SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A' Grado

Session- 2021-2022

Name of School/ Department-Centre for Climate Change and Water Research

[redacted]

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B. List of post graduate programs offered

M.Sc Geoinformatics

M.Tech Geoinformatics

C. List of Ph.D. Programs offered

Programme Outcomes:

PO 1: It will help the students to grow as an effective spatial data professional/scientist/researcher by solving real world problems.
PO 2: It will strengthen the students to work in a team, effective communication, critical thinking and technical skills.
PO 3: Students will learn to develop professional approach that prepares them for immediate employment and for life-long learning in advanced areas of Geoinformatics and related fields.
PO 4: It will support the student's seeking carrier in higher education, research and academics
PO 5: Increased student success & placements in industries
PO 6: Students will learn to develop multi-disciplinary research activities related to social issues
PO 7: Students will be able to develop required knowledge and technical skills for being a good entrepreneur.
PO 8: It will help to grow in a nurturing environment and promoting intellectual stimulation

Programme specific outcomes:

PSO 1: Basic and advanced knowledge based on hands on training of Geoinformatics and related fields.
PSO 2: Development of required skills based on lab experiments for effective learning of remote sensing, GIS, GPS etc.
PSO 3: Understanding and analyzing spatial data for solving real world problems.
PSO 4: Improve technical skills of geo-statistical modeling, analysis and digital image processing
PSO 5: Increase academic standards and rigor
PSO 6: Achieve academic excellence and uniqueness through high quality research publication

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Course Outcome
M. Tech Geoinformatics

Course code	Course name	Course outcomes
1 Semester		
EM 501	Employability Skill 1	Effective leaning of industry orientated technical skills of the subject, Personality development, Communication skills, Placement procedure
FD 102	Foundation Course-I	To learn various topics of Historical evolution, Sociology, Economics and capital Geography and earth systems
CWR 501	Principles of Remote Sensing and Photogrammetry	Through this course students should be able to understand the fundamentals of remote sensing techniques, types of remote sensing satellites, Photogrammetric techniques and applications, Earth observation methods
CWR 503	Geographic Information System	To understand basics of GIS, Geo-spatial data sources, Geospatial data storage and processing, Applications in SDGs
CWR 505	Cartography & Global Positioning System	To learn methods of map making and designing, Basics and principles of GPS and DGPS surveying technique, applications of GNSS
CWR 507	Geosciences and Advanced Remote Sensing	Through this course students should be able to understand basics of geosciences, Various earth surface processes, Identification and mapping of different land features
CWR 509	Computer programming & Web GIS	Through this course students should be able to learn various programming languages various applications, Customization of software, Development of GIS tools
CWR 511	Minor Project-I	It will provide basic understanding of literature review and paper writing on various applications of geoinformatics
CWR 513	Seminar I	It enhances the ability of the presentation of various topic, Written and verbal communication skills, Communication skills
CWR 551	Principles of Remote Sensing and Photogrammetry Lab	It will provide practical knowledge of interpretation, information extraction from satellite images, Geometric measurements, Photogrammetry
CWR 553	Geographic Information System Lab	It will provide practical and hands on knowledge of different spatial data analysis tools, spatial data generation, database integration, topology and its implementation

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CWR 555	Cartography & Global Positioning System Lab	It will provide Fundamental knowledge of map making, Designing and scales, Ground data collection, Surveying using GPS
CWR 557	Geosciences and Advanced Remote Sensing Lab	It will provide practical knowledge of Image interpretation for various earth surface features/processes, Feature identification and mapping using SAR, LIDAR images, Hyperspectral image analysis and processing
CWR 515	Fundamentals of Mathematics	To understand basic mathematics, Different mathematical bases, Differential equation Matrix
CWR 519	Artificial Intelligence	To understand image formation, image processing algorithms and applications, image enhancement algorithms, information extraction using images
2 Semester		
CWR 521	Geoinformatics in Satellite meteorology, Agriculture, Soil & Land	Through this course students should be able to understand application of Geoinformatics in Earthquakes, seismic activities and its risk assessment, Geological factors, Earth system sciences
CWR 559	Geoinformatics in Satellite meteorology, Agriculture, Soil & Land Evaluation Lab	It will provide Fundamental knowledge of weather forecasting, Crop mapping and monitoring, Land degradation and soil erosion, Soil salinity and water logging
EM 502	Employability Skill	Effective leaning of industry orientated technical skills of the subject, Personality development, Communication skills, Placement procedure
FD 104	Foundation Course-I	To learn various topics of Historical evolution, Sociology, Economics and capital Geography and earth systems
CWR 502	Geoinformatics in Ecology & Forestry	Through this course students should be able to understand application of Geoinformatics in Forest inventory and mapping, Forest fire simulation and mapping, Forest health assessment and conservation, Ecosystem services
CWR 504	Spatial Modelling & Analysis	Through this course students should be able to understand types of geographic data, Database management system, Analysis of geographic data, Modelling of geospatial data
CWR 506	Digital Image Processing	To understand different image processing techniques and analysis, Information extraction, digital image classification
CWR 508	Statistics for Geoinformatics	It will provide knowledge of basic statistical operations like mean, median, mode, variance & co-variance, Correlation and sampling techniques

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CWR 510	Geoinformatics in Disaster Management	To understand application of RS and GIS in disaster management, Forest fire simulation and mapping, Landslides and flood mapping, Air pollution control
CWR 552	Geoinformatics in Ecology & Forestry Lab	To understand application of Geoinformatics in Forest inventory and mapping, Forest fire simulation and mapping, Forest conservation, Ecosystem services
CWR 554	Spatial Modelling & Analysis Lab	It will provide hands on training on database creation, Data models, Spatial data analysis and modeling, Spatial query
CWR 556	Digital Image Processing Lab	It will provide hands on knowledge of different image processing techniques, Image analysis, Information extraction, Digital image classification
CWR 558	Geoinformatics in Disaster Management Lab	It will provide hands on knowledge of the application of RS and GIS in disaster management, Forest fire simulation and mapping, Landslides and flood mapping, Air pollution monitoring
CWR 512	Seminar-2	It enhances the ability of power point presentation of topics, Written and verbal communication skills, PPT preparation Communication skills
CWR 514	Geoinformatics in Urban and Regional Planning	Through this course students should be able to understand Urban mapping, Town and regional planning, Urban growth modelling Transportation analysis
CWR 560	Geoinformatics in Urban and Regional Planning Lab	It will provide hands on training using remote sensing images in mapping of urban area, Urban growth modelling and analysis Planning and management of urban areas etc.
CWR 516	Geoinformatics in Hydrology & Water Resources	Through this course students should be able to understand application RS and GIS in water resource management, Ground water zonation, Ground water quality assessment Watershed management and irrigation system etc.
CWR 562	Geoinformatics in Hydrology & Water Resources Lab	It will provide practical knowledge of Remote sensing and GIS in water quality assessment, Management of watershed, Drainage analysis, Morphometry and geomorphology
CWR 518	Geoinformatics in Desert	Through this course students should be able to understand topographical analysis of desert surfaces, Different desert landforms Soil erosion, Water conservation etc.
CWR 564	Geoinformatics in Desert Lab	Identification of different desert landforms, Interpretation of satellite images, Water resource management, Soil erosion and desertification process

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CWR 520	Geoinformatics in Earthquakes	To understand application of Geoinformatics in Earthquakes, seismic activities and its risk assessment, Geological factors, Earth system sciences
CWR 522	Geoinformatics in Mineral Exploration	Through this course students should be able to understand application of Geoinformatics in Mineral exploration and mapping, Geological structure, Spectral response of minerals and coals
CWR 524	Geoinformatics in Environmental Monitoring	Through this course students should be able to understand application of Geoinformatics in Environmental impact assessment, Air and water pollution, Urban climate, Disaster and natural hazard management
CWR 566	Geoinformatics in Environmental Monitoring Lab	It will provide hands on training to analyse remote sensing images for environmental impact assessment, Air and water pollution Urban climate etc.
3 Semester		
CWR 523	Research Methodology & Project Formulation	Through this course students should be able to understand Research projects/proposal, Implications and management, project formulation and writing, Ground surveying methods
CWR 525	Dissertation and Project work	It will provide comprehensive knowledge of research and paper writing on various applications of geoinformatics
CWR 527	Seminar-3	It will improve the subject matter presentation, Written and verbal communication skills, PPT preparation and presentation skills
CWR 526	Geoinformatics in snow and glacier hydrology	It will provide the knowledge of glaciological process and its impact on hydrological processes.
CWR 528	Geoinformatics in Climate Change and Environment Impact Assessment	To know about how the geoinformatics application can useful for Environmental Impact assessment

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Teaching and Examination Scheme

To commence from the Academic year: 2021-2022

Centre: Centre for Climate Change and Water Research **Year: I**

Program: M.Tech. Geoinformatics **Semester-I**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
		University Core							
1	PC 501	Proficiency and Co- Curriculum activity -I	2	0	0	0		100	
2	FD 102	Foundation Course-I	1	1	0	0	3	25	75
3	EM 501	Employability Skills	1	0	2	0	3	40	60
		Program Core							
4	CWR 501	Principles of Remote Sensing & Photogrammetry	3	3	0	0	3	40	60
5	CWR 503	Geographic Information System	3	3	0	0	3	40	60
6	CWR 505	Cartography & Global Positioning System	3	3	0	0	3	40	60
7	CWR 507	Geoscience and Advanced Remote Sensing	3	3	0	0	3	40	60
8	CWR 509	Computer programming & Web GIS.	3	3	0	0	3	40	60
9	CWR 511	Minor Project -I	3	0	0	3	-	60	40
10	CWR 513	Seminar-1	1		2			60	40
11	CWR 551	Principles of Remote Sensing & Photogrammetry Lab	1	0	0	2	3	60	40
12	CWR 553	Geographic Information System Lab	1	0	0	2	3	60	40
13	CWR 555	Cartography & Global Positioning System Lab	1	0	0	2	3	60	40
14	CWR 557	Geoscience, Image interpretation & Advanced Remote Sensing Lab	1	0	0	2	3	60	40
		Program Elective (Any One)							
15	CWR 515	Fundamentals of Mathematics	3	3	0	0	3	40	60
16	CWR 517	Neural Networks and Fuzzy Logic	3	3	0	0	3	40	60
17	CWR 519	Artificial Intelligence	3	3	0	0	3	40	60
18	CWR 521	Geoinformatics in Satellite meteorology, agriculture, soil & land evaluation	3	3	0	0	3	40	60
19	CWR 559	Geoinformatics in Satellite meteorology, agriculture, soil & land -evaluation Lab	1	0	0	2	2	60	40
		Total	**30**	**18**	**2**	**8**			
		Grand Total	**30**						

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BoS_____

Signature of Member Secretary

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Teaching and Examination Scheme
To commence from the Academic year: 2018-2019

Centre: Centre for Climate Change and Water Research **Year: I**
Program: M.Tech. Geoinformatics **Semester-II**

L - Lecture CIE – Continuous Internal Evaluation

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
		University Core							
1	EM 502	Employability Skills	1		2		3	40	60
2	PC 502	Proficiency and Co-Curriculum Activities-II	2	0	0	0	-	100	
3	FD 104	Foundation Course-II	1	1	0	0	3	25	75
		Program Core							
4	CWR 502	Geoinformatics in Ecology & Forestry	3	3	0	0	3	40	60
5	CWR 504	Spatial Modeling & Analysis	3	3	0	0	3	40	60
6	CWR 506	Digital Image Processing	3	3	0	0	3	40	60
7	CWR 508	Statistics for Geoinformatics	3	3	0	0	3	40	60
8	CWR 510	Geoinformatics in Disaster Management	3	3	0	0	3	40	60
9	CWR 552	Geoinformatics in Ecology & Forestry Lab	1	0	0	2	2	60	40
10	CWR 554	Spatial Modeling & Analysis Lab	1	0	0	2	2	60	40
11	CWR 556	Digital Image Processing Lab	1	0	0	2	2	60	40
12	CWR 558	Geoinformatics in Disaster Management Lab	1	0	0	2	2	60	40
13	CWR 512	Seminar-2	1	0	2	0		60	40
		Program Elective (Any One)							
14	CWR 514	Geoinformatics in Urban and Regional Planning	3	3	0	0	3	40	60
15	CWR 560	Geoinformatics in Urban and Regional Planning lab	1	0	0	2	2	60	40
16	CWR 516	Geoinformatics in Hydrology & Water Resources	3	3	0	0	3	40	60
17	CWR 562	Geoinformatics in Hydrology & Water Resources lab	1	0	0	2	2	60	40
18	CWR 518	Geoinformatics in Desert	3	3	0	0	3	40	60
19	CWR 564	Geoinformatics in Desert Lab	1	0	0	2	2	60	40
20	CWR 520	Geoinformatics in Earthquakes	3	3	0	0	3	40	60
21	CWR 522	Geoinformatics in Mineral Exploration	3	3	0	0	3	40	60
22	CWR 524	Geoinformatics in Environmental Monitoring	3	3	0	0	3	40	60
23	CWR 566	Geoinformatics in Environmental Monitoring Lab	1	0	0	2	3	60	40
24	CWR 526	Geoinformatics in Snow and Glacier Hydrology	3	3	0	0	3	40	60
25	CWR 528	Geoinformatics in Climate Change and Environmental Impact Assessment	3	3	0	0	3	40	60
26	CWR 568	Geoinformatics in Snow and Glacier Hydrology Laboratory	1	0	0	2	3	60	40
27	CWR 570	Geoinformatics in Climate Change and Environmental Impact Assessment Laboratory	1	0	0	2	3	60	40
		Grand total	**28**	**18**	**2**	**10**			

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T – Tutorial
P – Practical

ESE – End Semester Examination

Signature of Concerned Teacher

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S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in %)	
				L	T	P		CIE	ESE
		University Core							
1	PC 601	Proficiency and Co- Curriculum Activity -III	2	0	0	0	-	100	
		Program Core							
2	CWR 523	Research Methodology & Project Formulation	4	4	0	0	3	40	60
3	CWR 525	Dissertation/Project Work - 1	12	0	0	3	3	40	60
4	CWR 527	Seminar-3	1	0	2	0		60	40

Teaching and Examination Scheme
To commence from the Academic year: 2018-2019

Centre: Centre for Climate Change and Water Research
Program: M.Tech. Geoinformatics

Year: II
Semester-III

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		Total	19						
		Grand total	**19**	**4**	**3**	**3**			

L - Lecture

T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation

ESE – End Semester Examination

Signature of Concerned Teacher **Signature of Convener-BoS**_____

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Shweta

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Teaching and Examination Scheme
To commence from the Academic year: 2018-2019

Centre: Centre for Climate Change and Water Research **Year: II**
Program :M.Tech. Geoinformatics **Semester-IV**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
1.	CWR 526	Dissertation/Project Work - 2	20	0	0	4	3	60	40
		Total	20	0	0	4			
		Grand total	20						

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

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Syllabus of M.Tech. Geoinformatics

Centre: Centre for Climate Change and Water Research

CWR 501 PRINCIPLES OF REMOTE SENSING & PHOTOGRAMMETRY **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASIC PRINCIPLES:** Remote Sensing: History, Development, Definition, Advantages and Limitations, Concept & Principles, Electromagnetic Radiation (EMR): Spectrum and its properties, wavelength regions and their applications Atmospheric windows, Interaction of EMR with atmosphere & Earth's Surface, Spectral response pattern, Spectral, Spatial, Temporal and Radiometric Resolutions, Multi-concept in RS, teledection and earth observation, Atmospheric effects	8
UNIT II	**SENSORS, SCANNERS AND DETECTORS:** Photographic System: Cameras, filters & Films; Remote Sensing Systems: Platform, types of platforms & its characteristics; Sensor classification: Active and Passive, Coherence, polarimetry, Optical-Mechanical Scanners & Push-broom scanners; Ground Truth Instruments: GTR, Imaging and non-imaging scanners, Scanning systems	7
UNIT III	**REMOTE SENSING SATELLITES:** Satellites & their characteristics – Geostationary & Sun Synchronous; Earth Resource Satellite: Introduction to commonly used multi-spectral remote sensing satellite systems: IRS Series of Satellites, Landsat, SPOT, Ikonos, Quickbird, Modis, Radarsat, ERS, etc.; Weather & Communication Satellites: Introduction, NOAA, TERRA, MOS, INSAT, GOES, etc.; Remote Sensing (RS) Applications: Agriculture, Forestry, Land cover/Land use, Water resources & Earth System Science, Earth observation for SDGs	7
UNIT IV	**AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY:** Introduction: Fundamentals of Aerial Photography, Aerial photography planning & execution of photographic flights; aerial sensors, Photogrammetry: Basic concepts of scale, measurements of object height and length; Stereo Photogrammetry: Stereovision & Stereoscopes, Stereoscopic Parallax & Parallax Equations; Relief displacement, Vertical exaggeration, photographic camera	7
UNIT V	**DIGITAL PHOTOGRAMMETRY:** Basic Concepts; Generation of Digital Photogrammetric Images; Interior Orientation, Exterior Orientation; Generation of Digital Elevation Models & Ortho-images, Applications of DEM data	7

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REFERENCE BOOKS

1. Jensen, J.R., (2006) "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi.
2. George Joseph, (2004) "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad.
3. Sabins, F.F. Jr., (2007) Edition. „Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.
4. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
5. Lillesand, Thomas M. and Kiefer, Ralph, W., (2007) "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York
6. Rampal, K.K., (1999) Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi

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CWR 503 GEOGRAPHIC INFORMATION SYSTEM **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**INTRODUCTION:** Philosophy & Definition of GIS; Basic concepts about spatial information; Historical evolution of GIS; Spatial vs. non-spatial data, Manual vs. automated GIS; Components of GIS, recent trends in GIS	7
UNIT II	**DATA STRUCTURE & FORMAT:** Data structure and formats; Spatial data models – Raster and Vector; Data base design - editing and topology creation in GIS, Linkage between spatial and non-spatial data; Raster Data & its Representation: Types, Data Structure, Data Compression and its types, BIL, BIP, BSQ, Data Files, Data Conversions; Vector data representation: Topological & Non-topological Vector Data, Map scale, Spatial Resolution, Spatial Data Accuracy, Location Data Accuracy and Precision, Vector Data Sources; Comparison between Raster & Vector Data; Data inputting in GIS	8
UNIT III	**RASTER DATA ANALYSIS & VECTOR DATA ANALYSIS:** Integration of Raster & Vector Data; Advantages & Limitations of Raster Based GIS; Cartographic Modelling - Map Algebra; Raster Data Analysis – Overlay Operations, Slope & Aspects, Statistical Analysis; Geometric Transformations - Affine Transformation and Geometric Transformation Coefficients, RMS Error; Vector Data Analysis (Basic Concepts); Feature Based Topological functions: Buffering Overlay Analysis, Distance Measurements; Layer Based Topological Functions, rasterization and vectorization, raster data conversion	7
UNIT IV	**DATA EXPLORATION:** Interactive Data Exploration, Vector Data Query, Attribute Data Query; Logical Expressions, Types of Operations; Relational Database Query, Use of SQL to Query a Database, Descriptive Statistics of Attribute Data; Spatial Data Query, Raster Data Query, Query by Cell Value, Query using Graphical Methods, Charts; Geographic Visualization, Data Classification, Spatial Aggregation, Map Comparison, Role of GIS in surface generation, conversion of geographic features	7
UNIT V	**GIS DATA INTEGRATION, PROJECT MANAGEMENT & APPLICATONS OF GIS:** Introduction, Integration of RS & GIS; Problem Identification & Designing a Data Model; GIS project planning; Geographic Database Design Methodology; Approaches to the study of GIS; GIS for natural resources monitoring & management; Application of GIS in Various Fields; Web GIS, , Role of GIS in SDGs	7

REFERENCE BOOKS

1. Kang-tsung Chang (2007), „Introduction to Geographic Information Systems" Tata McGraw Hill, New Delhi.
2. C.P.Lo and Albert K.W.Yeung (2006) "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India,New Delhi.
3. Burrough, Peter A. and Rachael McDonnell,(1998), „ Principles of Geographical Information Systems" Oxford University Press, New York.

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CWR 505 CARTOGRAPHY & GLOBAL POSITIONING SYSTEM **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASIC CONCEPT OF CARTOGRAPHY & MAP PROJECTIONS:** Introduction to cartography-Nature Scope & its role; Basic Characteristics of Map, Study of different types of Map and Scale; Survey of India National Series maps and its interpretation; Introduction to Geometrics, Reference and Coordinate System; Basic Assumptions & Use of Projection; Classification & Selection, Important Map Projections-Conic, Cylindrical, Zenithal, Mercator`s, Polyconic, Lambert, Orthomorphic, UTM Grid & their comparison; Map Projection Transformation, Analysis and Visualization of distortion, interpolation methods, reprojection of maps, displaying of maps	8
UNIT II	**EARTH, ITS CARTOGRAPHIC ABSTRACTION AND MAPPING:** Approximation of the Earth; Generalization- Elements, Control & Classification (Semantic & Geometric); Symbolization for different feature attributes, Pattern used by SOI ,Mapping the statistical surface with dot, isopleth and choropleth mapping; Map compilation & method of map printing	7
UNIT III	**CARTOGRAPHIC COMMUNICATION & VISUALIZATION OF GEOSPATIAL DATA:** Map Design, Map lettering & its placement; Graphic Symbology & Visual Variables; Multivariate, Interactive Cartography & 3D Visualization	7
UNIT IV	**FUNDAMENTALS OF GPS & GPS SURVEYING METHODS AND ACCURACY:** Introduction to Global Positioning System; Satellite constellation, GPS signals; Geopositioning- Basic Concepts, Pseudo Range Measurement, Phase Difference Measurement, NAVSTAR, GLONASS, GALILEO; Methods-Static & Rapid Static; Kinematic-Real Time Kinematic; GPS Survey Planning – GPS & DGPS Data Processing and Accuracy, Satellite geometry, Basic Trilateration	7
UNIT V	**GEODESY & COMPONENTS OF GLOBAL POSITIONING SYSTEM:** Basic geodesy; Geoid/datum/Ellipsoid- definition and basic concepts, GPS Datum Vs Indian Geodetic Datum; Geoid and its importance in surface mapping, Coordinate Systems, Transformation of coordinates; Application of Geodesy; GPS Segments: Control, Space, User & its Functions; GPS Positioning Types- Absolute, Differential; Selection of Reference Station, Reference Station Equipment: GPS`` receiver, GPS antenna. Radio and its types, Radio Antenna	7

REFERENCE BOOKS

1. Keates, J.S., (2008): Cartographic Design and production, London, Longman
2. Ramesh, P. A., (2000): Fundamentals of Cartography, Concept Publishing Co., New Delhi.
3. Rampal, K.K., (2004): Mapping and Compilation, Concept Publishing Co.,New Delhi.
4. Anson, R.W.& Ormeling, F.J., (2008), Basic Cartography, Vol. 1, 2nd ed., Elsevier Applied Science Publishers, London.
5. Robinson A.H. & Morrison J.L, (1995) Elements of Cartography, John Wiley & Sons
6. Singh, R.L & Dutt. P.K,(2008), "Elements of Practical geography", Students Friends Allahabad
7. Peterson, M.P., (1995) "Interactive and Animated Cartography" Upper Sadde River, NJ: Prentice Hall
8. N.K.Agrawal , (2004) ,Essentials of GPS, Spatial Network Pvt. Ltd
9. Sathish Gopi , (2000), GPS and Surveying using GPS
10. Leica. A., (2003), GPS Satellite Surveying, John Wiley & Sons, use. New York
11. Terry-Karen Steede, (2002), Integrating GIS and the Global Positioning System, ESRI Press

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CWR 507 GEOSCIENCES AND ADVANCED REMOTE SENSING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**THE EARTH SYSTEM & IMAGE INTERPRETATION FOR EARTH SURFACE MAPPING:** Concept of Earth System; Lithosphere, Biosphere, Hydrosphere & Atmosphere; Continental Drift, Plate Tectonics Theory and its relationship to earthquakes and volcanic activity; Visual and digital image interpretation techniques; Elements of image interpretation; Development of interpretation keys for land use/ land cover, role of satellite image in earth system sciences, factors affecting image interpretation, activities of image interpretation	8
UNIT II	**ROCK TYPES & ROCK STRUCTURES:** Igneous, Sedimentary and Metamorphic Rocks: Types, Forms; spectral signatures of rocks, Field characteristics and rock type delineation on satellite Images; Mineral deposits & their types; Geoinformatics in mineral exploration; Folds, Faults and Joints; Field characteristics of rock structures and delineation on satellite images; Lineaments mapping; Geoinformatics in engineering geological investigation: Tunnel, dam & reservoir	7
UNIT III	**GEOMORPHOLOGY AND LANDFORMS:** Fundamental concepts, geomorphic agents; Classification of fluvial, eolian, glacial and marine landforms; Drainage patterns and significance, Image characteristics of landforms; Hydro geomorphological mapping in Groundwater exploration, Lineaments mapping using earth observation datasets	7
UNIT IV	**LiDAR REMOTE SENSING & HYPERSPECTRAL REMOTE SENSING:** Altimetric LiDAR: Physics of laser, spectral characteristics of laser, laser interaction with objects, Airborne Altimetric LiDAR: principle, Multiple return, Components of LiDAR system; INS technology, INS-GPS integration, measurement of laser range, calibration, flight planning, laser range to xyz coordinates, accuracy of various components of LiDAR, error analysis of data and error removal, raw data of DEM processing, filtering of data uses of return strength/waveform, data classification techniques, LiDAR data integration with spectral data, LiDAR applications; Hyper-spectral Imaging: Hyper spectral concepts, data collection systems, calibration techniques, data processing techniques; preprocessing, N-dimensional scatter-plots, Special angle mapping; Spectral mixture analysis, Spectral Matching, Mixture tuned matched filtering, Classification techniques, airborne and space-borne hyper-spectral sensors, applications; High resolution hyper-spectral satellite systems: Sensors, orbit characteristics, description of satellite systems, data processing aspects, applications	7
UNIT V	**THERMAL, MICROWAVE, EXTRA-TERRESTRIAL REMOTE SENSING:** Thermal radiation Properties, Kinetic Heat & temperature, Radiant Energy and Flux, Thermal Capacity and conductivity, Thermal Inertia of earth"s materials, Military application, UHI; Microwave: Passive & Active Microwave Sensors, Side looking Airborne/ Space borne RADAR, Back scatter coefficient, Phase unwrapping, coherence, Radargrammetry; Lunar mission, Mars mission	7

RECOMMENDED READINGS

1. Iain H. Woodhouse 2005, Introduction to Microwave Remote Sensing, CRC Press
2. Greenhagen, 2011, Thermal Emission Remote Sensing of the Moon: Design and Development of Diviner Lunar Radiometer Compositional Capabilities. , Proquest, Umi Dissertation Publishing
3. S Jin, 2014, Planetary Geodesy and Remote Sensing, CRC Press
4. H.Grahn & Geladi, 2007,Techniques and Applications of Hyperspectral Image Analysis,Wiley-Blackwell

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CWR 509 COMPUTER PROGRAMMING & WEB GIS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASICS OF C LANGUAGE, DECISION & CONTROL VARIABLES:** C Fundaments, Data Types, Variables, Constants; Operators, Expressions, Statements; Decision Making & Branching; Decision Making & Looping.	8
UNIT II	**STRINGS, POINTERS & C WITH USER DEFINED DATA STRUCTURES:** Strings and String Handling; Pointers, Use and Benefits of Pointers; User defined data structures – enumerators, unions & structures, File handling (sequential & random files).	7
UNIT III	**Web GIS & Client/server Computing:** Definition, concept of Web GIS, History of Web GIS, components of web GIS, internet, web GIS v/s Internet GIS, Fundamentals of computer networking – network environment – network communication models –protocols – TCP/IP. Applications of web GIS, users and stake holders of web GIS, advantages and limitations of web GIS, overview of Web GIS. Client – server – glue – client/server system partition– layered architecture – advantages and disadvantages of client server architecture. Distributed component framework – web mapping – static and interactive web mapping – open GIS web map server.	7
UNIT IV	**: Functions of Web GIS & Design of User Graphic Interface:** Display of general information for the public, display of planning information, interactive display of spatial information, sharing and distribution of spatial data as well as management of spatial data. User friendly interface, characteristics, menus and icons, common terms. **Graphic Appearance** - colours, sizes, fonts, scales and arrangement. Brands of software used to develop web GIS at the server and client sides. Evaluation of different brands, ArcIMS, Map Objects, and Map guide, Map Server, Geomediawebmap, Fulcrum, and Vectoreyes.	7
UNIT V	**Web GIS Data & its applications:** Classification of WEB GIS data, Geospatial data, type, characteristics, distribution, GIS interactive maps,- general maps at regional level, very detailed maps down to lot level. Level of Service (LOS) Level of Contents (LOC) Level of GIS Functions or Level of Functions (LOF). A Cross Tabular Matrix (CTM) approach. Participatory GIS -Web-based GIS for Collaborative Planning and Public Participation, Digital Democracy for planning, web GIS an Aid to Local Environmental Decision-making, web GIS for regional and local level planning. Community GIS, Internet GIS Applications in intelligent transportation systems, planning and resource management. E-Governance, Bhoomi project, Bangalore-1, Electronic Government Proposals.	7

REFERENCE BOOKS:

1. E Balaguruswamy , (2009) " Programming in ANSI C " TMH
2. Yashwant Kanetkar , (2008), "Let us C", BPB Publications
3. Korte,G. B., (2001})"The GIS book": 5th Edition, Onward press, Australia.
4. Cartwright, W., M.P. Peterson, G. Gartner (Eds) "Multimedia Cartography", Berlm:Springer.
5. Kraak, M., and A. Brown (2001)" Web Cartography: Development and Prospects, London": Taylor and Francies.

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CWR 515 FUNDAMENTALS OF MATHEMATICS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Review of limits, continuity, and differentiability. Mean value theorem, Taylors Theorem, Maxima and Minima. Riemann intergrals, Fundamental Theorem of Calculus, Improper integrals, applications to area, volume. Convergence of sequence and series, power series.	8
UNIT II	Partial derivatives, gradient and directional derivatives, chain rule, maxima and minima, Lagrange multipliers. Double and Triple integration, Jacobians and change of variables formula. Parametrization of curves and surfaces, Vector Fields, line and surface integrals. Divergence and curl, Theorems of Green, Gauss and Stokes.	7
UNIT III	Linear Algebra: Vectors in R^n and C^n, notions of linear dependence and independence, linear span of a set of vectors, vector subspaces of R^n and C^n, the basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants.	7
UNIT IV	Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product space, the Gram-Schmidt process, orthonormal bases, projections, and the least sqaures approximation. Eigenvalues and eigenvectors, Charecteristic polynomials, the eigenvalue of special matrices (orthogonal, unitary, symmetric, Hermitian, skew-symmetric, normal). Algebraic and geometric multiplicities, diagonalisation by similarity transformations, Spectral theorem for real symmetric matrices and applications to quadratic forms.	7
UNIT V	Differetial Equations- I: Basic concepts, Geometric meaning, Direction fields. 1st order linear equations, homogeneous and non-homogeneous, Solution Method for Nonlinear equations, Separation of variables, Exact Differential equations, integrating factors Bernoulli equation, orthogonal trajectories, Existence Uniqueness: Picards iteration, 2nd order, Linear differential equations: homogeneous equation with constant coefficients, Mass spring system, Existence Uniqueness, Wronskian, non-homogeneous equation, Method of undetermined coefficients, variation of parameters method, Higher Order equations: Wronskian Existence of solution: Solution Methods for constant coefficients, Laplace transform generalities, Shifting theorems, Convolution theorem.	7

REFERENCE BOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th edition, Wiley, 2005.

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2. G. Strang, Linear Algebra and its applications, 4th edition, Thomson, 2006.
3. W.E. Boyce and R.C. Diprima, Elementary Differential Equation, 8th edition, Wiley, 2005.
4. H. Anton, C. Rorres, Elementary linear algebra with applications, 9th edition, Wiley, 2005.
5. T.M Apostol, Calculus, Volume II, 2nd edition, Wiley, 1980.
6. G.B. Thomas and R.L. Finney, calculus and analytic Geometry, 11th edition, Pearson, 2008.
7. T.M. Apostol, Calculus, Volumes 1 and 2, 2nd edition, Wiley, 1980.
8. J. Stewart: Calculus, 5th edition, Thomson, 2003

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CWR 517 NEURAL NETWORKS AND FUZZY LOGIC **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Evolution of neural networks; Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Unsupervised and Reinforcement; Fundamentals of connectionist modeling: McCulloach – Pits model, Perceptron, Adaline, Madaline.	8
UNIT II	Topology of Multilayer perceptron, Back propagation learning algorithm, limitations of Multilayer perceptron. Radial Basis Function networks: Topology, learning algorithm; Kohenen"s self-organising network: Topology, learning algorithm; Bidirectional associative memory Topology, learning algorithm, Applications, ANN in SDGs	7
UNIT III	Recurrent neural networks: Basic concepts, Dynamics, Architecture and training algorithms, Applications; Hopfield network: Topology, learning algorithm, Applications; Industrial and commercial applications of Neural networks: Semiconductor manufacturing processes, Communication, Process monitoring and optimal control, Robotics, Decision fusion and pattern recognition, Deep learning and its applications	7
UNIT IV	Classical and fuzzy sets: Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and maxmin method; Fuzzification: Membership value assignment Inference, rank ordering, angular fuzzy sets. Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy arithmetic; composition and inference; Considerations of fuzzy decision making.	7
UNIT V	Basic structure and operation of Fuzzy logic control systems; Design methodology and stability analysis of fuzzy control systems; Applications of Fuzzy controllers. Applications of fuzzy theory. ANFIS algorithms	7

REFERENCE BOOKS:

1. Limin Fu, "Neural Networks in Computer Intelligence," McGraw Hill, 2003.
2. Fakhreddine O. Karray and Clarence De Silva., "Soft Computing and Intelligent Systems Design, Theory, Tools and Applications," Pearson Education, India, 2009.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," McGraw Hill,1995.
4. B.Yegnanarayana, "Artificial Neural Networks," PHI, India, 2006.

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CWR 519 ARTIFICIAL INTELLIGENCE **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system-Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms, Advances in AI	8
UNIT II	Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic- Structured representation of knowledge.	7
UNIT III	Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	7
UNIT IV	Basic plan generation systems - Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.	7
UNIT V	Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	7

REFERENCE BOOKS:

TEXT BOOKS:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008. (Units- I,II,VI & V)
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Unit-III).

REFERENCES:

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
3. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.
4. http://nptel.ac.in

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CWR 521 GEOINFORMATICS IN SATELLITE METEOROLOGY, AGRICULTURE, SOIL & LAND EVALUATION **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**SOIL MAPPING & GEOINFORMATICS IN AGRICULTURE MANAGEMENT:** Soil, factors of soil formation, soil forming processes(podsolization, laterisation,salinisation and gleying); Physical and chemical characteristics, soil quality, soil problems(salinity, erosion), Soil survey; Factors affecting spectral characteristics of soil, optical, microwave and hyperspectral remote sensing of soil; Soil Classification: zonal, intrazonal and azonal, major soil types and their distribution in India; Spectral characteristics of leaves and crops; Crop identification and acreage estimation, Crop yield parameters, crop condition monitoring & crop production forecasting; Role of Geoinformatics in irrigation management & Agro-Climatic Regional Planning.	8
UNIT II	**LAND COVER AND LAND USE ASSESSMENT & GEOINFORMATICS IN CROP DAMAGE ASSESSMENT:** Concept of land cover and land use, their interrelation and importance; Role of Geoinformatics in land cover and land use study, Land use/land cover matrix; Classification of land cover and land use at different levels; Crop damage assessment due to pests and diseases, water-logging and salinity & drought and flood.	7
UNIT III	**LAND EVALUATION AND ASSESSMENT:** Concept of land and land evaluation, land characteristics, land quality and diagnostic criteria, multiple and compound land utilisation. Principles and methodology for land evaluation; Role of Geoinformatics in soil conservation and management; Land Capability Classification; Command area development and watershed planning for agriculture and soil development.	7
UNIT IV	**FUNDAMENTALS OF METEOROLOGY:** Weather Forecasting; Short, medium and long range weather prediction; Observations and transmission of meteorological information; synoptic charts and its analysis; Synoptic features associated with onset, withdrawal, break active and weak monsoons and prediction.	7
UNIT V	**SATELLITE METEOROLOGY:** Meteorological satellite: TRMM, TIROS, NIMBUS, NOAA, SEASAT, GOES, METEOSAT and INSAT; Satellite based atmospheric temperature, surface radiation, wind and aerosols measurement and analysis; Rainfall Monitoring: Cloud indexing method, Life-history method and Bio-spectral methods, Microwave data for clouds, precipitation and lightening assessment; Interpretation of meteorological Satellite images for weather systems and cyclones.	7

RECOMMENDED READINGS

1. Steven, M.D. and Clark, J.A.:1991, „Application of Remote Sensing in Agriculture", Butterworths.
2. Asrar, G.:1989, „Theory and application of optical remote sensing", John Wiley & Sons, USA.
3. Space Applications Centre(SAC):1990, „Manual of procedure for Forest, Mapping and Damage Detection using satellite data", Report No. IRS-UP/SAC/FMDD/TN/16/90, India.
4. Space Applications Centre(SAC):1990, „Status Report on Crop Acreage and Production Estimation", Report No. RSAM/SAC/CAPE/SR/ 25/90, India.

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CWR 502 GEOINFORMATICS IN ECOLOGY & FORESTRY **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT- 1	**FOREST ECOLOGY:** Forest eco-systems; Biotic and abiotic components; forest community concepts; Ecological succession and climax, primary productivity, nutrient cycling and water relations; Physiology in stress environments (drought, water logging and salinity), Conservation of forest ecosystems, Forest types and its phenology	8
UNIT- II	**FOREST CLASSIFICATION & SURVEYING:** Forest types in India, identification of species, composition and associations; Conventional Survey, different methods of surveying, maps and map reading; Remote sensing based classification of forests, Spectral properties of vegetation, Machine and deep learning methods in forest types mapping, time series analysis for forest health assessment	7
UNIT- III	**FOREST MENSURATION AND REMOTE SENSING:** Sampling methods and sample plots. Yield calculation; yield and stand tables; Forest Applications: Sensor Requirements, forest cover monitoring through remote sensing; Geographic Information Systems for management and modelling, Forest biomass estimation	7
UNIT-IV	**FOREST PROTECTION AND DAMAGE ASSESSMENT:** Role of afforestation and forest regeneration; Human impacts; encroachment, poaching, grazing, shifting cultivation and control; Forest fire detection, Risk assessment and management through RS & GIS; Insect-pests, disease and stress Detection, Forest fire simulation and mapping, Thermal remote sensing	7
UNIT-V	**FOREST CONSERVATION & MANAGEMENT:** Principles of conservation, needs for forest conservation; RS & GIS techniques for forest conservation& management *viz.* Microwave & LiDAR; Working plans-preparation and control, Sustainable development of forest resources	7

RECOMMENDED READINGS

5. Kimmins JP. 2003. Forest Ecology. MacMillan.
6. Adrian Newton. 2007. Forest Ecology and Conservation: A Handbook of Techniques (Techniques in Ecology & Conservation).
7. Steven E. Franklin. 2001. Remote Sensing for Sustainable Forest Management.CRC Press.
8. Köhl, Michael, Magnussen, Steen S., Marchetti, Marco.2006,.Sampling Methods, Remote Sensing and GIS Multiresource Forest Inventory,XIX, 373 p.

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CWR 504 SPATIAL MODELING & ANALYSIS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT- 1	Definition, Introductory concepts (data, information, database, DBMS, meta data), Components of DBMS (Data, Hardware, Software, Users/ Clients) and Advantages of DBMS, GIS and Remote Sensing data, data conversion, reduction and enlargement, Recent trends in DBMS	8
UNIT-II	Types of Model in DBMS (Relational, Hierarchical, Network, Object oriented), DBMS Architecture, DBMS Function, People around DBs/ DBMSs, Database Administrator, instances, schema, DDL, DML.Types & Classification of attribute data (Nominal, Ordinal, Ratio and Interval), Advances in data modelling, interoperable data models	7
UNIT-III	Real (and Virtual) World Models, raster and vector model, Active-Database Technology, Various Semantics in Modeling, Tessellations, TIN, Quad Tree concepts, Spatial data accuracy and standards, use of SQL in geodatabase, Advanced data mining techniques	7
UNIT-IV	Field based & Object based data (OGIS) models, Conceptual Data base model: The ERD Model, Intersection Model, Spaghetti model, Positional accuracy, Attribute accuracy, Data Normalization in GIS, Interoperability in GIS	7
UNIT-V	Spatial Modelling, overlay analysis, raster overlay tools, reclassification, Spatial Interpolation methods, Trend surface analysis, AHP, Fuzzy AHP, ANN, Decision Support System, decision tree and random forest, classification and regression tree (CART)	7

RECOMMENDED READINGS

1. S. Shekhar & S. Chawla, 2002 Spatial Databases: A Tour, Prentice Hall;
2. P. Rigaux, M. Scholl, & A. Voisard 2001, Spatial Databases: With Application to GIS, Morgan Kaufmann; 2nd ed.
3. Andrienko & Andrienko,2005,Exploratory Analysis of Spatial and Temporal Data: Systematic Approach, Springer.
4. Bonham Carter G.F (1994) GIS for Geoscientists: Modeling with GIS Pergamon Publications.
5. Samet, H. 1990, The Design and Analysis of Spatial Data Structures, Addison–Wesley.
   A. Silberschats, Henry F. Korth "Database System Concepts", 3rd Edition, TMH, 1998
6. Goodchild, M.F. (1978) - Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley and Reading Press.
7. U.K. Gupta 2012, An Analysis on Spatial Database: Volume 1, CreateSpace Independent Publishing Platform
8. J. Friedrich, 2004, Spatial Modeling in Natural Sciences and Engineering: Software Development and Implementation, Springer
9. V. Lakshmanan, 2012, Automating the Analysis of Spatial Grids: A Practical Guide to Data Mining Geospatial Images for Human & Environmental Applications (Geotechnologies and the Environment), Springe

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CWR 506 DIGITAL IMAGE PROCESSING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**INTRODUCTION:** Concepts about digital image and its characteristics; Spectral, Spatial, Radiometric and Temporal resolution; Visual vs. Digital methods, Image data storage and retrieval, raster data compression, raster data conversion	8
UNIT II	**BASIC PRINCIPLES:** System design considerations; Sources of image degradation - Image restoration and Noise Abatement, Radiometric and Geometric correction technique; Interpolation methods – linear and nonlinear transformation for geometric corrections, post-processing of images, Sun-angle correction	7
UNIT III	**IMAGE ENHANCEMENT:** Look-up Tables (LUT) and Types of images displays and FCC; Radiometric enhancement techniques, Spatial enhancement techniques; Contrast stretching: Linear and non-linear methods; Band ratio, Types of Vegetation indices; Principal Component Analysis, Multi dated data analysis and Change detection, Fourier transformation, FFT	7
UNIT IV	**FILTERING TECHNIQUES:** Low Pass Filtering: Image smoothing; High Pass Filtering: Edge enhancement and Edge detection; Gradient filters, Directional and non-directional filtering, band rationing	7
UNIT V	**PATTERN RECOGNITION:** Concept of Pattern Recognition, Multi-spectral pattern recognition; Spectral discrimination, Signature bank, Parametric and Non-Parametric classifiers; Unsupervised classification methods; Supervised classification techniques, Limitations of standard classifiers, Advanced classification methods, AI/ML, deep learning	7

REFERENCE BOOKS

- Sabins, Floyd F. (2007), Remote Sensing: Principles and Interpretation, H. Freeman and C., New York.
- Thomas M. Lillesand & Kiefer, Ralph W. (2007), Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
- Jensen, JR. (2006), Remote Sensing of the Environment – An Earth Resources Perspective, Prentice Hall Inc.
- Rencz, Andrew N. , (1999), Remote Sensing for the Earth Sciences: Manual of Remote Sensing, 3rd ed., John Wiley & Sons, Inc., New York.
- Curran, P., (1985), Principles of Remote Sensing, Longman, London.
- Campbell, James B., (2006), Introductory Remote Sensing: Principles and Concepts, Routledge.
- Gibson, P.J., (2000), Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London.
- Cracknell, A.P. & Hayes, L.W B., (2007), Introduction to Remote Sensing, Taylor & Francis, London.

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CWR 508 STATISTICS FOR GEOINFORMATICS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**ELEMENTARY STATISTICS:** Geographic Data: Sources, data types, organization of data, Scale of Measurements; Organization of data: Review of frequency distribution. Presentation of Data: Tables, Diagrams (Bar, Pie, histogram, polygon and frequency curve) and time series graph; Descriptive Statistics: Measure of central tendency, measure of location, dispersion, skewness and kurtosis. Moments and Central moments; Matrix theory: Types, Addition, Subtraction, Multiplication and Inverse.	8
UNIT II	**PROBABILITY, PROBABILITY DISTRIBUTION AND RANDOM VARIABLE:** Concept of Probability, Addition, Multiplication and Independence law. Probability distribution, Discrete and Continuous probability distribution. Binomial, Poisson and Normal distribution with Application; Random variable, its types and characteristics.	7
UNIT III	**CORRELATION, REGRESSION AND SAMPLING:** Correlation: Simple Correlation, Rank Correlation and partial correlation; Curve Fitting: Simple linear regression analysis by method of least square, multiple regression with application on spatial data; Sampling: Concept of sample, population, parameter and statistics. Brief review of sampling technique, its type and applications.	7
UNIT IV	**STATISTICAL INFEREENCE & QUANTIFICATION OF SPATIAL CONTINUITY:** Statistical Hypothesis, One sided and two sided test, General procedure of hypothesis testing; Testing of population means for large and small samples (One sample and two samples); F-test and Chi-Square goodness of fit test; Spatial Continuity analysis, spatial co-variability, calculation of spatial variogram; Introduction to kriging, simple kriging and its Application.	7
UNIT V	**ANALYSIS OF VARIANCE & MULTIVARIATE STATISTICS:** Analysis of variance: One way and two way analysis of variance test; Introduction to non-linear Regression. Simulation of data and Model validation; Introduction to multivariate techniques, Mean vector, variance and covariance matrix; Correlation matrix, testing of population mean vector; Principle component analysis.	7

REFERENCE BOOK

- Arora, P. N., Arora, Sumeet and Arora, S. Comprehensive Statistical Methods. S. Chand Pub.
- Sharma, D.D. (2002). Geostatistics with application in earth science, Capital Pub.
- Chiles, J.P., (1999). Geo-statistics: Modeling spatial uncertainty, Wiley Interscience Pub.
- Gupta, S.C. and Kapoor, V. K. (2004). Fundamentals of Mathematical Statistics. Sultan Chand Pub.
- Gupta, C. B. and Gupta, Vijay. Introduction to Statistical Methods, 23rd revised edition. Vikas Pub.

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CWR 510 GEOINFORMATICS IN DISASTER MANAGEMENT (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**INTRODUCTION & DISASTER MANAGEMENT:** Fundamental concepts of hazards and disasters, their types, and characterization; Zonation of hazards, natural and human induced disasters; Disaster and National losses, historical perspective of disasters in India; Fundamental concept of Disaster Management; Government, NGOs and people's participation disaster management; Existing organization structure for managing disasters in India; Geoinformatics in disaster mitigation, Role of NDRF	8
UNIT II	**GEOLOGICAL HAZARDS:** Landslide, Earthquake; Mining hazards (Land subsidence, Mine flooding etc.); Volcanic hazards, Groundwater hazards, Glacial hazards, Role of machine and deep leaning in disaster management and planning, Susceptibility mapping using ensemble machine learning methods	7
UNIT III	**HYDRO METEOROLOGICAL HAZARDS:** Flash floods, River floods; Dam burst, Cloud burst; Cyclones, Coastal hazards and Drought, Role of SAR images in flood mapping and monitoring	7
UNIT IV	**ENVIRONMENTAL HAZARDS:** Forest hazards (Deforestation, Degradation and Forest fire); Land & soil degradation, Desertification; Pollution (Water, air and soil), forest fire simulation and modeling	7
UNIT V	**GEOINFORMATICS APPLICATIONS & FEW CASE STUDIES:** Geoinformatics models in managing forest fires, floods, landslides, cyclone and earthquake, multiple hazard mapping; Earthquakes in India; Floods in Indo Gangetic plains; Landslides in Himalayan region; Drought in Indian plateau regions.	7

REFERENCE BOOKS

- P.S. Roy (2000). Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS).
- Sdidmore A (2002) Environmental Modeling with GIS & Remote Sensing, Taylor & Francis.
- Anji Reddy. M. (2004) Geoinformatics for environmental Management. B. S. Publication.

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CWR 514 GEOINFORMATICS IN URBAN AND REGIONAL PLANNING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**URBANIZATION AND URBAN GROWTH:** Concept of urbanisation and impacts, Urbanization pattern in India; Urban growth: stages & models; Urban problems: housing, slums, traffic, pollution, health, environment; Geoinformatics in urban and regional planning, GRC and its concepts, types of sensors and its applications	8
UNIT II	**URBAN PLANNING:** Planning: urban and regional, Master Plan and development plan; Planning laws and bylaws, zoning; Urban utility/ services planning, Urban green space; Urban development in India,	7
UNIT III	**URBAN MAPPING:** Urban area interpretation, Urban land use/ land cover; Space use mapping, traffic and parking survey; Slum, renovation & rehabilitation; High resolution and hyperspectral imaging for urban/ regional mapping, Advanced methods for image processing for urban area mapping, Role of Optical and SAR images in slum mapping, AI/ML in urban planning	7
UNIT IV	**URBAN ANALYSIS:** Urban growth and sprawl: monitoring & Management, Shannon entropy; Density Analysis, Urban heat island; Urban Analysis and Modelling with GIS, Markov chain and CA methods, Urban growth simulation using ensemble machine learning methods	7
UNIT V	**URBAN MODELLING AND MANAGEMENT:** Urban feature extraction, SAVI, NDBI; Site suitability built-up development; Urban risk assessment, geospatial modelling; Transportation Network Analysis, Building information Management; Decision Support System for urban and regional management, Role of Geoinformatics in traffic management	7

RECOMMENDED READINGS

- Ramachandran, 1999. Urbanization and Urban systems in India, Oxford Publications: New Delhi
- Rangwala, 2008. Urban Planning,
- Xiaojun Yang, 2011. Urban remote sensing: monitoring, synthesis and modeling in the urban environment
- Verma, LN, 2008. Urban Geography, Rawat Publications
- TarekRashed and CarstenJ rgens, 2010, Remote sensing of urban and suburban areas
- Brench M.C., (1972), City Planning and Aerial Information, Harvard University, Cambridge,
- Weng, Qihao and Quattrochi, Dale A, 2013, Urban remote sensing, CRC press
- Maik Netzband, William Stefanov, Charles Redman, 2007, Applied remote sensing for urban planning, governance and sustainability. New York: Springer
- Khats & Khatsu 2011, Urban Multi-Hazard Risk Analysis Using GIS and Remote Sensing, Lambert Academic Publishing
- Oluleye, Ufuah, Rilwani 2011, Urban Growth Dynamics of Zaria Using Geoinformatic Techniques, Lambert Academic Publishing
- Gallion, 2005. The Urban Pattern: City Planning and Design, Gallion Pub.
- J. Sen , 2012, Sustainable Urban Planning, The Energy and Resources Institute, TERI

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CWR 516 GEOINFORMATICS IN HYDROLOGY & WATER RESOURCES (L, T, P) = 3 (3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASIC CONCEPTS:** Hydrologic cycle, hydrological parameters; Groundwater flows hydraulics, Darcy law; Base Flows, Loosing and gaining stream; Water table and Water Level, Vertical Profile of Ground Water, Sustainable water harvesting	8
UNIT II	**AQUIFERS:** Type of aquifers, quality constraint; Geological formations as aquifers; Groundwater mining and aquifer stress; Ground water budgeting; Ground water models, Use of RS and GIS in ground water potential zonation mapping	7
UNIT III	**WATERSHED MANAGEMENT:** Watershed and its characteristics, delineation and codification; Drainage Morphometric Analysis; Watershed problems and management, Water logging issues; Geoinformatics in watershed prioritization; Water balance, Water budgeting, interlinking of rivers and basin management; Methods of Water harvesting, Rainwater harvesting, artificial ground water recharge	7
UNIT IV	**REMOTE SENSING IN SURFACE-SUBSURFACE WATER EXPLORATION:** hydro geomorphological mapping for ground water exploration; Geophysical Methods for Groundwater Exploration; Water pollution, Water quality parameters, monitoring, DRASTIC model; Arsenic and Fluoride contamination and impacts; Impact of climate change on water resources, Advanced methods for ground water mapping, soil salinity and water logging	7
UNIT V	**GEOINFORMATICS BASED OPERATIONAL APPLICATIONS:** Flood Inundation Mapping and Modelling; Snow Cover Mapping, Snowmelt Runoff Modelling; Reservoir Sedimentation Assessment; Runoff & Hydrological Modelling; Hydrological Drought Assessment; Hydrological Software: Mudflow, Mike SHE, SWAT etc, HEC-RAS model and its applications	7

RECOMMENDED READINGS

- Schultz, G. A. and Engman, E. T. , (2000), Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, Germany.
- Murthy, J. V. S. (1994). Watershed Management in India. Wiley Eastern Ltd., New Delhi.
- Todd David Keith., (2005), Groundwater Hydrology, John Wiley & Sons, New York, Second Edition.

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CWR 518 GEOINFORMATICS IN DESERTS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Definition and distribution of deserts – causes of aridity – Global distribution of deserts – Genesis and evolution of deserts – Topographic survey of desert surfaces – weathering processes and forms (Exfoliation, Frost weathering, wet – dry weathering, salt weathering, weathering of sandstone).	8
UNIT II	Definition – sources of sand – actions of wind – wind erosion and landforms (wind carved rocks, bowels and caves, Desert parameters deflation basins blow out etc.,) Landforms of wind transport – Land forms of wind deposition (different types of dunes Loess deposits) – Palaeo Aeolian deposits.	7
UNIT III	Mountain – Plain evolution: general model slope retreat hypothesis (parallel retreat, down wearing retreat, drainage basin, mantle controlled plantation, etc - hypothesis) – Cold deserts (Processes)	7
UNIT IV	Precipitation – Run off – Stream erosion landforms – Piedmonts – debris covered slopes – Debris fans, Wash Controlled slopes – Ephemeral Streams – Channel geometrics in desert – Perennial rivers – Palaeo fluvial landforms and buried rivers – Alluvial fans – Mudflows – Playa lakes	7
UNIT V	Mechanisms of Soil Conservation – Dune stabilization – Water conservation and management.	7

RECOMMENDED READINGS

1. Sen, A.K. and Amal Kar, Desertification and its control in the Thar, Sahara & Sahel Regions, Scientific Publishers, Jodhpur, India, 1993.
2. Ron Cooke, Andrew Warren and Andrew Goudie, Desert Geomorphology, UCL Press Limited, London, England, 1993.
3. Thornbury, W.D. Principles of Geomorphology, John Wiley & Sons, New York, Second Edition, 1985.
4. Bloom, A.L. Geomorphology – A systematic analysis of Late Cenozoic landforms. Prentice-Hall, New Delhi.
5. Arthur Holmes and Doris L. Holmes Principles of Physical Geology, ELBS, English Language Book Society / Van Nostrand Reinhold (UK) Co. Ltd, Third Edition, 1978.
6. Doehring, Geomorphology in Arid Regions, Allen and Unwin, London. 1980.
7. Rice R.J. Fundamentals of Geomorphology, E.L.B.S, Longman, 1988.
8. Keller E.A., Environmental Geology, CBS Publishers, 1985. 9. Drury, S.A, A guide to Remote Sensing Interpreting Images of Earth, Oxford Science Publications, Oxford. 1990

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CWR 520 GEOINFORMATICS IN EARTHQUAKES **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Fundamentals of Neo – Seism tectonics: Strain Accumulation – Elastic Rebound and Faulting – Energy Release and Seismic waves – Physical parameters of Earthquake source – Magnitude –Seismic moment and Fault plane solution - Geological and Seismological input for Seismic evaluation on magnitude – Frequency relations.	8
UNIT II	Remote Sensing Inputs in Neo-Seism tectonics: Anomaly Mapping using raw and Digitally Enhanced Aerial & Satellite Remote Sensing data, Shaded Relief Maps and FCC wrapped DEM – Lineament Anomalies - Disharmonies in Structural Trend Lines and Fold Styles - Geomorphic anomalies (Tectonic, Denudational, Fluvial, and Coastal & Aeolian).	7
UNIT III	Geophysical Inputs in Neo-Seism tectonics Identification of Resistivity, Seismic, and Gravity & Geomagnetic anomalies – Three Dimensional Modelling of Subsurface Geological Structures using GIS - Ground water anomalies – Historic seismic data analysis – Generation of GIS Database.	7
UNIT IV	Seismic Hazard Mapping and Risk Assessment through seismic data analysis: Intensity and earthquake strong motion – seismic hazard analysis and estimation of design ground motions – seismic hazard mapping – seismic zonation and response – design codes – protective and reducing measures for infrastructures and structures – regulation of landuse.	7
UNIT V	Geoinformatics in Seismic hazard mapping and risk assessment: GIS Integration of Remote sensing derived inputs, Geophysical Inputs, Groundwater Anomalies and Historic data and Vulnerability analysis (Hazard Zonation Mapping) and Risk Assessment. Case Studies.	7

RECOMMENDED READINGS

1. Bell, F.G. Geological Hazards: Their Assessment, Avoidance and Mitigation. E and FN SPON, Routledge, London, 1999.
2. David Alxander, National Disasters. UCL Press, London. Research Press, New Delhi, 1993.
3. Moores, E.M. and Twiss, R.J., Tectonics. W.H.Freeman and Company, New York, 1995.
4. Nick Carter, W. Disaster Management – A Disaster Manager"s Handbook. Asian Development Bank, Philippines, 1991.
5. Penelis, G. G and Kappos, A.J. Earthquake-resistant Concrete Structures, E and FN SPON, London, 1997.
6. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers, Jaipur
7. Avasthy R.K., Bhoop Singh, Sivakumar R. Landslides: A Perception and Initiatives of DST. Indian Society of Engineering Geology. 2006.
8. Gupta P.N, Roy, A.K. Mountain Resource Management and Remote Sensing. Surya Publications, Dehradun. 1991.
9. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi, 2000

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CWR 522 GEOINFORMATICS IN MINERAL EXPLORATION (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Introduction: Ore genesis in relation to mineral exploration – Controls of mineralization (physiographic, mineralogical, structural controls) – Guides to ore deposits (physiographic, mineralogical, stratigraphic, lithological and structural guides).	8
UNIT II	Geological techniques and procedures of exploration - study of outcrops – sampling of on spot and lab analysis of samples – panning of soils and their interpretation - trenching – pitting – exploratory drills – Geological logging of bore hole samples – calculation of average grades – documentation of exploration.	7
UNIT III	Remote Sensing based mineral targeting: Mapping of Lithologically, Structurally and Geomorphologically Controlled Mineral Deposits Using Raw and Digitally Enhanced Data – Optimisation of Spectral Bands and Enhancement Techniques for mineral targeting– Thermal and Microwave Remote Sensing for Mineral Exploration – Imaging Spectometry.	7
UNIT IV	GIS based mineral targeting: GIS based visualization of geophysical data (resistivity, gravity, magnetic, seismic, radiometric, aero geophysical and geochemical data) for Mineral exploration.	7
UNIT V	Geostatistical Modeling: GIS Integration of Multi Thematic Data for Mineral Exploration – Prognostic Modelling of Target areas for Mineral Exploration.	7

RECOMMENDED READINGS

1. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church, Virginia. 1983.
2. Gary L.Prost Remote Sensing for Geologists - A Guide to Image interpretation, Gordon and Breach Science Publishers, The Netherlands. 1997.
3. Bateman, A. Economic Mineral Deposits, John Wiley.
4. Krishnasamy S., Indian"s Mineral Resources, Oxford IBH, 1980.
5. Sinha R.K., A Treatises on industrial Minerals of India - Allied Publishers.
6. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers,Jaipur
7. Alexey F. Bunlcin and Konstantin I-Voliak, Lasser Remote Sensing of the Ocean Methods and Applications – Wiley Series, John Wiley & Sons. inc. New York, pp.244.
8. Lavorsen, A.I. Geology of Petroleum, Second Edition, CBS Publishers and Distributors, New Delhi, p.724, 1985.
9. Rao, D.P. Remote Sensing for Earth Resources, Second Edition, Association of Exploration Geophysicist, Hyderabad p.212, (CERS-236), 1999.
10. Amurskii G.I., Abramenok, G.A., Bondarieva M.S. and Solov"ev, N.N., Remote Sensing Methods in Studying Tectonic Fractures in Oil and Gas bearing formations, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, p.138,1991.
11. Alistarir R. Brown, Interpretation of Three Dimensional Seismic Data, American Association of Petroleum Geologists, USA, p.194, 1986.
12. Kearey P. and M. Brooks, An introduction to Geophysical Exploration, English Language Book Society / Blackwell Scientific Publications, p. 296 (CERS 51). 1989.

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CWR 524 GEOINFORMATICS FOR ENVIRONMENTAL MONITORING (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**FUNDAMENTAL CONCEPTS:** Environment: components and controlling factors; Environment Impact Assessment (EIA); Legal Issues, Environmental Protection Acts, Green tribunal.	8
UNIT II	**AIR POLLUTION:** Air quality parameters and standards; Air pollution sources monitoring and control mechanisms; Geoinformatics for Air quality monitoring, Satellite sensors; Aerosol monitoring, Ozone monitoring.	7
UNIT III	**WATER POLLUTION:** Water quality parameters and standards; Water pollution: sources, measurement, monitoring and control mechanisms; Remote Sensing and Water quality management.	7
UNIT IV	**URBAN ENVIRONMENT:** Urban areas: problems, waste disposal and management; Industrial pollution: sources, monitoring and control; Remote Sensing and Urban environment management.	7
UNIT V	**MARINE ENVIRONMENT:** Ocean surface temperature and Chlorophyll detection; Marine pollution: sources and mitigation measures; Sensors (Thermal and Microwave) for marine environment monitoring and assessment.	7

RECOMMENDED READINGS

- Joseph Awange (Author), John B. Kyalo Kiema , 2013, Environmental Geoinformatics: Monitoring and Management (Environmental Science and Engineering / Environmental Science), Springer
- M. Anji Reddy, 2013, Environmental Impact Assessment: Theory and Practice, BS Publications
- Baretl, E.C. and Culis I.F. Introduction to Environmental Remote Sensing, second edition, Chapman and Hall, New York, 1993.
- Lintz, J. and Simonent, D.S. Remote Sensing of environment Addision Wesley, Rading mars, 1976.

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CWR 523 RESEARCH METHODOLOGY & PROJECT FORMULATION **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Identification of problems of regional and Local level; geographic data sources and natures of data to be used; Hypotheses and Models; Formulation of research schemes.	8
UNIT II	Preparation of field reports; Spatial data, classification and sampling problems; Need for sampling, types of sampling, sample size, sampling area.	7
UNIT III	Project Definition, Importance of Projects and Project Management; Project Management context. Basics of project management; Project formulation, Time management; Budget estimates, Cost-benefit calculation techniques; Project bidding, Project plan; Task Definition, Project Resource; Scheduling, line Management, Project Team.	7
UNIT IV	Project Administrator, Classification of Projects; Product Management, Problems and opportunities in Projects; Project Communications and Presentation; Project Management Software, Project Administration.	7
UNIT V	Evolution, Revolution; Termination of Project; Project Change; End of Projects, Project report preparation.	7

REFERENCE BOOKS:

- W.E. Huxold & A.G. Lerinsons Aronoft.S.,(1995) Managing Geographic Information Projects.
- Earickson, R,. and Harlin, J., (1994) Geographic Measurement & Quantitative Analysis
- Macmillan, N.York
- Bennet P. Lientz & Kathryn P., (2001) Project Management for the 21st Century Academic Press, California

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CWR 333 GEOINFORMATICS IN DESERTS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Definition and distribution of deserts – causes of aridity – Global distribution of deserts – Genesis and evolution of deserts – Topographic survey of desert surfaces – weathering processes and forms (Exfoliation, Frost weathering, wet – dry weathering, salt weathering, weathering of sandstone).	8
UNIT II	Definition – sources of sand – actions of wind – wind erosion and landforms (wind carved rocks, bowels and caves, Desert parameters deflation basins blow out etc.,) Landforms of wind transport – Land forms of wind deposition (different types of dunes Loess deposits) – Palaeo Aeolian deposits.	7
UNIT III	Mountain – Plain evolution: general model slope retreat hypothesis (parallel retreat, down wearing retreat, drainage basin, mantle controlled plantation, etc - hypothesis) – Cold deserts (Processes)	7
UNIT IV	Precipitation – Run off – Stream erosion landforms – Piedmonts – debris covered slopes – Debris fans, Wash Controlled slopes – Ephemeral Streams – Channel geometrics in desert – Perennial rivers – Palaeo fluvial landforms and buried rivers – Alluvial fans – Mudflows – Playa lakes	7
UNIT V	Mechanisms of Soil Conservation – Dune stabilization – Water conservation and management.	7

RECOMMENDED READINGS

1. Sen, A.K. and Amal Kar, Desertification and its control in the Thar, Sahara & Sahel Regions, Scientific Publishers, Jodhpur, India, 1993.

2. Ron Cooke, Andrew Warren and Andrew Goudie, Desert Geomorphology, UCL Press Limited, London, England, 1993.

3. Thornbury, W.D. Principles of Geomorphology, John Wiley & Sons, New York, Second Edition, 1985.

4. Bloom, A.L. Geomorphology – A systematic analysis of Late Cenozoic landforms. Prentice-Hall, New Delhi.

5. Arthur Holmes and Doris L. Holmes Principles of Physical Geology, ELBS, English Language Book Society / Van Nostrand Reinhold (UK) Co. Ltd, Third Edition, 1978.

6. Doehring, Geomorphology in Arid Regions, Allen and Unwin, London. 1980.

7. Rice R.J. Fundamentals of Geomorphology, E.L.B.S, Longman, 1988.

8. Keller E.A., Environmental Geology, CBS Publishers, 1985. 9. Drury, S.A, A guide to Remote Sensing Interpreting Images of Earth, Oxford Science Publications, Oxford. 1990

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CWR 335 GEOINFORMATICS IN REGIONAL AND URBAN PLANNING (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Planning Concepts and definitions, Role of remote sensing and GIS in regional planning, Urban and regional mapping, Base map preparation, regional, city, intra–city, Scale and Resolution concepts, GRC and its concepts, types of sensors and its applications	8
UNIT II	Techniques of visual and digital image interpretation, Important elements of image interpretation in Human Settlement Analysis, Recognition and detection of objects, preparation of land use maps, Digital image processing techniques in preparation of land use and urban land use maps, Preparation of base map, Advanced methods for image processing	7
UNIT III	Creation of data base for urban planning; Updating of urban land use maps; Classification of residential areas, estimation of population concentrations, urban growth monitoring, and urban change detection; Route location and site planning, Urban development planning; Location of amenities facility, Slum identification and improvement, Role of Optical and SAR images in slum mapping, AI/ML in urban planning	7
UNIT IV	Urban and regional plans formulation, regional plan. Master plan, detailed development plan- Methodologies and stages, Case studies, coastal and wasteland development plans. Traffic And Parking Survey Methods of population estimation Assessment of urban environment quality, Role of Geoinformatics in traffic management	7
UNIT V	Urban Analysis, Urban Growth, Trend Analysis, Change Detection, Housing Typology and Density Analysis, Population Estimation, Environmental Quality Rating- Transportation Network Analysis- Case Studies. Urban analysis and modeling with GIS, Markov chain and CA methods, Decision support system for urban and regional management, Urban growth simulation using ensemble machine learning methods	7

REFERENCE BOOKS

1. Brench M.C., (1972), City Planning and Aerial Information, Harvard University, Cambridge,
2. Gautam, N.C.: *Urban Landuse Study through Aerial Photo Interpretation Techniques*, Pink Publishing House, Mathura, 1970
3. Nag, Prithvish: Thematic Cartography and Remote Sensing, Concept, New Delhi, 1992
4. Richardson, B.F(ed): Introduction to Remote Sensing of the Environment, Kendall/Hunt, Dubuque, Iowa, 1978
5. Sundaram, K.V.: Urban and Regional Planning in India, Concept, New Delhi, 1977
6. Taylor, John,L.: Urban Planning Practice in Developing Countries, Pergamon Press, Williams, David C 1981.

Shruti

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CWR 337 GEOINFORMATICS IN DISASTER MANAGEMENT (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT- 1	Fundamental concepts of hazards, risk, vulnerability and capacity, Disaster: types and characterization, Zonation of hazards, Disasters in context of climate change, Disaster and National losses, historical perspective of disasters in India, Role of NDRF	8
UNIT- II	Fundamental concept, Disaster management cycle, Existing organizational structure for managing disasters in India, Disaster management act, policy and guidelines, Geoinformatics in hazard prediction and disaster management, Role of machine and deep leaning in disaster management and planning	7
UNIT- III	Earthquake, Landslide, Glacial hazards, Volcanic hazards, Mining hazards: land subsidence, mine flooding, coal mine fire, Susceptibility mapping using ensemble machine learning methods	7
UNIT-IV	Flash floods, river floods, urban floods, Coastal hazards, Cyclones, tsunami, sea level rise, Drought, Lightening hazards, Role of SAR images in flood mapping and monitoring	7
UNIT-V	Forest hazards: deforestation, degradation and forest fire, Land & soil degradation, Desertification, Pollution: water, air, soil, solid waste dumping and oil spills, Early warning system: forest fires, floods, landslides, cyclone and earthquake, Multiple hazard mapping, forest fire simulation and modeling	7

RECOMMENDED READINGS

Text/Reference books:

1. P.S. Roy (2000). Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS).
2. Sdidmore A (2002) Environmental Modeling with GIS & Remote Sensing, Taylor & Francis.
3. Anji Reddy. M. (2004) Geoinformatics for environmental Management. B. S. Publication.
4. Alexander David, Introduction in 'Confronting Catastrophe', Oxford University Press, 2000
5. Andharia J. Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social Sciences Working Paper no. 8, 2008.

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CWR 339 GEOINFORMATICS IN ECOLOGY & FORESTRY **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Forest eco-systems; Biotic and abiotic components; forest community concepts, Ecological succession and climax, primary productivity, nutrient cycling and water relations, Physiology in stress environments (drought, water logging and salinity), Conservation of forest ecosystems, Forest types and its phenology	8
UNIT II	Forest types in India, identification of species, composition and associations; Conventional Survey, different methods of surveying, maps and map reading, Remote sensing-based classification of forests, Spectral properties of vegetation, Machine and deep learning methods in forest types mapping, time series analysis for forest health assessment	7
UNIT III	Sampling methods and sample plots. Yield calculation; yield and stand tables, Forest Applications: Sensor Requirements, forest cover monitoring through remote sensing; Geographic Information Systems for management and modelling, Forest biomass estimation	7
UNIT IV	General forest protection against fire, Fire Identification and Control through RS & GIS, Role of afforestation and forest regeneration. Human impacts; encroachment, poaching, grazing, shifting cultivation and control, Forest fire simulation and mapping, Thermal remote sensing	7
UNIT V	Injuries to forest – abiotic and biotic, insect-pests and disease, Disease and Stress Detection, Susceptibility of forests to damage, nature of damage, cause, prevention, protective measures and role of RS & GIS in benefits. Principles of conservation, needs for forest conservation, RS & GIS techniques for forest conservation & management, Working plans-preparation and control, Sustainable development of forest resources	7

Text books

1. Kimmins JP. 2003. Forest Ecology. MacMillan.
2. Adrian Newton. 2007. Forest Ecology and Conservation: A Handbook ofTechniques (Techniques in Ecology & Conservation).
3. Steven E. Franklin. 2001. Remote Sensing for Sustainable Forest Management.CRC Press.
4. Köhl, Michael, Magnussen, Steen S., Marchetti, Marco.2006,.Sampling Methods, Remote Sensing and GIS Multiresource Forest Inventory, XIX, 373 p.

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CWR 341 GEOINFORMATICS FOR COASTAL ZONE MANAGEMENT (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Definitions and Scope, Coastal Zone Processes – Waves, Tides and Currents, Coastal Classification, Coastal Landforms, Morphology of Indian coasts, Coral reefs, River Deltas: Types of Delta's and Dynamics	8
UNIT II	Mangrove swamps, marshes, lagoons, tidal channels/creeks, Continental margins – forms and processes, Sea level changes – factors involved and effects of sea level rise	7
UNIT III	Storm surges and Tsunamis - Origin and impacts, Satellite sensors for coastal hazard studies, Coastal hazards risk management	7
UNIT IV	Deforestation, Agriculture, Aquaculture, Pollution, Offshore Mining, Oil Spills, Waste dumping, Coastal aquifers; Freshwater-Seawater interface, Satellite based observation: Bathymetric studies, Sea Surface Temperature, Ocean Color Monitoring	7
UNIT V	Landuse pattern, Coastal vegetation, Shelter belts, Management Issues, Sea level rise and Shore line erosion, Geospatial Information Systems for Coastal Zone Management	7

RECOMMENDED READINGS

1. Geomorphology by A.L. Bloom, Waveland Pr.Inc. 2004
2. Deltas, Coleman, J.M., Continuing education Publication Co.Inc. 1976
3. Coastal Sedimentary Environments, Davis, A.R. (Jr.), Springer-Verlag, 1985.
4. Beaches and Coasts, King, C.A.M., Edward Arnold, 1972
5. Introduction to Marine Geology and Geomorphology, King, C.A.M., Edward Arnold, 1974
6. Applications in Coastal Zone Research Management, Martin, K.St. (ed), U.N. Institute for Training and Research, 1993.

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Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme

To commence from the Academic year: 2021-2022

Centre: Centre for Climate Change and Water Research **Year: I**

Program: M.Tech. Geoinformatics **Semester-I**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
		University Core							
1	PC 501	Proficiency and Co- Curriculum activity -I	2	0	0	0		100	
2	EM 501	Employability Skills	1	0	2	0	3	40	60
		Program Core							
3	CWR 501	Principles of Remote Sensing & Photogrammetry	3	3	0	0	3	40	60
4	CWR 503	Geographic Information System	3	3	0	0	3	40	60
5	CWR 505	Cartography & Global Positioning System	3	3	0	0	3	40	60
6	CWR 507	Geoscience and Advanced Remote Sensing	3	3	0	0	3	40	60
7	CWR 509	Computer programming & Web GIS.	3	3	0	0	3	40	60
8	CWR 511	Minor Project -I	3	0	0	3	-	60	40
9	CWR 513	Seminar-1	1		2			60	40
10	CWR 551	Principles of Remote Sensing & Photogrammetry Lab	1	0	0	2	3	60	40
11	CWR 553	Geographic Information System Lab	1	0	0	2	3	60	40
12	CWR 555	Cartography & Global Positioning System Lab	1	0	0	2	3	60	40
13	CWR 557	Geoscience, Image interpretation & Advanced Remote Sensing Lab	1	0	0	2	3	60	40
		Program Elective (Any One)							
14	CWR 515	Fundamentals of Mathematics	3	3	0	0	3	40	60
15	CWR 517	Neural Networks and Fuzzy Logic	3	3	0	0	3	40	60
16	CWR 519	Artificial Intelligence	3	3	0	0	3	40	60
17	CWR 521	Geoinformatics in Satellite meteorology, agriculture, soil & land evaluation	3	3	0	0	3	40	60
18	CWR 559	Geoinformatics in Satellite meteorology, agriculture, soil & land -evaluation Lab	1	0	0	2	2	60	40
		Total	**30**	**18**	**2**	**8**			
		Grand Total	**30**						

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BoS_____

Signature of Member Secretary

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Teaching and Examination Scheme
To commence from the Academic year: 2021-2022

Centre: Centre for Climate Change and Water Research **Year: I**
Program: M.Tech. Geoinformatics **Semester-II**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
		University Core							
1	EM 502	Employability Skills	1		2		3	40	60
2	PC 502	Proficiency and Co-Curriculum Activities-II	2	0	0	0	-	100	
		Program Core							
3	CWR 502	Geoinformatics in Ecology & Forestry	3	3	0	0	3	40	60
4	CWR 504	Spatial Modeling & Analysis	3	3	0	0	3	40	60
5	CWR 506	Digital Image Processing	3	3	0	0	3	40	60
6	CWR 508	Statistics for Geoinformatics	3	3	0	0	3	40	60
7	CWR 510	Geoinformatics in Disaster Management	3	3	0	0	3	40	60
8	CWR 552	Geoinformatics in Ecology & Forestry Lab	1	0	0	2	2	60	40
9	CWR 554	Spatial Modeling & Analysis Lab	1	0	0	2	2	60	40
10	CWR 556	Digital Image Processing Lab	1	0	0	2	2	60	40
11	CWR 558	Geoinformatics in Disaster Management Lab	1	0	0	2	2	60	40
12	CWR 512	Seminar-2	1	0	2	0		60	40
		Program Elective (Any One)							
13	CWR 514	Geoinformatics in Urban and Regional Planning	3	3	0	0	3	40	60
14	CWR 560	Geoinformatics in Urban and Regional Planning lab	1	0	0	2	2	60	40
15	CWR 516	Geoinformatics in Hydrology & Water Resources	3	3	0	0	3	40	60
16	CWR 562	Geoinformatics in Hydrology & Water Resources lab	1	0	0	2	2	60	40
17	CWR 518	Geoinformatics in Desert	3	3	0	0	3	40	60
18	CWR 564	Geoinformatics in Desert Lab	1	0	0	2	2	60	40
19	CWR 520	Geoinformatics in Earthquakes	3	3	0	0	3	40	60
20	CWR 522	Geoinformatics in Mineral Exploration	3	3	0	0	3	40	60
21	CWR 524	Geoinformatics in Environmental Monitoring	3	3	0	0	3	40	60
22	CWR 566	Geoinformatics in Environmental Monitoring Lab	1	0	0	2	3	60	40
		Grand total	**28**	**18**	**2**	**10**			

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BoS_____

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Accredited by NAAC with 'A' Grade

Teaching and Examination Scheme
To commence from the Academic year: 2021-2022

Centre: Centre for Climate Change and Water Research **Year: II**
Program: M.Tech. Geoinformatics **Semester-III**

L - Lecture CIE – Continuous Internal Evaluation

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
		University Core							
1	PC 601	Proficiency and Co- Curriculum Activity -III	2	0	0	0	-	100	
		Program Core							
2	CWR 523	Research Methodology & Project Formulation	4	4	0	0	3	40	60
3	CWR 525	Dissertation/Project Work - 1	12	0	0	3	3	40	60
4	CWR 527	Seminar-3	1	0	2	0		60	40
		Total	19						
		Grand total	**19**	**4**	**3**	**3**			

T – Tutorial ESE – End Semester Examination
P – Practical

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Teaching and Examination Scheme
To commence from the Academic year: 2021-2022

Centre: Centre for Climate Change and Water Research **Year: II**
Program :M.Tech. Geoinformatics **Semester-IV**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T	P		CIE	ESE
1.	CWR 526	Dissertation/Project Work - 2	20	0	0	4	3	60	40
		Total	20	0	0	4			
		Grand total	**20**						

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

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Syllabus of M.Tech. Geoinformatics

Centre: Centre for Climate Change and Water Research

CWR 501 PRINCIPLES OF REMOTE SENSING & PHOTOGRAMMETRY **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASIC PRINCIPLES:** Remote Sensing: History, Development, Definition, Advantages and Limitations, Concept & Principles, Electromagnetic Radiation (EMR): Spectrum and its properties, wavelength regions and their applications Atmospheric windows, Interaction of EMR with atmosphere & Earth's Surface, Spectral response pattern, Spectral, Spatial, Temporal and Radiometric Resolutions, Multi-concept in RS, teledection and earth observation, Atmospheric effects	8
UNIT II	**SENSORS, SCANNERS AND DETECTORS:** Photographic System: Cameras, filters & Films; Remote Sensing Systems: Platform, types of platforms & its characteristics; Sensor classification: Active and Passive, Coherence, polarimetry, Optical-Mechanical Scanners & Push-broom scanners; Ground Truth Instruments: GTR, Imaging and non-imaging scanners, Scanning systems	7
UNIT III	**REMOTE SENSING SATELLITES:** Satellites & their characteristics – Geostationary & Sun Synchronous; Earth Resource Satellite: Introduction to commonly used multi-spectral remote sensing satellite systems: IRS Series of Satellites, Landsat, SPOT, Ikonos, Quickbird, Modis, Radarsat, ERS, etc.; Weather & Communication Satellites: Introduction, NOAA, TERRA, MOS, INSAT, GOES, etc.; Remote Sensing (RS) Applications: Agriculture, Forestry, Land cover/Land use, Water resources & Earth System Science, Earth observation for SDGs	7
UNIT IV	**AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY:** Introduction: Fundamentals of Aerial Photography, Aerial photography planning & execution of photographic flights; aerial sensors, Photogrammetry: Basic concepts of scale, measurements of object height and length; Stereo Photogrammetry: Stereovision & Stereoscopes, Stereoscopic Parallax & Parallax Equations; Relief displacement, Vertical exaggeration, photographic camera	7
UNIT V	**DIGITAL PHOTOGRAMMETRY:** Basic Concepts; Generation of Digital Photogrammetric Images; Interior Orientation, Exterior Orientation; Generation of Digital Elevation Models & Ortho-images, Applications of DEM data	7

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REFERENCE BOOKS

1. Jensen, J.R., (2006) "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi.
2. George Joseph, (2004) "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad.
3. Sabins, F.F. Jr., (2007) Edition. „Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.
4. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
5. Lillesand, Thomas M. and Kiefer, Ralph, W., (2007) "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York
6. Rampal, K.K., (1999) Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi

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CWR 503 GEOGRAPHIC INFORMATION SYSTEM **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**INTRODUCTION:** Philosophy & Definition of GIS; Basic concepts about spatial information; Historical evolution of GIS; Spatial vs. non-spatial data, Manual vs. automated GIS; Components of GIS, recent trends in GIS	7
UNIT II	**DATA STRUCTURE & FORMAT:** Data structure and formats; Spatial data models – Raster and Vector; Data base design - editing and topology creation in GIS, Linkage between spatial and non-spatial data; Raster Data & its Representation: Types, Data Structure, Data Compression and its types, BIL, BIP, BSQ, Data Files, Data Conversions; Vector data representation: Topological & Non-topological Vector Data, Map scale, Spatial Resolution, Spatial Data Accuracy, Location Data Accuracy and Precision, Vector Data Sources; Comparison between Raster & Vector Data; Data inputting in GIS	8
UNIT III	**RASTER DATA ANALYSIS & VECTOR DATA ANALYSIS:** Integration of Raster & Vector Data; Advantages & Limitations of Raster Based GIS; Cartographic Modelling - Map Algebra; Raster Data Analysis – Overlay Operations, Slope & Aspects, Statistical Analysis; Geometric Transformations - Affine Transformation and Geometric Transformation Coefficients, RMS Error; Vector Data Analysis (Basic Concepts); Feature Based Topological functions: Buffering Overlay Analysis, Distance Measurements; Layer Based Topological Functions, rasterization and vectorization, raster data conversion	7
UNIT IV	**DATA EXPLORATION:** Interactive Data Exploration, Vector Data Query, Attribute Data Query; Logical Expressions, Types of Operations; Relational Database Query, Use of SQL to Query a Database, Descriptive Statistics of Attribute Data; Spatial Data Query, Raster Data Query, Query by Cell Value, Query using Graphical Methods, Charts; Geographic Visualization, Data Classification, Spatial Aggregation, Map Comparison, Role of GIS in surface generation, conversion of geographic features	7
UNIT V	**GIS DATA INTEGRATION, PROJECT MANAGEMENT & APPLICATONS OF GIS:** Introduction, Integration of RS & GIS; Problem Identification & Designing a Data Model; GIS project planning; Geographic Database Design Methodology; Approaches to the study of GIS; GIS for natural resources monitoring & management; Application of GIS in Various Fields; Web GIS, , Role of GIS in SDGs	7

REFERENCE BOOKS

1. Kang-tsung Chang (2007), „Introduction to Geographic Information Systems" Tata McGraw Hill, New Delhi.
2. C.P.Lo and Albert K.W.Yeung (2006) "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India,New Delhi.
3. Burrough, Peter A. and Rachael McDonnell,(1998), „ Principles of Geographical Information Systems" Oxford University Press, New York.

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CWR 505 CARTOGRAPHY & GLOBAL POSITIONING SYSTEM **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASIC CONCEPT OF CARTOGRAPHY & MAP PROJECTIONS:** Introduction to cartography-Nature Scope & its role; Basic Characteristics of Map, Study of different types of Map and Scale; Survey of India National Series maps and its interpretation; Introduction to Geometrics, Reference and Coordinate System; Basic Assumptions & Use of Projection; Classification & Selection, Important Map Projections-Conic, Cylindrical, Zenithal, Mercator`s, Polyconic, Lambert, Orthomorphic, UTM Grid & their comparison; Map Projection Transformation, Analysis and Visualization of distortion, interpolation methods, reprojection of maps, displaying of maps	8
UNIT II	**EARTH, ITS CARTOGRAPHIC ABSTRACTION AND MAPPING:** Approximation of the Earth; Generalization- Elements, Control & Classification (Semantic & Geometric); Symbolization for different feature attributes, Pattern used by SOI ,Mapping the statistical surface with dot, isopleth and choropleth mapping; Map compilation & method of map printing	7
UNIT III	**CARTOGRAPHIC COMMUNICATION & VISUALIZATION OF GEOSPATIAL DATA:** Map Design, Map lettering & its placement; Graphic Symbology & Visual Variables; Multivariate, Interactive Cartography & 3D Visualization	7
UNIT IV	**FUNDAMENTALS OF GPS & GPS SURVEYING METHODS AND ACCURACY:** Introduction to Global Positioning System; Satellite constellation, GPS signals; Geopositioning- Basic Concepts, Pseudo Range Measurement, Phase Difference Measurement, NAVSTAR, GLONASS, GALILEO; Methods-Static & Rapid Static; Kinematic-Real Time Kinematic; GPS Survey Planning – GPS & DGPS Data Processing and Accuracy, Satellite geometry, Basic Trilateration	7
UNIT V	**GEODESY & COMPONENTS OF GLOBAL POSITIONING SYSTEM:** Basic geodesy; Geoid/datum/Ellipsoid- definition and basic concepts, GPS Datum Vs Indian Geodetic Datum; Geoid and its importance in surface mapping, Coordinate Systems, Transformation of coordinates; Application of Geodesy; GPS Segments: Control, Space, User & its Functions; GPS Positioning Types- Absolute, Differential; Selection of Reference Station, Reference Station Equipment: GPS`` receiver, GPS antenna. Radio and its types, Radio Antenna	7

REFERENCE BOOKS

1. Keates, J.S., (2008): Cartographic Design and production, London, Longman
2. Ramesh, P. A., (2000): Fundamentals of Cartography, Concept Publishing Co., New Delhi.
3. Rampal, K.K., (2004): Mapping and Compilation, Concept Publishing Co.,New Delhi.
4. Anson, R.W.& Ormeling, F.J., (2008), Basic Cartography, Vol. 1, 2nd ed., Elsevier Applied Science Publishers, London.
5. Robinson A.H. & Morrison J.L, (1995) Elements of Cartography, John Wiley & Sons
6. Singh, R.L & Dutt. P.K,(2008), "Elements of Practical geography", Students Friends Allahabad
7. Peterson, M.P., (1995) "Interactive and Animated Cartography" Upper Sadde River, NJ: Prentice Hall
8. N.K.Agrawal , (2004) ,Essentials of GPS, Spatial Network Pvt. Ltd
9. Sathish Gopi , (2000), GPS and Surveying using GPS
10. Leica. A., (2003), GPS Satellite Surveying, John Wiley & Sons, use. New York
11. Terry-Karen Steede, (2002), Integrating GIS and the Global Positioning System, ESRI Press

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CWR 507 GEOSCIENCES AND ADVANCED REMOTE SENSING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**THE EARTH SYSTEM & IMAGE INTERPRETATION FOR EARTH SURFACE MAPPING:** Concept of Earth System; Lithosphere, Biosphere, Hydrosphere & Atmosphere; Continental Drift, Plate Tectonics Theory and its relationship to earthquakes and volcanic activity; Visual and digital image interpretation techniques; Elements of image interpretation; Development of interpretation keys for land use/ land cover, role of satellite image in earth system sciences, factors affecting image interpretation, activities of image interpretation	8
UNIT II	**ROCK TYPES & ROCK STRUCTURES:** Igneous, Sedimentary and Metamorphic Rocks: Types, Forms; spectral signatures of rocks, Field characteristics and rock type delineation on satellite Images; Mineral deposits & their types; Geoinformatics in mineral exploration; Folds, Faults and Joints; Field characteristics of rock structures and delineation on satellite images; Lineaments mapping; Geoinformatics in engineering geological investigation: Tunnel, dam & reservoir	7
UNIT III	**GEOMORPHOLOGY AND LANDFORMS:** Fundamental concepts, geomorphic agents; Classification of fluvial, eolian, glacial and marine landforms; Drainage patterns and significance, Image characteristics of landforms; Hydro geomorphological mapping in Groundwater exploration, Lineaments mapping using earth observation datasets	7
UNIT IV	**LiDAR REMOTE SENSING & HYPERSPECTRAL REMOTE SENSING:** Altimetric LiDAR: Physics of laser, spectral characteristics of laser, laser interaction with objects, Airborne Altimetric LiDAR: principle, Multiple return, Components of LiDAR system; INS technology, INS-GPS integration, measurement of laser range, calibration, flight planning, laser range to xyz coordinates, accuracy of various components of LiDAR, error analysis of data and error removal, raw data of DEM processing, filtering of data uses of return strength/waveform, data classification techniques, LiDAR data integration with spectral data, LiDAR applications; Hyper-spectral Imaging: Hyper spectral concepts, data collection systems, calibration techniques, data processing techniques; preprocessing, N-dimensional scatter-plots, Special angle mapping; Spectral mixture analysis, Spectral Matching, Mixture tuned matched filtering, Classification techniques, airborne and space-borne hyper-spectral sensors, applications; High resolution hyper-spectral satellite systems: Sensors, orbit characteristics, description of satellite systems, data processing aspects, applications	7
UNIT V	**THERMAL, MICROWAVE, EXTRA-TERRESTRIAL REMOTE SENSING:** Thermal radiation Properties, Kinetic Heat & temperature, Radiant Energy and Flux, Thermal Capacity and conductivity, Thermal Inertia of earth"s materials, Military application, UHI; Microwave: Passive & Active Microwave Sensors, Side looking Airborne/ Space borne RADAR, Back scatter coefficient, Phase unwrapping, coherence, Radargrammetry; Lunar mission, Mars mission	7

RECOMMENDED READINGS

1. Iain H. Woodhouse 2005, Introduction to Microwave Remote Sensing, CRC Press
2. Greenhagen, 2011, Thermal Emission Remote Sensing of the Moon: Design and Development of Diviner Lunar Radiometer Compositional Capabilities. , Proquest, Umi Dissertation Publishing
3. S Jin, 2014, Planetary Geodesy and Remote Sensing, CRC Press
4. H.Grahn & Geladi, 2007,Techniques and Applications of Hyperspectral Image Analysis,Wiley-Blackwell

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CWR 509 COMPUTER PROGRAMMING & WEB GIS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASICS OF C LANGUAGE, DECISION & CONTROL VARIABLES:** C Fundaments, Data Types, Variables, Constants; Operators, Expressions, Statements; Decision Making & Branching; Decision Making & Looping.	8
UNIT II	**STRINGS, POINTERS & C WITH USER DEFINED DATA STRUCTURES:** Strings and String Handling; Pointers, Use and Benefits of Pointers; User defined data structures – enumerators, unions & structures, File handling (sequential & random files).	7
UNIT III	**Web GIS & Client/server Computing:** Definition, concept of Web GIS, History of Web GIS, components of web GIS, internet, web GIS v/s Internet GIS, Fundamentals of computer networking – network environment – network communication models –protocols – TCP/IP. Applications of web GIS, users and stake holders of web GIS, advantages and limitations of web GIS, overview of Web GIS. Client – server – glue – client/server system partition– layered architecture – advantages and disadvantages of client server architecture. Distributed component framework – web mapping – static and interactive web mapping – open GIS web map server.	7
UNIT IV	**: Functions of Web GIS & Design of User Graphic Interface:** Display of general information for the public, display of planning information, interactive display of spatial information, sharing and distribution of spatial data as well as management of spatial data. User friendly interface, characteristics, menus and icons, common terms. **Graphic Appearance** - colours, sizes, fonts, scales and arrangement. Brands of software used to develop web GIS at the server and client sides. Evaluation of different brands, ArcIMS, Map Objects, and Map guide, Map Server, Geomediawebmap, Fulcrum, and Vectoreyes.	7
UNIT V	**Web GIS Data & its applications:** Classification of WEB GIS data, Geospatial data, type, characteristics, distribution, GIS interactive maps,- general maps at regional level, very detailed maps down to lot level. Level of Service (LOS) Level of Contents (LOC) Level of GIS Functions or Level of Functions (LOF). A Cross Tabular Matrix (CTM) approach. Participatory GIS -Web-based GIS for Collaborative Planning and Public Participation, Digital Democracy for planning, web GIS an Aid to Local Environmental Decision-making, web GIS for regional and local level planning. Community GIS, Internet GIS Applications in intelligent transportation systems, planning and resource management. E-Governance, Bhoomi project, Bangalore-1, Electronic Government Proposals.	7

REFERENCE BOOKS:

1. E Balaguruswamy , (2009) " Programming in ANSI C " TMH
2. Yashwant Kanetkar , (2008), "Let us C", BPB Publications
3. Korte,G. B., (2001)"The GIS book": 5th Edition, Onward press, Australia.
4. Cartwright, W., M.P. Peterson, G. Gartner (Eds) "Multimedia Cartography", Berlm:Springer.
5. Kraak, M., and A. Brown (2001)" Web Cartography: Development and Prospects, London": Taylor and Francies.

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CWR 515 FUNDAMENTALS OF MATHEMATICS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Review of limits, continuity, and differentiability. Mean value theorem, Taylors Theorem, Maxima and Minima. Riemann intergrals, Fundamental Theorem of Calculus, Improper integrals, applications to area, volume. Convergence of sequence and series, power series.	8
UNIT II	Partial derivatives, gradient and directional derivatives, chain rule, maxima and minima, Lagrange multipliers. Double and Triple integration, Jacobians and change of variables formula. Parametrization of curves and surfaces, Vector Fields, line and surface integrals. Divergence and curl, Theorems of Green, Gauss and Stokes.	7
UNIT III	Linear Algebra: Vectors in R^n and C^n, notions of linear dependence and independence, linear span of a set of vectors, vector subspaces of R^n and C^n, the basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants.	7
UNIT IV	Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product space, the Gram-Schmidt process, orthonormal bases, projections, and the least sqaures approximation. Eigenvalues and eigenvectors, Charecteristic polynomials, the eigenvalue of special matrices (orthogonal, unitary, symmetric, Hermitian, skew-symmetric, normal). Algebraic and geometric multiplicities, diagonalisation by similarity transformations, Spectral theorem for real symmetric matrices and applications to quadratic forms.	7
UNIT V	Differetial Equations- I: Basic concepts, Geometric meaning, Direction fields. 1st order linear equations, homogeneous and non-homogeneous, Solution Method for Nonlinear equations, Separation of variables, Exact Differential equations, integrating factors Bernoulli equation, orthogonal trajectories, Existence Uniqueness: Picards iteration, 2nd order, Linear differential equations: homogeneous equation with constant coefficients, Mass spring system, Existence Uniqueness, Wronskian, non-homogeneous equation, Method of undetermined coefficients, variation of parameters method, Higher Order equations: Wronskian Existence of solution: Solution Methods for constant coefficients, Laplace transform generalities, Shifting theorems, Convolution theorem.	7

REFERENCE BOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th edition, Wiley, 2005.

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2. G. Strang, Linear Algebra and its applications, 4th edition, Thomson, 2006.
3. W.E. Boyce and R.C. Diprima, Elementary Differential Equation, 8th edition, Wiley, 2005.
4. H. Anton, C. Rorres, Elementary linear algebra with applications, 9th edition, Wiley, 2005.
5. T.M Apostol, Calculus, Volume II, 2nd edition, Wiley, 1980.
6. G.B. Thomas and R.L. Finney, calculus and analytic Geometry, 11th edition, Pearson, 2008.
7. T.M. Apostol, Calculus, Volumes 1 and 2, 2nd edition, Wiley, 1980.
8. J. Stewart: Calculus, 5th edition, Thomson, 2003

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CWR 517 NEURAL NETWORKS AND FUZZY LOGIC **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Evolution of neural networks; Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Unsupervised and Reinforcement; Fundamentals of connectionist modeling: McCulloach – Pits model, Perceptron, Adaline, Madaline.	8
UNIT II	Topology of Multilayer perceptron, Back propagation learning algorithm, limitations of Multilayer perceptron. Radial Basis Function networks: Topology, learning algorithm; Kohenen"s self-organising network: Topology, learning algorithm; Bidirectional associative memory Topology, learning algorithm, Applications, ANN in SDGs	7
UNIT III	Recurrent neural networks: Basic concepts, Dynamics, Architecture and training algorithms, Applications; Hopfield network: Topology, learning algorithm, Applications; Industrial and commercial applications of Neural networks: Semiconductor manufacturing processes, Communication, Process monitoring and optimal control, Robotics, Decision fusion and pattern recognition, Deep learning and its applications	7
UNIT IV	Classical and fuzzy sets: Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and maxmin method; Fuzzification: Membership value assignment Inference, rank ordering, angular fuzzy sets. Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy arithmetic; composition and inference; Considerations of fuzzy decision making.	7
UNIT V	Basic structure and operation of Fuzzy logic control systems; Design methodology and stability analysis of fuzzy control systems; Applications of Fuzzy controllers. Applications of fuzzy theory. ANFIS algorithms	7

REFERENCE BOOKS:

1. Limin Fu, "Neural Networks in Computer Intelligence," McGraw Hill, 2003.
2. Fakhreddine O. Karray and Clarence De Silva., "Soft Computing and Intelligent Systems Design, Theory, Tools and Applications," Pearson Education, India, 2009.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," McGraw Hill,1995.
4. B.Yegnanarayana, "Artificial Neural Networks," PHI, India, 2006.

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CWR 519 ARTIFICIAL INTELLIGENCE **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system-Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms, Advances in AI	8
UNIT II	Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic- Structured representation of knowledge.	7
UNIT III	Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	7
UNIT IV	Basic plan generation systems - Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.	7
UNIT V	Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	7

REFERENCE BOOKS:

TEXT BOOKS:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008. (Units- I,II,VI & V)
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Unit-III).

REFERENCES:

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, PearsonEducation, 2007.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
3. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.
4. http://nptel.ac.in

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CWR 521 GEOINFORMATICS IN SATELLITE METEOROLOGY, AGRICULTURE, SOIL & LAND EVALUATION **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**SOIL MAPPING & GEOINFORMATICS IN AGRICULTURE MANAGEMENT:** Soil, factors of soil formation, soil forming processes(podsolization, laterisation,salinisation and gleying); Physical and chemical characteristics, soil quality, soil problems(salinity, erosion), Soil survey; Factors affecting spectral characteristics of soil, optical, microwave and hyperspectral remote sensing of soil; Soil Classification: zonal, intrazonal and azonal, major soil types and their distribution in India; Spectral characteristics of leaves and ' crops; Crop identification and acreage estimation, Crop yield parameters, crop condition monitoring & crop production forecasting; Role of Geoinformatics in irrigation management & Agro-Climatic Regional Planning.	8
UNIT II	**LAND COVER AND LAND USE ASSESSMENT & GEOINFORMATICS IN CROP DAMAGE ASSESSMENT:** Concept of land cover and land use, their interrelation and importance; Role of Geoinformatics in land cover and land use study, Land use/land cover matrix; Classification of land cover and land use at different levels; Crop damage assessment due to pests and diseases, water-logging and salinity & drought and flood.	7
UNIT III	**LAND EVALUATION AND ASSESSMENT:** Concept of land and land evaluation, land characteristics, land quality and diagnostic criteria, multiple and compound land utilisation. Principles and methodology for land evaluation; Role of Geoinformatics in soil conservation and management; Land Capability Classification; Command area development and watershed planning for agriculture and soil development.	7
UNIT IV	**FUNDAMENTALS OF METEOROLOGY:** Weather Forecasting; Short, medium and long range weather prediction; Observations and transmission of meteorological information; synoptic charts and its analysis; Synoptic features associated with onset, withdrawal, break active and weak monsoons and prediction.	7
UNIT V	**SATELLITE METEOROLOGY:** Meteorological satellite: TRMM, TIROS, NIMBUS, NOAA, SEASAT, GOES, METEOSAT and INSAT; Satellite based atmospheric temperature, surface radiation, wind and aerosols measurement and analysis; Rainfall Monitoring: Cloud indexing method, Life-history method and Bio-spectral methods, Microwave data for clouds, precipitation and lightening assessment; Interpretation of meteorological Satellite images for weather systems and cyclones.	7

RECOMMENDED READINGS

1. Steven, M.D. and Clark, J.A.:1991, „Application of Remote Sensing in Agriculture", Butterworths.
2. Asrar, G.:1989, „Theory and application of optical remote sensing", John Wiley & Sons, USA.
3. Space Applications Centre(SAC):1990, „Manual of procedure for Forest, Mapping and Damage Detection using satellite data", Report No. IRS-UP/SAC/FMDD/TN/16/90, India.
4. Space Applications Centre(SAC):1990, „Status Report on Crop Acreage and Production Estimation", Report No. RSAM/SAC/CAPE/SR/ 25/90, India.

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CWR 502 GEOINFORMATICS IN ECOLOGY & FORESTRY **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT- 1	**FOREST ECOLOGY:** Forest eco-systems; Biotic and abiotic components; forest community concepts; Ecological succession and climax, primary productivity, nutrient cycling and water relations; Physiology in stress environments (drought, water logging and salinity), Conservation of forest ecosystems, Forest types and its phenology	8
UNIT- II	**FOREST CLASSIFICATION & SURVEYING:** Forest types in India, identification of species, composition and associations; Conventional Survey, different methods of surveying, maps and map reading; Remote sensing based classification of forests, Spectral properties of vegetation, Machine and deep learning methods in forest types mapping, time series analysis for forest health assessment	7
UNIT- III	**FOREST MENSURATION AND REMOTE SENSING:** Sampling methods and sample plots. Yield calculation; yield and stand tables; Forest Applications: Sensor Requirements, forest cover monitoring through remote sensing; Geographic Information Systems for management and modelling, Forest biomass estimation	7
UNIT-IV	**FOREST PROTECTION AND DAMAGE ASSESSMENT:** Role of afforestation and forest regeneration; Human impacts; encroachment, poaching, grazing, shifting cultivation and control; Forest fire detection, Risk assessment and management through RS & GIS; Insect-pests, disease and stress Detection, Forest fire simulation and mapping, Thermal remote sensing	7
UNIT-V	**FOREST CONSERVATION & MANAGEMENT:** Principles of conservation, needs for forest conservation; RS & GIS techniques for forest conservation& management *viz.* Microwave & LiDAR; Working plans-preparation and control, Sustainable development of forest resources	7

RECOMMENDED READINGS

5. Kimmins JP. 2003. Forest Ecology. MacMillan.
6. Adrian Newton. 2007. Forest Ecology and Conservation: A Handbook of Techniques (Techniques in Ecology & Conservation).
7. Steven E. Franklin. 2001. Remote Sensing for Sustainable Forest Management.CRC Press.
8. Köhl, Michael, Magnussen, Steen S., Marchetti, Marco.2006,.Sampling Methods, Remote Sensing and GIS Multiresource Forest Inventory,XIX, 373 p.

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CWR 504 SPATIAL MODELING & ANALYSIS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT- 1	Definition, Introductory concepts (data, information, database, DBMS, meta data), Components of DBMS (Data, Hardware, Software, Users/ Clients) and Advantages of DBMS, GIS and Remote Sensing data, data conversion, reduction and enlargement, Recent trends in DBMS	8
UNIT-II	Types of Model in DBMS (Relational, Hierarchical, Network, Object oriented), DBMS Architecture, DBMS Function, People around DBs/ DBMSs, Database Administrator, instances, schema, DDL, DML.Types & Classification of attribute data (Nominal, Ordinal, Ratio and Interval), Advances in data modelling, interoperable data models	7
UNIT-III	Real (and Virtual) World Models, raster and vector model, Active-Database Technology, Various Semantics in Modeling, Tessellations, TIN, Quad Tree concepts, Spatial data accuracy and standards, use of SQL in geodatabase, Advanced data mining techniques	7
UNIT-IV	Field based & Object based data (OGIS) models, Conceptual Data base model: The ERD Model, Intersection Model, Spaghetti model, Positional accuracy, Attribute accuracy, Data Normalization in GIS, Interoperability in GIS	7
UNIT-V	Spatial Modelling, overlay analysis, raster overlay tools, reclassification, Spatial Interpolation methods, Trend surface analysis, AHP, Fuzzy AHP, ANN, Decision Support System, decision tree and random forest, classification and regression tree (CART)	7

RECOMMENDED READINGS

1. S. Shekhar & S. Chawla, 2002 Spatial Databases: A Tour, Prentice Hall;
2. P. Rigaux, M. Scholl, & A. Voisard 2001, Spatial Databases: With Application to GIS, Morgan Kaufmann; 2nd ed.
3. Andrienko & Andrienko,2005,Exploratory Analysis of Spatial and Temporal Data: Systematic Approach, Springer.
4. Bonham Carter G.F (1994) GIS for Geoscientists: Modeling with GIS Pergamon Publications.
5. Samet, H. 1990, The Design and Analysis of Spatial Data Structures, Addison–Wesley.
   A. Silberschats, Henry F. Korth "Database System Concepts", 3rd Edition, TMH, 1998
6. Goodchild, M.F. (1978) - Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley and Reading Press.
7. U.K. Gupta 2012, An Analysis on Spatial Database: Volume 1, CreateSpace Independent Publishing Platform
8. J. Friedrich, 2004, Spatial Modeling in Natural Sciences and Engineering: Software Development and Implementation, Springer
9. V. Lakshmanan, 2012, Automating the Analysis of Spatial Grids: A Practical Guide to Data Mining Geospatial Images for Human & Environmental Applications (Geotechnologies and the Environment), Springe

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CWR 506 DIGITAL IMAGE PROCESSING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**INTRODUCTION:** Concepts about digital image and its characteristics; Spectral, Spatial, Radiometric and Temporal resolution; Visual vs. Digital methods, Image data storage and retrieval, raster data compression, raster data conversion	8
UNIT II	**BASIC PRINCIPLES:** System design considerations; Sources of image degradation - Image restoration and Noise Abatement, Radiometric and Geometric correction technique; Interpolation methods – linear and nonlinear transformation for geometric corrections, post-processing of images, Sun-angle correction	7
UNIT III	**IMAGE ENHANCEMENT:** Look-up Tables (LUT) and Types of images displays and FCC; Radiometric enhancement techniques, Spatial enhancement techniques; Contrast stretching: Linear and non-linear methods; Band ratio, Types of Vegetation indices; Principal Component Analysis, Multi dated data analysis and Change detection, Fourier transformation, FFT	7
UNIT IV	**FILTERING TECHNIQUES:** Low Pass Filtering: Image smoothing; High Pass Filtering: Edge enhancement and Edge detection; Gradient filters, Directional and non-directional filtering, band rationing	7
UNIT V	**PATTERN RECOGNITION:** Concept of Pattern Recognition, Multi-spectral pattern recognition; Spectral discrimination, Signature bank, Parametric and Non-Parametric classifiers; Unsupervised classification methods; Supervised classification techniques, Limitations of standard classifiers, Advanced classification methods, AI/ML, deep learning	7

REFERENCE BOOKS

- Sabins, Floyd F. (2007), Remote Sensing: Principles and Interpretation, H. Freeman and C., New York.
- Thomas M. Lillesand & Kiefer, Ralph W. (2007), Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
- Jensen, JR. (2006), Remote Sensing of the Environment – An Earth Resources Perspective, Prentice Hall Inc.
- Rencz, Andrew N. , (1999), Remote Sensing for the Earth Sciences: Manual of Remote Sensing, 3rd ed., John Wiley & Sons, Inc., New York.
- Curran, P., (1985), Principles of Remote Sensing, Longman, London.
- Campbell, James B., (2006), Introductory Remote Sensing: Principles and Concepts, Routledge.
- Gibson, P.J., (2000), Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London.
- Cracknell, A.P. & Hayes, L.W B., (2007), Introduction to Remote Sensing, Taylor & Francis, London.

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CWR 508 STATISTICS FOR GEOINFORMATICS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**ELEMENTARY STATISTICS:** Geographic Data: Sources, data types, organization of data, Scale of Measurements; Organization of data: Review of frequency distribution. Presentation of Data: Tables, Diagrams (Bar, Pie, histogram, polygon and frequency curve) and time series graph; Descriptive Statistics: Measure of central tendency, measure of location, dispersion, skewness and kurtosis. Moments and Central moments; Matrix theory: Types, Addition, Subtraction, Multiplication and Inverse.	8
UNIT II	**PROBABILITY, PROBABILITY DISTRIBUTION AND RANDOM VARIABLE:** Concept of Probability, Addition, Multiplication and Independence law. Probability distribution, Discrete and Continuous probability distribution. Binomial, Poisson and Normal distribution with Application; Random variable, its types and characteristics.	7
UNIT III	**CORRELATION, REGRESSION AND SAMPLING:** Correlation: Simple Correlation, Rank Correlation and partial correlation; Curve Fitting: Simple linear regression analysis by method of least square, multiple regression with application on spatial data; Sampling: Concept of sample, population, parameter and statistics. Brief review of sampling technique, its type and applications.	7
UNIT IV	**STATISTICAL INFEREENCE & QUANTIFICATION OF SPATIAL CONTINUITY:** Statistical Hypothesis, One sided and two sided test, General procedure of hypothesis testing; Testing of population means for large and small samples (One sample and two samples); F-test and Chi-Square goodness of fit test; Spatial Continuity analysis, spatial co-variability, calculation of spatial variogram; Introduction to kriging, simple kriging and its Application.	7
UNIT V	**ANALYSIS OF VARIANCE & MULTIVARIATE STATISTICS:** Analysis of variance: One way and two way analysis of variance test; Introduction to non-linear Regression. Simulation of data and Model validation; Introduction to multivariate techniques, Mean vector, variance and covariance matrix; Correlation matrix, testing of population mean vector; Principle component analysis.	7

REFERENCE BOOK

- Arora, P. N., Arora, Sumeet and Arora, S. Comprehensive Statistical Methods. S. Chand Pub.
- Sharma, D.D. (2002). Geostatistics with application in earth science, Capital Pub.
- Chiles, J.P., (1999). Geo-statistics: Modeling spatial uncertainty, Wiley Interscience Pub.
- Gupta, S.C. and Kapoor, V. K. (2004). Fundamentals of Mathematical Statistics. Sultan Chand Pub.
- Gupta, C. B. and Gupta, Vijay. Introduction to Statistical Methods, 23rd revised edition. Vikas Pub.

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CWR 510 GEOINFORMATICS IN DISASTER MANAGEMENT (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**INTRODUCTION & DISASTER MANAGEMENT:** Fundamental concepts of hazards and disasters, their types, and characterization; Zonation of hazards, natural and human induced disasters; Disaster and National losses, historical perspective of disasters in India; Fundamental concept of Disaster Management; Government, NGOs and people's participation disaster management; Existing organization structure for managing disasters in India; Geoinformatics in disaster mitigation, Role of NDRF	8
UNIT II	**GEOLOGICAL HAZARDS:** Landslide, Earthquake; Mining hazards (Land subsidence, Mine flooding etc.); Volcanic hazards, Groundwater hazards, Glacial hazards, Role of machine and deep leaning in disaster management and planning, Susceptibility mapping using ensemble machine learning methods	7
UNIT III	**HYDRO METEOROLOGICAL HAZARDS:** Flash floods, River floods; Dam burst, Cloud burst; Cyclones, Coastal hazards and Drought, Role of SAR images in flood mapping and monitoring	7
UNIT IV	**ENVIRONMENTAL HAZARDS:** Forest hazards (Deforestation, Degradation and Forest fire); Land & soil degradation, Desertification; Pollution (Water, air and soil), forest fire simulation and modeling	7
UNIT V	**GEOINFORMATICS APPLICATIONS & FEW CASE STUDIES:** Geoinformatics models in managing forest fires, floods, landslides, cyclone and earthquake, multiple hazard mapping; Earthquakes in India; Floods in Indo Gangetic plains; Landslides in Himalayan region; Drought in Indian plateau regions.	7

REFERENCE BOOKS

- P.S. Roy (2000). Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS).
- Sdidmore A (2002) Environmental Modeling with GIS & Remote Sensing, Taylor & Francis.
- Anji Reddy. M. (2004) Geoinformatics for environmental Management. B. S. Publication.

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CWR 514 GEOINFORMATICS IN URBAN AND REGIONAL PLANNING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**URBANIZATION AND URBAN GROWTH:** Concept of urbanisation and impacts, Urbanization pattern in India; Urban growth: stages & models; Urban problems: housing, slums, traffic, pollution, health, environment; Geoinformatics in urban and regional planning, GRC and its concepts, types of sensors and its applications	8
UNIT II	**URBAN PLANNING:** Planning: urban and regional, Master Plan and development plan; Planning laws and bylaws, zoning; Urban utility/ services planning, Urban green space; Urban development in India,	7
UNIT III	**URBAN MAPPING:** Urban area interpretation, Urban land use/ land cover; Space use mapping, traffic and parking survey; Slum, renovation & rehabilitation; High resolution and hyperspectral imaging for urban/ regional mapping, Advanced methods for image processing for urban area mapping, Role of Optical and SAR images in slum mapping, AI/ML in urban planning	7
UNIT IV	**URBAN ANALYSIS:** Urban growth and sprawl: monitoring & Management, Shannon entropy; Density Analysis, Urban heat island; Urban Analysis and Modelling with GIS, Markov chain and CA methods, Urban growth simulation using ensemble machine learning methods	7
UNIT V	**URBAN MODELLING AND MANAGEMENT:** Urban feature extraction, SAVI, NDBI; Site suitability built-up development; Urban risk assessment, geospatial modelling; Transportation Network Analysis, Building information Management; Decision Support System for urban and regional management, Role of Geoinformatics in traffic management	7

RECOMMENDED READINGS

- Ramachandran, 1999. Urbanization and Urban systems in India, Oxford Publications: New Delhi
- Rangwala, 2008. Urban Planning,
- Xiaojun Yang, 2011. Urban remote sensing: monitoring, synthesis and modeling in the urban environment
- Verma, LN, 2008. Urban Geography, Rawat Publications
- TarekRashed and CarstenJ rgens, 2010, Remote sensing of urban and suburban areas
- Brench M.C., (1972), City Planning and Aerial Information, Harvard University, Cambridge,
- Weng, Qihao and Quattrochi, Dale A, 2013, Urban remote sensing, CRC press
- Maik Netzband, William Stefanov, Charles Redman, 2007, Applied remote sensing for urban planning, governance and sustainability. New York: 'Springer
- Khats & Khatsu 2011, Urban Multi-Hazard Risk Analysis Using GIS and Remote Sensing, Lambert Academic Publishing
- Oluleye, Ufuah, Rilwani 2011, Urban Growth Dynamics of Zaria Using Geoinformatic Techniques, Lambert Academic Publishing
- Gallion, 2005. The Urban Pattern: City Planning and Design, Gallion Pub.
- J. Sen , 2012, Sustainable Urban Planning, The Energy and Resources Institute, TERI

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CWR 516 GEOINFORMATICS IN HYDROLOGY & WATER RESOURCES (L, T, P) = 3 (3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**BASIC CONCEPTS:** Hydrologic cycle, hydrological parameters; Groundwater flows hydraulics, Darcy law; Base Flows, Loosing and gaining stream; Water table and Water Level, Vertical Profile of Ground Water, Sustainable water harvesting	8
UNIT II	**AQUIFERS:** Type of aquifers, quality constraint; Geological formations as aquifers; Groundwater mining and aquifer stress; Ground water budgeting; Ground water models, Use of RS and GIS in ground water potential zonation mapping	7
UNIT III	**WATERSHED MANAGEMENT:** Watershed and its characteristics, delineation and codification; Drainage Morphometric Analysis; Watershed problems and management, Water logging issues; Geoinformatics in watershed prioritization; Water balance, Water budgeting, interlinking of rivers and basin management; Methods of Water harvesting, Rainwater harvesting, artificial ground water recharge	7
UNIT IV	**REMOTE SENSING IN SURFACE-SUBSURFACE WATER EXPLORATION:** hydro geomorphological mapping for ground water exploration; Geophysical Methods for Groundwater Exploration; Water pollution, Water quality parameters, monitoring, DRASTIC model; Arsenic and Fluoride contamination and impacts; Impact of climate change on water resources, Advanced methods for ground water mapping, soil salinity and water logging	7
UNIT V	**GEOINFORMATICS BASED OPERATIONAL APPLICATIONS:** Flood Inundation Mapping and Modelling; Snow Cover Mapping, Snowmelt Runoff Modelling; Reservoir Sedimentation Assessment; Runoff & Hydrological Modelling; Hydrological Drought Assessment; Hydrological Software: Mudflow, Mike SHE, SWAT etc, HEC-RAS model and its applications	7

RECOMMENDED READINGS

- Schultz, G. A. and Engman, E. T. , (2000), Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, Germany.
- Murthy, J. V. S. (1994). Watershed Management in India. Wiley Eastern Ltd., New Delhi.
- Todd David Keith., (2005), Groundwater Hydrology, John Wiley & Sons, New York, Second Edition.

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CWR 518 GEOINFORMATICS IN DESERTS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Definition and distribution of deserts – causes of aridity – Global distribution of deserts – Genesis and evolution of deserts – Topographic survey of desert surfaces – weathering processes and forms (Exfoliation, Frost weathering, wet – dry weathering, salt weathering, weathering of sandstone).	8
UNIT II	Definition – sources of sand – actions of wind – wind erosion and landforms (wind carved rocks, bowels and caves, Desert parameters deflation basins blow out etc.,) Landforms of wind transport – Land forms of wind deposition (different types of dunes Loess deposits) – Palaeo Aeolian deposits.	7
UNIT III	Mountain – Plain evolution: general model slope retreat hypothesis (parallel retreat, down wearing retreat, drainage basin, mantle controlled plantation, etc - hypothesis) – Cold deserts (Processes)	7
UNIT IV	Precipitation – Run off – Stream erosion landforms – Piedmonts – debris covered slopes – Debris fans, Wash Controlled slopes – Ephemeral Streams – Channel geometrics in desert – Perennial rivers – Palaeo fluvial landforms and buried rivers – Alluvial fans – Mudflows – Playa lakes	7
UNIT V	Mechanisms of Soil Conservation – Dune stabilization – Water conservation and management.	7

RECOMMENDED READINGS

1. Sen, A.K. and Amal Kar, Desertification and its control in the Thar, Sahara & Sahel Regions, Scientific Publishers, Jodhpur, India, 1993.
2. Ron Cooke, Andrew Warren and Andrew Goudie, Desert Geomorphology, UCL Press Limited, London, England, 1993.
3. Thornbury, W.D. Principles of Geomorphology, John Wiley & Sons, New York, Second Edition, 1985.
4. Bloom, A.L. Geomorphology – A systematic analysis of Late Cenozoic landforms. Prentice-Hall, New Delhi.
5. Arthur Holmes and Doris L. Holmes Principles of Physical Geology, ELBS, English Language Book Society / Van Nostrand Reinhold (UK) Co. Ltd, Third Edition, 1978.
6. Doehring, Geomorphology in Arid Regions, Allen and Unwin, London. 1980.
7. Rice R.J. Fundamentals of Geomorphology, E.L.B.S, Longman, 1988.
8. Keller E.A., Environmental Geology, CBS Publishers, 1985. 9. Drury, S.A, A guide to Remote Sensing Interpreting Images of Earth, Oxford Science Publications, Oxford. 1990

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CWR 520 GEOINFORMATICS IN EARTHQUAKES **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Fundamentals of Neo – Seism tectonics: Strain Accumulation – Elastic Rebound and Faulting – Energy Release and Seismic waves – Physical parameters of Earthquake source – Magnitude –Seismic moment and Fault plane solution - Geological and Seismological input for Seismic evaluation on magnitude – Frequency relations.	8
UNIT II	Remote Sensing Inputs in Neo-Seism tectonics: Anomaly Mapping using raw and Digitally Enhanced Aerial & Satellite Remote Sensing data, Shaded Relief Maps and FCC wrapped DEM – Lineament Anomalies - Disharmonies in Structural Trend Lines and Fold Styles - Geomorphic anomalies (Tectonic, Denudational, Fluvial, and Coastal & Aeolian).	7
UNIT III	Geophysical Inputs in Neo-Seism tectonics Identification of Resistivity, Seismic, and Gravity & Geomagnetic anomalies – Three Dimensional Modelling of Subsurface Geological Structures using GIS - Ground water anomalies – Historic seismic data analysis – Generation of GIS Database.	7
UNIT IV	Seismic Hazard Mapping and Risk Assessment through seismic data analysis: Intensity and earthquake strong motion – seismic hazard analysis and estimation of design ground motions – seismic hazard mapping – seismic zonation and response – design codes – protective and reducing measures for infrastructures and structures – regulation of landuse.	7
UNIT V	Geoinformatics in Seismic hazard mapping and risk assessment: GIS Integration of Remote sensing derived inputs, Geophysical Inputs, Groundwater Anomalies and Historic data and Vulnerability analysis (Hazard Zonation Mapping) and Risk Assessment. Case Studies.	7

RECOMMENDED READINGS

1. Bell, F.G. Geological Hazards: Their Assessment, Avoidance and Mitigation. E and FN SPON, Routledge, London, 1999.
2. David Alxander, National Disasters. UCL Press, London. Research Press, New Delhi, 1993.
3. Moores, E.M. and Twiss, R.J., Tectonics. W.H.Freeman and Company, New York, 1995.
4. Nick Carter, W. Disaster Management – A Disaster Manager"s Handbook. Asian Development Bank, Philippines, 1991.
5. Penelis, G. G and Kappos, A.J. Earthquake-resistant Concrete Structures, E and FN SPON, London, 1997.
6. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers, Jaipur
7. Avasthy R.K., Bhoop Singh, Sivakumar R. Landslides: A Perception and Initiatives of DST. Indian Society of Engineering Geology. 2006.
8. Gupta P.N, Roy, A.K. Mountain Resource Management and Remote Sensing. Surya Publications, Dehradun. 1991.
9. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi, 2000

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CWR 522 GEOINFORMATICS IN MINERAL EXPLORATION (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Introduction: Ore genesis in relation to mineral exploration – Controls of mineralization (physiographic, mineralogical, structural controls) – Guides to ore deposits (physiographic, mineralogical, stratigraphic, lithological and structural guides).	8
UNIT II	Geological techniques and procedures of exploration - study of outcrops – sampling of on spot and lab analysis of samples – panning of soils and their interpretation - trenching – pitting – exploratory drills – Geological logging of bore hole samples – calculation of average grades – documentation of exploration.	7
UNIT III	Remote Sensing based mineral targeting: Mapping of Lithologically, Structurally and Geomorphologically Controlled Mineral Deposits Using Raw and Digitally Enhanced Data – Optimisation of Spectral Bands and Enhancement Techniques for mineral targeting– Thermal and Microwave Remote Sensing for Mineral Exploration – Imaging Spectometry.	7
UNIT IV	GIS based mineral targeting: GIS based visualization of geophysical data (resistivity, gravity, magnetic, seismic, radiometric, aero geophysical and geochemical data) for Mineral exploration.	7
UNIT V	Geostatistical Modeling: GIS Integration of Multi Thematic Data for Mineral Exploration – Prognostic Modelling of Target areas for Mineral Exploration.	7

RECOMMENDED READINGS

1. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church, Virginia. 1983.
2. Gary L.Prost Remote Sensing for Geologists - A Guide to Image interpretation, Gordon and Breach Science Publishers, The Netherlands. 1997.
3. Bateman, A. Economic Mineral Deposits, John Wiley.
4. Krishnasamy S., Indian"s Mineral Resources, Oxford IBH, 1980.
5. Sinha R.K., A Treatises on industrial Minerals of India - Allied Publishers.
6. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers,Jaipur
7. Alexey F. Bunlcin and Konstantin I-Voliak, Lasser Remote Sensing of the Ocean Methods and Applications – Wiley Series, John Wiley & Sons. inc. New York, pp.244.
8. Lavorsen, A.I. Geology of Petroleum, Second Edition, CBS Publishers and Distributors, New Delhi, p.724, 1985.
9. Rao, D.P. Remote Sensing for Earth Resources, Second Edition, Association of Exploration Geophysicist, Hyderabad p.212, (CERS-236), 1999.
10. Amurskii G.I., Abramenok, G.A., Bondarieva M.S. and Solov"ev, N.N., Remote Sensing Methods in Studying Tectonic Fractures in Oil and Gas bearing formations, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, p.138,1991.
11. Alistarir R. Brown, Interpretation of Three Dimensional Seismic Data, American Association of Petroleum Geologists, USA, p.194, 1986.
12. Kearey P. and M. Brooks, An introduction to Geophysical Exploration, English Language Book Society / Blackwell Scientific Publications, p. 296 (CERS 51). 1989.

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CWR 524 GEOINFORMATICS FOR ENVIRONMENTAL MONITORING (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	**FUNDAMENTAL CONCEPTS:** Environment: components and controlling factors; Environment Impact Assessment (EIA); Legal Issues, Environmental Protection Acts, Green tribunal.	8
UNIT II	**AIR POLLUTION:** Air quality parameters and standards; Air pollution sources monitoring and control mechanisms; Geoinformatics for Air quality monitoring, Satellite sensors; Aerosol monitoring, Ozone monitoring.	7
UNIT III	**WATER POLLUTION:** Water quality parameters and standards; Water pollution: sources, measurement, monitoring and control mechanisms; Remote Sensing and Water quality management.	7
UNIT IV	**URBAN ENVIRONMENT:** Urban areas: problems, waste disposal and management; Industrial pollution: sources, monitoring and control; Remote Sensing and Urban environment management.	7
UNIT V	**MARINE ENVIRONMENT:** Ocean surface temperature and Chlorophyll detection; Marine pollution: sources and mitigation measures; Sensors (Thermal and Microwave) for marine environment monitoring and assessment.	7

RECOMMENDED READINGS

- Joseph Awange (Author), John B. Kyalo Kiema , 2013, Environmental Geoinformatics: Monitoring and Management (Environmental Science and Engineering / Environmental Science), Springer
- M. Anji Reddy, 2013, Environmental Impact Assessment: Theory and Practice, BS Publications
- Baretl, E.C. and Culis I.F. Introduction to Environmental Remote Sensing, second edition, Chapman and Hall, New York, 1993.
- Lintz, J. and Simonent, D.S. Remote Sensing of environment Addision Wesley, Rading mars, 1976.

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CWR 523 RESEARCH METHODOLOGY & PROJECT FORMULATION **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Identification of problems of regional and Local level; geographic data sources and natures of data to be used; Hypotheses and Models; Formulation of research schemes.	8
UNIT II	Preparation of field reports; Spatial data, classification and sampling problems; Need for sampling, types of sampling, sample size, sampling area.	7
UNIT III	Project Definition, Importance of Projects and Project Management; Project Management context. Basics of project management; Project formulation, Time management; Budget estimates, Cost-benefit calculation techniques; Project bidding, Project plan; Task Definition, Project Resource; Scheduling, line Management, Project Team.	7
UNIT IV	Project Administrator, Classification of Projects; Product Management, Problems and opportunities in Projects; Project Communications and Presentation; Project Management Software, Project Administration.	7
UNIT V	Evolution, Revolution; Termination of Project; Project Change; End of Projects, Project report preparation.	7

REFERENCE BOOKS:

- W.E. Huxold & A.G. Lerinsons Aronoft.S.,(1995) Managing Geographic Information Projects.
- Earickson, R,. and Harlin, J., (1994) Geographic Measurement & Quantitative Analysis
- Macmillan, N.York
- Bennet P. Lientz & Kathryn P., (2001) Project Management for the 21st Century Academic Press, California

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