical Model, Network Model, Relational Model

Spatial Database Management: Concept of Spatial Database, Database Management System, Basic Concepts of Entity, Relationship and Primary Key, Database Structure

Data Organization: Chain Coding, Run-length Coding, Block Coding

Spatial Analysis: Types of Spatial Analysis, Measurement in GIS, Query – Query by Attributes, Spatial Queries, Attribute Based Operation, Neighborhood Analysis, Connectivity Analysis, Overlay and Coverage Rebuilding
Data Quality and Errors in GIS: Errors and Uncertainty in GIS data, Positional and Attribute Accuracy
Web GIS, Mobile GIS

Module-3: Geodesy (20 Lectures)

The Planet Earth, Geoids, Concept of Spherical Geometry and Geodesy, Reference Spheroid and Mean Sea Level

Introduction to different spheroid / ellipsoid systems with special reference to Everest and WGS-84 - Geometric Constants, Indian Geodetic Datum; Rectangular and Geographical Co-ordinate System - Conversion of latitudes and longitudes to linear distances, Coordinate Transformations, Geoidal parameters and their relationship.

Dimensions of some well-known Spheroids, Definition and Determination of Geoid Undulation, Coordinate System used in Geodesy, Coordinate System used by Survey of India (φ, λ, H) Redefinition of Horizontal and Vertical Datum in India, Indian Mean Sea Level Datum.

Satellite Geodesy: Early satellites, Interferometry, Doppler, Point Positioning, Translocation, Observational systems, New Satellite gravity missions

Reference Books:

1. An Introduction to Satellite Image Interpretation, Eric D. Conway, Johns Hopkins University Press, 1997
2. Satellite Communications, Charles Bostian, Jeremy Allnutt Timothy Pratt, Wiley; Second edition, 2006
3. Spatial Data Analysis: Theory and Practice, Robert Haining, Cambridge University Press; 1 edition, 2003
4. GIS Fundamentals: A First Text on Geographic Information Systems, Paul Bolstad, Xan Edu Publishing Inc; 5th edition edition,2016
5. Geodesy, an introduction, Wolfgang Torge, De Gruyter, 1980
6. Basic Geodesy: An Introduction to the History and Concepts of Modern Geodesy Without Mathematics, James R. Smith, Landmark Enterprises, 1988
7. Geodesy, Wolfgang Torge and Jürgen Müller**,** De Gruyter, 2014

Core Course-3
Earth Science Fundamentals and Application of Geo-informatics
(60 Lectures)(Theory) (MRS-303)

Module-1: Fundamentals of Earth Science (30 Lectures)

1. The Earth System: Concept of Earth System, lithosphere, biosphere, hydrosphere & tmosphere, plate tectonic theory and its relationship to earthquakes, and volcanic activity.
2. Petrology and Quaternary Geology: igneous, sedimentary and metamorphic rocks, their characteristics, types and forms, delineation on satellite images. Quaternary geological mapping concept using RS data.
3. Rock Structures: Folds, faults, joints and lineaments, field characteristics, delineation on satellite images and analysis.
4. Applied Geomorphology: Fundamental concepts, geomorphic agents and processes, drainage patterns, classification of landforms. Image characteristics of major landforms.

Module-2: Application of Geo-informatics in Earth Science (30 Lectures)

1. Visual/ Digital Satellite Image Interpretation: Elements of image interpretation, Digital image enhancement techniques for lithological discrimination. Application of Remote Sensing in Geological Mapping (both Litho logical and Structural)
2. Geo-technical Engineering & Environmental Management, Digital terrain models for selection of dam site, road, and canal construction.
3. Multivariate data modeling: Concept and application in geosciences: Disaster Management, Landslide hazard zonation, mineral targeting. Rock Information System. GIS based multivariate analysis in mineral targeting.
4. Case Studies: GPS in plate tectonic studies in Himalayas, Predicting seismicity in peninsular region through lineament studies, Study of hydro-geomorphology in West Bengal

Reference Books:

1. GIS Technology Applications in Environmental and Earth Sciences, BaiTian, CRC Press, 2016
2. Principles Of Geoinformatics, R.K. Gupta, SubhashChander, Jain Brothers; 5Edition edition, 2008
3. Environmental Geoinformatics: Monitoring and Management, Joseph L. Awange, John B. KyaloKiema, Springer; 2013
4. GIS for Environmental Applications: A practical approach, Xuan Zhu, Routledge; 1 edition, 2016

Core Course-4
Resources: Applications of RS & GIS in Resource Management
(60 Lectures)(Theory)(MRS-304)

Module-1: Concepts in Resources: (25 Lectures)

Resources classification systems, natural and cultural resources, renewable and non- renewable resources

Resource Conservation: Remote sensing based Land use- Land cover mapping for resource monitoring and management Sustainable development of natural resources.

Land Resources: Introduction to soil, mineral resources, remote sensing in mapping soil degradation, impact of surface mining on land resources,

Module-2: Applications of Remote Sensing and GIS in Resource Management (35 Lectures)

Bio-Resources: Remote sensing application in agriculture, forest resources and wildlife habitat assessment; Mapping of forest density and type, issues in forest management.

Water Resources: Remote sensing application in surface and sub-surface water resources evaluation, water mining and pollution, issues in water resources management.

Energy Resources: Coal, oil and nuclear energy, non-conventional energy resources, future potential and requirement of energy resources; GIS in energy resources management.

Geoinformtics Models in Resource Management: Forest Fire Modeling, Wild Life Habitat Assessment Modeling, Soil Erosion Modeling, Land Resources Development Prioritization Modeling.

Reference Books:

1. Geoinformatics for Natural Resource Management, P. K. Joshi, Paolo Pani, S.N. Mohapartra, T. P. Singh, Nova Science Publishers Inc; UK ed. Edition, 2009
2. Geoinformatics in Applied Geomorphology, Siddan Anbazhagan, S.K. Subramanian, XiaojunYang, CRC Press; 1 edition, 2017
3. Environmental Geoinformatics: Monitoring and Management, Joseph L. Awange, John B. KyaloKiema, Springer; 2013
4. GIS for Environmental Applications: A practical approach, Xuan Zhu, Routledge; 1 edition, 2016
5. Principles Of Geoinformatics, R.K. Gupta, Subhash Chander, Jain Brothers; 5Edition edition, 2008

Core Course-5

Lab.1. Digital Signal and Image Processing Lab; Lab.2: Earth Science and Geology Lab

(120 periods)(Practical)(MRS-391)

Lab.1: Digital Signal and Image Processing Lab (60 Periods)

1. Sampled sinusoidal signal, various sequences and different arithmetic operations.
2. Convolution of two sequences using graphical methods and using commands- verification of the properties of convolution.
3. Radio mapping of signals at low frequencies and their spectral patterns during disturbed atmospheric conditions
4. VLF and LF radio signal reception and comparison of spectral pattern
5. Long distance VHF radio signals propagating through ionosphere and their characteristic variations
6. Atmospheric Correction, Image enhancement and filtering of multispectral optical data
7. Image classification (Unsupervised, Supervised) and Accuracy assessment
8. Radar image interpretation (DWR): Speckle suppression, Texture analysis, Texture & Object based classification.

Lab.2: Earth Science and Geology Lab (60 Periods)

1. Identification of rocks and minerals in hand specimen
2. Study of topographic maps and geologic maps,
3. Mapping a specified area to delineate rock types, rock lineaments and other structures
4. Application of Geo-informatics in Environmental issues, Measurement of Canopy Cover through Leaf Area Index (LAI) Meter
5. Morphometric analysis of terrain, satellite image based hydro-geomorphological interpretation for ground water targeting.
6. Runoff & Soil Loss estimation based on empirical models.
7. Digital terrain models for selection of dam site, road, and canal construction, Cut & Fill analysis using DEM
8. Spatial Decision Support System

Semester- 4

Discipline Specific Elective-1(DSE-1)
(MRS-401)

Option-1: Geoinformatics in Coastal Zone Management (MRS-401/1) (60 Lectures)

1. Coastal morpho dynamics: Micro, macro and biogenic forms. Systems of change in coasts: cyclical and progressive. Classification of coasts based on processes and sediment characteristics.
2. Coastal biogeography with special reference to sea weeds, mangroves, dune vegetation and corals, Coastal pollution: Sources, impacts and management, Integrated Coastal Management: Concepts, techniques and applications.
3. Natural coastal hazards and their management: Sea level rise, erosion, sedimentation and tropical cyclones, Coastal engineering and its impacts: Ports and harbors, measures for prevention of erosion and sedimentation.
4. Techniques of monitoring changes in coastal processes and landforms.
5. Human utilization of coasts, environmental impacts and management: Navigation, mining, fishing and fish-processing, off-shore oil exploitation, reclamation and tourism.

Potential Application areas of RS /GIS

1. Indian coast: Major environmental issues, problems and their management
2. Application of Remote Sensing with special reference to Coastal Zone Management
3. Monitoring Surface waters in Coastal Regulatory Zone(CRZ)
4. Study of Suspended mineralin water
5. Study of Chlorophyll in water
6. Measurement of Sea Surface Temperature(SST)

Reference Books:

1. Geoinformatics for Marine and Coastal Management , Darius Bartlett, Louis Celliers, CRC Press; 1 edition, 2017
2. GIS for Coastal Zone Management , Jennifer Smith, Darius Bartlett, Taylor & Francis Group, 2004
3. Principles Of Geoinformatics, R.K. Gupta, SubhashChander, Jain Brothers; 5Edition edition, 2008
4. Environmental Geoinformatics: Monitoring and Management, Joseph L. Awange, John B. KyaloKiema, Springer; 2013
5. GIS for Environmental Applications: A practical approach, Xuan Zhu, Routledge; 1 edition, 2016

Option-2: Geoinformatics in Water ResourceManagement (MRS-401/2) (60 Lectures)

Water Resources and Watershed Management:

1. Surface water-ground water, water deciphering
2. Quality inventory and monitoring, quantity assessment–Parametric watershed modeling – Dimensional consideration of basic dynamics – evaluation of hydrologic parameters
3. Concept of watershed, Morphometric Analysis
4. Hydro-morph geologic interpretation techniques for targeting ground water potential zones in alluvial, sedimentary and hard rock areas, location of aquifer
5. Watershed management, techniques of soil and water conservation.

Remote Sensing in Water resource Evaluation:

1. Drought & flood Assessment, flood plain mapping, soil moisture, water quality, snow & cloud mapping.
2. Estimation of Aquatic biodiversity, Runoff and soil loss estimation.
3. Site location for storage and diversion projects, dam site selection, tunnel and canal alignment
4. Case Studies.

Reference Books:

1. GIS for Water Resource and Watershed Management, John G. Lyon, CRC Press; 1 edition , 2002
2. Watershed Management, J.V.S. Murthy, New Age Publishers; Second edition , 2017
3. Principles Of Geoinformatics, R.K. Gupta, SubhashChander, Jain Brothers; 5Edition edition, 2008
4. Environmental Geoinformatics: Monitoring and Management, Joseph L. Awange, John B. KyaloKiema, Springer; 2013
5. GIS for Environmental Applications: A practical approach, Xuan Zhu, Routledge; 1 edition, 2016

Discipline Specific Elective-2(DSE-2)
(MRS-402)

Option-1: Radar Systems &Satellite Techniques (MRS-402/1)(60 Lectures)

Radar Systems (30 Lectures)

Introduction to Radar: Historical background, radar terminology, radar band designations, Radar block diagram, Radar equation: detection of signals in noise and signal-to-noise ratio, Probabilities of detection

& False alarm, integration of radar pulses, radar cross section, distributed targets, Transmitted power, pulse-repetition frequency, antenna parameters & system losses, introduction to radar clutter.
Radar Types: Pulse radars and CW radars, Advantages of coherent radar, Doppler radar and MTI: Doppler effect, delay-line cancellers, blind speeds, staggered PRFs, Digital filter bank, Moving Target Detector, limitations of MTI, tracking with radar, monopulse tracking, conical scan, limitation to tracking accuracy,
Radar signals & clutter: Basic radar measurement, theoretical accuracy of radar measurements, Range and velocity ambiguities, the ambiguity diagram, pulse compression-principles, the matched filter, chirp waveforms, Waveform design: nonlinear FM, phase codes, waveform generation and compression Descriptions of land & sea clutter, statistical models for surface clutter, detection of targets in clutter.
Devices and Radar Systems: Radar transmitter: Solid-state RF power source, Magnetron, other RF power sources, Radar receiver: Super heterodyne receiver, receiver noise figure, duplexers & diplexers, Receiver protectors, Applications: Electronic Warfare: ESM, ECM, ECCM; super resolution, IFM, types of jammers, Stealth and counter-stealth: stealth techniques for aircraft and other target types, low frequency and UWB radar, System design examples.

Satellite Techniques for system dynamics and Analysis (30 Lectures)

Satellite fundamentals: Preliminaries, up and down link, frequency allocations, satellite types, geo-stationary satellite, modem and codec, jamming margin, band width, time division multiplexing, satellite principles and applications,
Architectures, Transmission techniques, Link budget fundamentals, Transmission techniques and multiple access basics, overview of broadcasting systems in satcoms (including DVB-Sx, SD, HDTV etc.), broadcast services (such as Direct to Home (DTH), Satellite News Gathering (SNG), Content Distribution Networks (CDN), corporate networks and more), orbital positions, frequency bands for satellite broadband, system architecture (hubs, terminals, mobile terminals etc.). Commercial offers of capacity / services, value chain, vendors, customers, the economics of satellite broadcast systems.

Satellite broadband systems: overview of modern broadband satcom systems, multiple spot beam, flexibility, high throughput satellites, system architectures (hubs, terminals and frequency bands), capabilities and limitations, connectivity packages, commercial offers/price per bit, value chain, vendors, customers, the economics of satellite broadband systems.

Mobile satcom systems and services: Overview of modern mobile satcom systems, typical systems and services: land, maritime, aerospace, system architectures, terminals (SOTM, portable, transportable), commercial offers, pricing strategies, value chain, vendors, customers, the economics of satellite broadband systems and services including procurement model analysis.

Reference Books:

1. Radar Handbook,Merrill I Skolnik, McGraw-Hill Education; 3 edition, 2008
2. Introduction to Radar Systems, Merrill Skolnik, McGraw Hill Education; 3 edition, 2017
3. Satellite Communications, VarshaAgrawal Anil K. Maini, WILEY INDIA PVT.LTD, 2010.
4. Satellite Technology: Principles and Applications, Anil K. Maini, VarshaAgrawal, Wiley; 2 edition, 2010.
5. Radar Systems, Lynn, Paul A.,Springer, 1987
6. Radar Systems and Radio Aids to Navigation, A. K. Sen, A. B. Bhattacharya, Mercury Learning and Information, Dulles, 2019

Option-2: Geoinformatics in Natural Hazards Management (MRS-402/2) (60 Lectures)

Fundamental concepts of hazards and disasters:

1. Introduction: Types of hazards and disasters, characterization, zonation of hazards, natural and human induced disasters.
2. Disaster and National losses, historical perspective of disasters in India.
3. Disaster Management: Fundamental concept of Disaster Management, government, NGOs and peoples participation disaster management. Existing organization structure for managing disasters in India.
4. Geoinformatics in disastermitigation.

Application of Geo-informatics in Hazards and Disasters Management:

1. Geological Hazards: Landslide, Earthquake, Mining hazards (subsidence, flooding etc.),Volcanic hazards, Groundwater hazards, Glacial hazards
2. HydrometeorologicalHazards:Flashfloods,Riverfloods,Damburst,Cloudburst, Cyclones, Coastal hazards and Drought
3. Environmental hazards: Forest hazards (Deforestation, Degradation and Forest fire), Land, soil degradation, desertification and Pollution (Water, air and soil)
4. Geoinformatics Applications: Geoinformatics models in managing forest fires, floods, landslides, cyclone and earthquake, multiple hazard mapping.
5. Case Studies: Earthquakes in India, Floods in Indo Gangetic plains, Landslides in Himalayan region, Drought in Indian plateau regions.

Reference Books:

1. Geographic Information Systems (GIS) for Disaster Management, Brian T omaszewski, Routledge; 1 edition, 2014.
2. GIS Technology Applications in Environmental and Earth Sciences, BaiTian, CRC Press, 2016
3. Principles Of Geoinformatics, R.K. Gupta, Subhash Chander, Jain Brothers; 5Edition edition, 2008
4. Environmental Geoinformatics: Monitoring and Management, Joseph L. Awange, John B. Kyalo Kiema, Springer; 2013
5. GIS for Environmental Applications: A practical approach, Xuan Zhu, Routledge; 1 edition, 2016

DSE-3 (Advanced experiment): MRS-491(120 Periods)

DSE-4 (Project): MRS-492 (120 Periods)

DSE-5 Grand Viva: MRS-493

CBCS

(MRS(GE)-001)

Geoinformatics in Environmental Science & Management

(60 Lectures)

Theoretical Considerations:

1. Water and the environment, R.S. of fluorescence- water quality- water pollution- pollution sources- water runoff, Remote Sensing and Water quality management – snow surface cover- floodprediction
2. Soils and land forms- insects and disease- soil erosion- salinity- flood damage- soil limitation –soil degradation using Remote Sensing andGIS.
3. Urban environment, General consideration rural structure- urban areas- Impact of industrial pollution- chemical effluents, land reclamation- disposal of solid waste- mining pollution

Application of Remote Sensing and GIS:

1. Ecology and ecosystem, Conservation and resource management – spectral reflectance from vegetated surface- Stress monitoring- forest conservation- wild life studies- GIS for monitoring non print source pollution.
2. Marine environment, Sensors for environmental monitoring sensors – visible and outside visible wave length – absorption spectrometers – selection of ground truth sites- sea truth observations –Radar techniques for sensing ocean surfaces- thermal measurements – application of sensing, mapping oil slicks – Chlorophyll detection- Fisheries resources- Coastal marine studies- determination of temperature and sea state.
3. Air pollution and global climatology, R.S. technique for Air quality monitoring- case studies- weather forecasting and climatology- emissivity characteristics.
4. Measurement of atmospheric temperature- composition- constituent distribution and concentration- composition- constituent distribution and concentration- wind flows and air circulation- Hurricane tracking – meteorological satellite systems.

Reference Books:

1. Environmental Geoinformatics: Monitoring and Management, Joseph L. Awange, John B. KyaloKiema, Springer; 2013
2. GIS for Environmental Applications: A practical approach, Xuan Zhu, Routledge; 1 edition, 2016
3. Principles Of Geoinformatics, R.K. Gupta, SubhashChander, Jain Brothers; 5Edition edition, 2008
4. GIS Technology Applications in Environmental and Earth Sciences, BaiTian, CRC Press, 2016.

CBCS

MRS (GE)-002

COMPUTER FUNDAMENTALS AND C PROGRAMMING

UNIT I: Computer Fundamentals: Introduction to Computers, Characteristics of Computers, Uses of computers, Types and generations of Computers, Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices, User Interface with the Operating System, System Tools

UNIT II: Data Representation: Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of bi. Networks terminology: Types of networks, router, switch, server-client architecture

UNIT III: Problem Solving: Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spread sheet

UNIT IV: General Awareness: IT Act, System Security (virus/firewall etc.) I-Tax, Reservations, Banking

UNIT V: Computer Programming in C: Basics: Variables, constants, expressions, operators and their precedence and associativity, basic input and output statements, control structures, simple programs in C using all the operators and control structure. Functions: Concept of a function, parameters and how they are passed, automatic variables, recursion, scope and extent of variables, writing programs using recursive and non-recursive functions. Arrays and Strings: Single and multidimensional arrays, character array as a string, functions on strings, writing C programs using arrays and for string manipulation. Structures: Declaring and using structures, operations on structures, arrays of structures, user defined data types, pointers to using files. Files: Introduction, file structure, file handing functions, file types, files, error handing, C programming examples for using files.

References :

1. Programming in ANSI C, E Balagurusamy, 6th Edition, McGraw Hill Education (India) Private Limited, 2017.
2. Introduction to Numerical Methods, SS Sastry, ISBN:9788120345928, Prentice Hall, 2012.
3. Let Us C, Yashwant Kanetkar, BPB Publications, 16th Edition, 2018
4. Computer Science, A structured programming approach using C", B.A. Forouzan and R.F. Gilberg, "3rd Edition, Thomson, 2007.
5. The C-Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI, 2015
6. Scientific Programming : C-Language, Algorithms and Models in Science, Luciano M. Barone (Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific, 2018