M. Sc. (Geoinformatics)
Duration: 02 years (04 semesters)

Programme Outcomes:

PO 1: Students will be able to establish themselves as effective professionals by solving real world problems.

PO 2: It helps 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 and research

PO 5: Students will learn to develop interdisciplinary research activities related to social concerns

PO 6: Students will be able to develop required knowledge and skills for being a good entrepreneur.

PO 7: It will help to grow in a nurturing environment and promoting intellectual stimulation

Programme specific outcomes

PSO 1: Fundamental knowledge 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 skills of geo-statistical modeling and analysis

PSO 5: Achieve academic excellence and distinctiveness through high quality research publications

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M. Sc. (Geoinformatics)
Course Outcome

Course code	Course name	Course outcomes
1 Semester		
EM 501	Employability Skills	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 301	Principles of Remote Sensing	To understand the basic concepts and principles of remote sensing techniques, Types of satellites, Electromagnetic radiation and spectrum, Active and passive sensors
CWR 303	Aerial photography and Photogrammetry	Through this course students should be able to understand Air-borne platforms, Aerial photography, Mathematical functions and Geometry, Applications of photogrammetry
CWR 305	Cartography and GPS	Through this course students should be able to understand map making techniques and designing, working principles of GPS, Surveying methods and GNSS
CWR 307	Geosciences & Image Interpretation	Through this course students should be able to understand fundamentals of geosciences, Various earth surface processes, Identification of earth surface features using remote sensing images
CWR 309	Computer Programming	Through this course students should be able to understand programming languages C/C++ and Java, Customization of GIS tools, Development of GIS software
CWR 311	Minor Project-I	It will provide basic understanding of literature review and paper writing on various applications of geoinformatics
CWR 313	Seminar-I	It enhances the ability of the presentation of various topic, Written and verbal communication skills, Communication skills
CWR 371	Aerial Photography & Photogrammetry Lab	It will provide hands on training on the Stereo pairs and parallax, Digital photogrammetry, Aerial image analysis
CWR 373	Cartography and GPS Lab	It will provide fundamental knowledge of map making methods, Ground data collection, Surveying using hand held GPS

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CWR 375	Geosciences & Image Interpretation Lab	It will provide fundamental knowledge of various earth surface processes, Image interpretation, Identification of earth surface features, Satellite data analysis
CWR 377	Computer Programming Lab	It will provide practical knowledge of Programming languages, Development of tools, C/C++ and Java, Customization of GIS tools
CWR 315	Fundamentals of Mathematics	Through this course students should be able to understand basics mathematical functions, Different mathematical bases, Differential equations, Matrix etc.
CWR 317	Neural Networks and Fuzzy Logic	Through this course students should be able to understand application of different neural network methods, Structure and applications of neural network, Fuzzy logic and its properties Ensemble methods
CWR 319	Artificial Intelligence	Through this course students should be able to understand applications of Artificial intelligence and its applications, Machine learning techniques, Advanced data mining techniques, Deep learning and modelling
CWR 379	Neural Networks and Fuzzy Logic	It will provide practical knowledge of Various neural network methods, Structure and applications of neural network, Fuzzy logic and its properties Ensemble methods
2 Semester		
EM 502	Employability Skills	Effective leaning of industry orientated technical skills of the subject, Personality development, Communication skills, Placement procedure
FD 104	Foundation Course-II	To learn various topics of Historical evolution, Sociology, Economics and capital Geography and earth systems
CWR 302	Digital Image Processing	Through this course students should be able to understand various image processing techniques, Basic concepts and applications of image enhancement techniques etc. Information extraction and transformation
CWR 304	Geographic information System	Through this course students should be able to understand fundamentals of GIS, Geographic data sources, Geospatial data storage and processing, Spatial data integration
CWR 306	Database Management System	Through this course students should be able to understand Database management, Database query, Structure and design of database, Fundamentals of spatial database

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CWR 308	Statistics for Geoinformatics	Through this course students should be able to understand statistical applications of geodatabase, Analysis and modeling of spatial data, Statistical analysis and methods, Time series analysis of datasets
CWR 310	Geoinformatics in Geo-hazards	Through this course students should be able to understand application of Geoinformatics in Geohazards management, Rescue plans and mitigation, Hazard zonation and mapping, Geological features and activities
CWR 312	Principles of Management	Through this course students should be able to understand industries and corporate sector, Companies and its policies, Management and planning activities in GIS projects
CWR 314	Seminar-2	It will enhance the ability of power point presentation of topics, Written and verbal communication skills, PPT preparation Communication skills
CWR 316	Minor Project-I	It will enhance small scale research skills, Project work and lab experiments, Scientific project writing etc., Research methods and formulation
CWR 318	Industrial Training	It will help to visit to subject related industries, paid internships in industries, Job opportunities
CWR 352	Digital Image Processing Lab	It will provide practical knowledge of Various image processing techniques Information extraction, Data integration and Image fileting methods
CWR 354	Geographic information System Lab	It will provide practical knowledge of Various Geoprocessing techniques, Spatial data generation, Database integration, Displaying of spatial data
CWR 356	Database Management System Lab	It will provide fundamental knowledge of database creation data models, Spatial data analysis, Spatial data modelling, Spatial data query and SQL
CWR 358	Geoinformatics in Geo-hazards Lab	It will provide hands on practical knowledge of mapping and monitoring hazards, Remote sensing image analysis, Digital image processing techniques Geological mapping
CWR 320	Geoinformatics in hydrocarbon and energy resources	Through this course students should be able to understand application of Geoinformatics in Energy resources and management, Geophysical methods of oil exploration, Coal mining activities, Hydrological mapping
CWR 322	Geoinformatics in Land Information System	Through this course students should be able to understand application of Geospatial techniques in land management system, Cadastral mapping, Urban

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		infrastructure and transformation, Decision support system
CWR 360	Geoinformatics in Land Information System Lab	It will provide practical knowledge of different Geoprocessing techniques, Land management system, Cadastral mapping Surveying and decision support system
3 Semester		
CWR 321	Research Methodology	Through this course students should be able to understand Research projects/proposal, Implications and management, project formulation and writing, Ground surveying methods
CWR 323	Geoinformatics in Natural Resource Management	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 325	Geoinformatics in Water resource management	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 327	Minor project-III	It will provide basic understanding of literature review and paper writing on various applications of geoinformatics
CWR 329	Seminar-III	It will be helpful to improve the ability of the presentation of various topics, Written and verbal communication skills, Communication skills
CWR 381	Geoinformatics in Natural Resource Management Lab	It will provide hands on training to analyse remote sensing images for environmental impact assessment, Air and water pollution Urban climate etc.
CWR 383	Geoinformatics in Water resource management Lab	It will provide practical knowledge of Remote sensing and GIS in water quality assessment, Management of watershed, Drainage analysis, Morphometry and geomorphology
CWR 335	Geoinformatics in Regional and Urban planning	Through this course students should be able to understand Urban mapping, Town and regional planning, Urban growth modelling Transportation analysis
CWR 337	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 339	Geoinformatics in Ecology & Forestry	To understand application of Geoinformatics in Forest inventory and mapping, Forest fire simulation and mapping, Forest conservation, Ecosystem services

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CWR 389	Geoinformatics in Regional and Urban 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 391	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 393	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 343	Geoinformatics in snow and glacier hydrology	It will provide the knowledge of glaciological process and its impact on hydrological processes.
CWR 347	Geoinformatics in Climate Change and Environment Impact Assessment	To know about how the geoinformatics application can useful for Environmental Impact assessment.
4 Semester		
CWR 324	Dissertation/Project work	It will provide comprehensive knowledge of research and paper writing on various applications of geoinformatics

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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.Sc. Geoinformatics **Semester-I**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T/S	P		CE	ESE
A	**University Core**								
1.	EM 501	Employability Skills	1		1		3	60	40
2.	PC-501	Proficiency and Co-Curricular Activity-I	2					100	
3.	FD 102	Foundation Course-I	1	1	0	0	3	25	75
B	**Program Core**								
4.	CWR 301	Principles of Remote Sensing	3	3		-	3	40	60
5.	CWR 303	Aerial Photography & Photogrammetry	3	3		-	3	40	60
6.	CWR 305	Cartography and GPS	3	3		-	3	40	60
7.	CWR 307	Geosciences & image Interpretation	3	3		-	3	40	60
8.	CWR 309	Computer Programming	3	3		-	3	40	60
9.	CWR 311	Minor Project -I	3	0	0	3		60	40
10.	CWR 313	Seminar–I	1	0	2	0		60	40
11.	CWR 371	Aerial Photography & Photogrammetry Lab	1	0	0	2	3	60	40
12.	CWR 373	Cartography and GPS Lab	1	0	0	2	3	60	40
13.	CWR 375	Geosciences & image Interpretation Lab	1	0	0	2	3	60	40
14.	CWR 377	Computer Programming Lab	1	0	0	2	3	60	40
C	**Program Elective(Any One)**								
15.	CWR 315	Fundamentals of mathematics	3	3	0	0	3	40	60
16.	CWR 317	Neural Networks and Fuzzy Logic	3	3	0	0	3	40	60
17.	CWR 319	Artificial Intelligence	3	3	0	0	3	40	60
18.	CWR 379	Neural Networks and Fuzzy Logic Lab	1	0	0	2	3	60	40
		Total	**30**					-	-

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher Shruti

Signature of Convener-BoS_____

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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.Sc. Geoinformatics **Semester-II**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T/S	P		CE	ESE
A	**University Core**								
1	EM-502	Employability Skills	1		1		3	60	40
2	PC-502	Proficiency and Co-Curricular Activity-II	2					100	
3	FD 104	Foundation Course-II	1	1	0	0	3	25	75
B	**Program Core**								
4	CWR 302	Digital Image Processing	3	3		-	3	40	60
5	CWR 304	Geographic information System	3	3		-	3	40	60
6	CWR 306	Database Management System	3	3		-	3	40	60
7	CWR 308	Statistics for Geoinformatics	3	3		-	3	40	60
8	CWR 310	Geoinformatics in Geo-hazards	3	3		-	3	40	60
9	CWR 312	Principles of Management	2	0	0	0	2	40	60
10	CWR 314	Seminar–II	1	0	2	2	3	60	40
11	CWR 316	Minor Project -II	3	0	0	3	3	60	40
12	CWR 318	Industrial Training	1	0	0	0	1		100
13	CWR 352	DIP Lab	1	0	0	2	3	60	40
14	CWR 354	Geographic information System lab	1	0	0	2	3	60	40
15	CWR 356	Database Management System lab	1	0	0	2	3	60	40
16	CWR 358	Geoinformatics in Geo-hazards lab	1	0	0	2	3	60	40
C		**Program Elective(Any One)**							
17	CWR 320	Geoinformatics in hydrocarbon and energy resources	3	3	0	0	3	40	60
18	CWR 322	Geoinformatics in Land Information System	3	3	0	0	3	40	60
19	CWR 360	Geoinformatics in Land Information System Lab	1	0	0	2	3	60	40
		Total	**33**	**15**	**3**	**11**		-	-

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

Signature of Concerned Teacher

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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.Sc. Geoinformatics **Semester: III**

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T/S	P		CE	ESE
	(A)University Core:								
1.	PC-601	Proficiency and Co-Curricular Activity-III	2	0	0	0	0	100	
	(B)Program Core								
2	CWR 321	Research Methodology	3	3	0	0	3	40	60
3	CWR 323	Geoinformatics in Natural Resources Management	3	3	0	0	3	40	60
4	CWR 325	Geoinformatics in Water Resources Management	3	3	0	0	3	40	60
5	CWR 327	Minor Project -III	3	0	0	3	3	60	40
6	CWR 329	Seminar–III	1		2		3	60	40
7	-	Elective I	3	3	0	0	3	40	60
8	-	Elective -II	3	3	0	0	3	40	60
9	CWR 381	GNRM Lab	1	0	0	2	3	60	40
10	CWR 383	GWRM Lab	1	0	0	2	3	60	40
11		Elective – I Lab	1	0	0	2	3	60	40
12		Elective – II Lab	1	0	0	2	3	60	40
		Total	25	15	3	11		-	-

L - Lecture
T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
ESE – End Semester Examination

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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.Sc. Geoinformatics Semester: III

S. No.	Course Code	Course Name	Credits	Contact			Exam Hrs.	Weightage (in	
				L	T/S	P		CE	ESE
1	CWR 331	Geoinformatics in Agriculture	3	3	0	0	3	40	60
2	CWR 333	Geoinformatics in Desert	3	3	0	0	3	40	60
3	CWR 335	Geoinformatics in Regional and Urban planning	3	3	0	0	3	40	60
4	CWR 337	Geoinformatics in Disaster Management	3	3	0	0	3	40	60
5	CWR 339	Geoinformatics in Ecology & Forestry	3	3	0	0	3	40	60
6	CWR 341	Geoinformatics for Coastal Zone Management	3	3	0	0	3	40	60
7	CWR 385	Geoinformatics in Agriculture Lab	1	0	0	2	3	60	40
8	CWR 387	Geoinformatics in Desert Lab	1	0	0	2	3	60	40
9	CWR 389	Geoinformatics in Regional and Urban planning Lab	1	0	0	2	3	60	40
10	CWR 391	Geoinformatics in Disaster Management Lab	1	0	0	2	3	60	40
11	CWR 393	Geoinformatics in Ecology & Forestry Lab	1	0	0	2	3	60	40
12	CWR 395	Geoinformatics for Coastal Zone Management Lab	1	0	0	2	3	60	40
13	CWR 343	Geoinformatics in Snow and Glacier Hydrology	3	3	0	0	3	40	60
14	CWR 347	Geoinformatics in Climate Change and Environmental Impact Assessment	3	3	0	0	3	40	60
15	CWR 397	Geoinformatics in Snow and Glacier Hydrology Laboratory	1	0	0	2	3	60	40
16	CWR 399	Geoinformatics in Climate Change and Environmental Impact Assessment Laboratory	1	0	0	2	3	60	40

List of Programme Elective - III SEM

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T – Tutorial
P – Practical

CIE – Continuous Internal Evaluation
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Signature of Teacher

Signature of Concerned

Convener-

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

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

Year: II
Semester: IV

S. No.	Course Code	Course Name	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
				L	T/S	P		CE	ESE
		A. Practical& Sessional:							
1	CWR 324	Dissertation/Project Work	20	0	0	0	2		100
		Total	20				-	-	-

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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Syllabus of M.Sc. Geoinformatics

Centre for Climate Change and Water Research

CWR 301 PRINCIPLES OF REMOTE SENSING **(L, T, P) = 3 (3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT 1	**Principles of Remote Sensing:** Definition - History & Concepts - Electromagnetic Radiation (Source, Mode of Energy transfer, Radiation Principles, Black body radiation), Multi-concept in RS, teledection and earth observation	8
UNIT 2	**Electro Magnetic Radiation (EMR):** EMR Spectrum, applications of spectral ranges, EMR Interaction with Atmosphere (Absorption, Scattering & Atmospheric windows) - EMR Interaction with Earth surface (Absorption & reflection) – Spectral Response pattern - Energy budgeting in Remote Sensing, Atmospheric effects	7
UNIT 3	**Sensors and Platforms:** Resolutions (Spectral, Spatial, Temporal, Radiometric) - Platforms - Sensors - Scanning & Orbiting Mechanism of Satellites and Data Acquisition. Optical Remote Sensing: Basic concepts – Optical sensors and scanners, Imaging and non-imaging scanners	7
UNIT 4	**Thermal & Microwave Remote Sensing:** Thermal Remote Sensing: Basic concepts - Thermal sensors & scanners - Thermal Inertia. Microwave Remote Sensing: Basic concepts - Microwave sensors and Radiometers-Geometric characters - Radargrammetry (SLAR / SAR), Coherence, polarimetry, LIDAR, LIDAR footprint, Hyper spectral Remote Sensing: basic concepts and applications	7
UNIT 5	Remote Sensing Satellites (LANDSAT Series - IRS Series - IRS-P series – Cartosat - Spot Series - ASTER, MODIS – IKONOS – QUICKBIRD - ORBVIEW – ERS) - Meteorological Satellites – Shuttle Mission – Developments of Remote Sensing in India - Future Remote Sensing Missions), Earth observation for SDGs	7

REFERENCE BOOKS

Text Books:

1. Lillesand, T.M. And P.W.Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York. Third Edition, 2007.

2. Curran, P. Principles of Remote Sensing, Longman, London. 1985. 3. Sabins, F.F.Jr., Remote Sensing Principles and Interpretation, Freeman, Sanfrancisco. 1978.

References:

1. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church, Virginia. 2nd Volume, 1983.

2. Lo.C.P. Applied Remote Sensing, Longman, London. 1986.

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3. Richadson, B.F.Jr. (Ed), Introduction to Remote Sensing of the Environment, Kendall / Hunt, Dubuque, Iowa. 1978.
4. Burney, S.S, Application of Thermal Imaging, Adam Hilger Publications, 1988.
5. Drury S.A, A Guide to Remote Sensing - Interpreting Images of Earth, Oxford Science Publications, Oxford. 1990.
6. Floyd M. Henderson, Principles & Applications of Imaging Radar, John Wiley & Sons, New York. 1998.
7. Duda, R.D and P.E.Hart Pattern Classification And Scene Analysis, Wiley Interscience, New York. 1972.

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CWR 303 AERIAL PHOTOGRAPHY & PHOTOGRAMMETRY (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT 1	Aerial Photography: History - Types of Photographs - Scale of Photographs, (Scale in Vertical & Tilted Photographs, Average Photo scale) - Relief displacement - Tilt displacement - Scale distortions - Radiometric characters, aerial sensors	7
UNIT 2	Stereo Models: Monoscopy - Stereoscopy - Pseudoscopy - Base height Ratio -Vertical Exaggeration - Stereoscopic Parallax & Height measurement - Analog Photogrametric Techniques. Photo Mosaics: Photo indexing - Photo mosaic (uncontrolled, semi controlled & controlled, mosaics) – Flight planning – Aerial triangulation, photographic camera	8
UNIT 3	Digital Photogrammetry I: Data sources and input processes (Digital Cameras, Operation principles, Scanners for analog to digital conversion) - Digital Photogrammetric techniques & processes (Digital Photogrammetric equipment, Stereo viewing, image measurements, co-ordinate systems, image transformation, image orientation).	7
UNIT 4	Digital Photogrammetry II: Ortho Photo – Rectification – DEM- ALTM – LIDAR – SRTM, Cartosat, Applications of DEM data	7
UNIT 5	Photo Interpretation Keys & Elements: Photo Interpretation Keys (Definition, its parts, Key sets, Types of Study) - Photo Interpretation Elements (Photo elements - Tone, Texture, Color, Shadow) - Geotechnical/ Geomorphic elements (Landforms, Drainage, Erosional pattern, vegetative cover, Land use, Shape & size of objects), factors affecting interpretation	7

REFERENCE BOOKS

1. Wolf, P.R. Elements of Photogrammetry Mcgraw Hill Book Co., Tokyo. 1974.
2. Moffit H.F. And Edward, M.M, Photogrammetry, 3rd Edition, Harper and Row Publishers, New York. 1980.
3. Bhatt. A.B., Aerial Photography & Remote Sensing (An Introduction), Bishen Singh& Mahendra Pal Singh Pub., 1994.
4. Rampal, Handbook of Aerial Photography and Interpretation, Concept publishing. 1999.
5. American Society of Photogrammetry, Manual of Remote Sensing (II Edition), ASP, Falls Church, Virginia. 1983.
6. Burnside, C.D., Mapping From Aerial Photographs, Collins Publishers. 1985.
7. John, T.Smith Jr, Manual of Colour Aerial Photography (I Edition) American Society of Photogrammetry, ASP Falls Church, Virginia, 1968.
8. Colwell, Robert, Manual of Photographic Interpretation, American Society Of Photogrammetry, ASP Falls Church, Virginia. 1960.
9. David Paine. Aerial Photography and Image Interpretation for Resource Management, John Wiley & Sons, New York. 2003.
10. Yves Egels; Digital Photogrammetry, Tailor & Francis Inc. 2002.
11. Yongru Huang A, Digital Photogrammetry system for Industrial Monitoring

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CWR 305 CARTOGRAPHY AND GPS (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT 1	Introduction to cartography, evolution and scope, Map elements, Classification of maps, Topographical maps, Survey of India National Series maps, indexing and map interpretation. Reference and Coordinate System	8
UNIT 2	Classification of Map Projections: Method of construction (conformal, equivalent and azimuthal), Perspective (Conical, Cylindrical, Zenithal), Conventional map Projections, Comparison among projections (UTM, Polyconic, LCC), Transformation, visualization of distortions, interpolation methods, reprojection of maps	7
UNIT 3	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 Design (manual vs. digital), compilation & printing, displaying of maps	7
UNIT 4	Global Positioning System, GPS Segments, Satellite constellation, GPS signals, GPS antenna, Type of GPS receivers, Geopositioning, Pseudo Range Measurement, Phase Difference Measurement, Geoid, Ellipsoid, Datum, Satellite geometry, Basic Trilateration	7
UNIT 5	GPS Positioning Types: Absolute & Differential, Real Time Kinematic, GPS Survey Planning, GPS & DGPS Data Processing and Accuracy, GNSS: NAVSTAR, GLONASS, GALILEO, COMPASS, Indian Navigation Satellite Missions. WAAS, GPS Applications.	7

REFERENCE BOOKS

1. Keates, J.S., (2008): Cartographic Design and production, London, Longman
2. Elliott D. Kaplan (Author, Editor), Christopher Hegarty (2005) Understanding GPS: Principles and Applications, Second Edition, Artech House
3. Ramesh, P. A., (2000): Fundamentals of Cartography, Concept Publishing Co., New Delhi.
4. Rampal, K.K., (2004): Mapping and Compilation, Concept Publishing Co. New Delhi.
5. Anson, R.W. & Ormeling, F.J., (2008), Basic Cartography, Vol. 1, 2nd ed., Elsevier Applied Science Publishers, London.
6. Robinson A.H. & Morrison J.L, (1995) Elements of Cartography, John Wiley & Sons
7. Singh, R.L & Dutt. P.K,(2008), "Elements of Practical geography", Students Friends Allahabad
8. Peterson, M.P., (1995) "Interactive and Animated Cartography" Upper Sadde River, NJ: Prentice Hall
9. N.K. Agrawal ,(2004) ,Essentials of GPS, Spatial Network Pvt. Ltd
10. Sathish Gopi (2000), GPS and Surveying using GPS
11. Leica. A., (2003), GPS Satellite Surveying, John Wiley & Sons, use. New York
12. Terry-Karen Steede, (2002), Integrating GIS and the Global Positioning System, ESRI Press.

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CWR 307 GEOSCIENCES AND IMAGE INTERPRETATION (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Concept of Earth System, Lithosphere, Biosphere, Hydrosphere & Atmosphere, Continental Drift, Plate Tectonics Theory and relationship to earthquakes and volcanic activity, role of satellite image in earth system sciences	8
UNIT II	Visual and digital image interpretation techniques, Elements of image interpretation, Development of interpretation keys, factors affecting image interpretation, activities of image interpretation	7
UNIT III	Igneous, Sedimentary and Metamorphic Rocks: Types, Forms, Field characteristics and rock type delineation on satellite Images, Mineral deposits & their types, spectral signatures of rocks	7
UNIT IV	Folds, Faults and Joints, Field characteristics of rock structures and delineation on satellite images, Lineaments mapping using earth observation datasets	7
UNIT V	Fundamental concepts, geomorphic agents, Classification of fluvial, aeolian, glacial and marine landforms Drainage patterns and significance, Image characteristics of landforms. Geoinformatics in mineral exploration, Engineering geological investigation: Tunnel, dam & reservoir, Groundwater exploration and zonation mapping using AI/ML	7

RECOMMENDED READINGS

1. Parbin Singh(2013) Engineering and General Geology, S.K. Kataria & Sons
2. Murk & Skinner, (1999). Geology Today - Understanding Our Planet, John Wiley And Sons Inc, New York
3. Lillisand, T. M. and Keifer, R. W., (2007). Remote Sensing and Image Interpretation', John Willey and Sons, New York, Fourth Edition
4. Pandey, S. N., (1987). Principles and Applications of Photogeology. New Delhi: Eastern Wiley.
5. Jenson, J.R., (2006). Remote Sensing of the Environment – An Earth Resource Perspective, Prentice Hall Inc.
6. Drury, S.A., (2004). Image Interpretation in Geology, Chapman & Hall, India.
7. Thornbury, W. D., (I969): Principles of Geomorphology, John Wiley and Sons, New York
8. Sabins, Floyd F., (2007). Remote Sensing: Principles and Interpretation, 2nd Ed., Freeman, New York.

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CWR 309 COMPUTER PROGRAMMING **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Programming languages, C++ Programming, Data Types, Variables, Constants, Expressions, Statements & Control Variables, Strings & Pointers	8
UNIT II	Operators, Functions, Function Overloading, Classes, Constructors, Destructors Inheritance and its types, Advance Feature of Classes, Templates	7
UNIT III	Principles of computer networks, protocols, TCP/IP Internet services, WWW, Web servers, Web clients. Web page design principles, HTML, XML, Php, Syntax, WebGIS Architectures, Web GIS System Integration, Application Development	7
UNIT IV	Internet GIS software & Open source, Internet services to GIS, Major WebGIS applications: ArcGIS IMS, ArcGIS Server, Erdas Titan, MangoMap, CartoDB, GeoCommons, CloudGIS, MapBox Interoperability issues & OpenGIS.	7
UNIT V	WebGIS services: USGS, Bhuwan 2D & 3D, Google Earth, E-Governance, Potential of Geoportals & NSDI, Crowd Mapping, Participatory GIS	7

REFERENCE BOOKS:

1. Pinde Fu, Jiulin Sun (2011), Web GIS: Principles and Applications, ESRI Press
2. Songnian Li, SuzanaDragicevic, Bert Veenendaal (2011) Advances in Web-based GIS, Mapping Services and Applications (ISPRS Book Series). CRC Press
3. GE Sherman (2008), Desktop GIS - Mapping the planet with Open Source, O'Reilly
4. Fatimah Abdullahi (2012) Design and Implementation of a Web-Based GIS, LAP Lambert Academic Publishing
5. Davis, S. (2007) GIS for Web Developers - Adding 'Where' to Your Web Applications, O'Reilly
6. Bill Kropla (2006) Beginning MapServer: Open Source GIS Development (Expert's Voice in Open Source)Apress
7. ErwanBocher (Editor), Markus Neteler (2012) Geospatial Free and Open Source Software in the 21st Century (Lecture Notes in Geoinformation and Cartography), Springer
8. Rene Rubalcava (2014) ArcGIS Web Development, Manning Publications
9. Hussein Nasser (2014) Administering ArcGIS for Server, Packt Publishing Limited
10. Regina O. Obe, Leo S. Hsu (2015) PostGIS in Action, Manning Publications; 2nd edition

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CWR 315 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 317 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.	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.	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 319 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, Ensemble artificial intelligence methods and applications	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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Semester II

CWR 302 DIGITAL IMAGE PROCESSING (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT- 1	Principles: Data encoding and decoding - digital image formats - band sequential and band interleaved - characteristic features. Software - raster and vector files, raster data compression, raster data conversion	8
UNIT-II	Image Rectification and Restoration: geometric correction, radiometric correction - noise removal - image enhancement: contrast manipulation - graylevel threshold, level slicing, and contrast stretching, post-processing of images, Sun-angle correction	7
UNIT- III	Histogram equalization – Image subtraction – Image averaging – Spatial filtering: Smoothing, sharpening filters – Laplacian filters – Frequency domain filters: Smoothing – Sharpening filters – Homomorphic filtering. Principal component analysis, Fourier transformation	7
UNIT- IV	Vegetation components - intensity - hue - saturation colour space transformation. Pattern Resolution: concepts - linear and non- linear discriminate function, Band rationing	7
UNIT-V	Image Classification: Supervised classification - classification stage - minimum distance to Means classifier - parallelepiped classifier - Gauss maximum likelihood classifier - training stage - Unsupervised classification - output stage - post classification smoothing - classification accuracy assessment, Advanced classification methods	7

Text Books

1. Lillisand T.M. , R.W.Kiefer and Chipman (2004) 5th edition. Remote sensing and image interpretation, John Wiley & Sons, New York.
2. American Society of Photogrammetry, (1983). Manual of Remote Sensing, (2nd edition), ASP, Falls Church, Virginia

References

1. Ekstrom, M. P. 1984, Digital image processing techniques. New York, Academic Press.
2. Harris,R. 1987, Satellite Remote Sensing - An Introduction. London, Routledge.
3. Moffit, H.F., and Edward, M.M., (1980). Photogrammetry, Harperand Row Publishers, New York.

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CWR 304 GEOGRAPHIC INFORMATION SYSTEM (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Basic concepts about spatial information (continuous and discrete), Applications potential of GIS, Historical evolution of GIS, Component of GIS, GIS operations, recent trends in GIS	8
UNIT II	Geospatial Data: Spatial (point, line polygon) & non-spatial (tables), Linkage of spatial and non-spatial data, Spatial data models: Raster and Vector, Comparison between Raster & Vector. Representation of raster and Vector data, Data type (.img, .tiff), Data Conversions- raster to vector, rasterization and vectorization, DATA compression techniques	7
UNIT III	Sources of raster data (satellite, AERIAL, TOPO etc.), Raster data structure: Cell by Cell, Run length encoding, Quart tree, Advantages & Limitations of Raster Based GIS, Raster Data Analysis: Overlay Operations, Statistical Analysis (Map Algebra), 3D models: DEM, DSM, DTM, TIN, Contours, spot heights, slope and aspect, Role of GIS in surface generation	7
UNIT IV	Digitization, type (hands on, online), projection and transformation, RMS Error, Database: designing, editing and manipulation; Topology: contiguity, connectivity, containment, Vector Data Analysis (Basic Concepts), errors (slivers, overshoot, undershoot, mismatch of two adjacent layers), Feature Based Topological functions: Overlay Analysis, Buffering, Distance Measurements, Layer Based Topological Functions, conversion of geographic features	7
UNIT V	Interactive Data Exploration, Attribute Data Query, Spatial Data Query, Raster Data Query, need of data integration, Integration of RS & GIS, Web GIS concepts and its application, GIS project planning, GIS Application in natural resources monitoring & management, Facility management, utility management, 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.
4. Magwire, D. J., Goodchild, M.F. and Rhind, D. M., (2005), „Geographical Information Systems: Principles and Applications', Longman Group, U.K.

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CWR 306 DATABASE MANAGEMENT SYSTEM **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Introduction to Database Management Systems: Data, Information, Database, Transaction and its desired properties, File Server Model, Client Server Model, Advantages of using DBMS over conventional methods, DBMS Features, Components of DBMS, Data Abstraction, Data Independence, Recent trends in DBMS	8
UNIT II	Data Modeling: Logical and Physical Data Models, E-R Modeling, Record Based Models, Relational Model An overview, Relational Concepts, Tables, Keys, Constraints, Data Integrity and Constraints, Integrity Rules, Normalization, Advances in data modelling, interoperable data models	7
UNIT III	Introduction to SQL: Introduction to SQL, SQL Features, SQL Operators, SQL Datatypes, SQL Parsing, Types of SQL Commands, Querying Data from the database, Correlated Sub-queries, Joins, Hierarchical Queries, PL/SQL Introduction, use of SQL in geodatabase	7
UNIT IV	Distributed Databases: Structure and design, Distributed query processing, Recovery, Commit protocols, Concurrency controls, Deadlock handling, Shadow paging	7
UNIT V	Emerging trends Object Oriented databases, Object oriented queries Active databases Deductive databases concepts of next generation databases, XML, Data Warehouses and data mining, Advanced data mining techniques	7

REFERENCE BOOK

Text Books

1. Abraham Silberschatz; Henry F Korth, Database System Concepts, McGraw Hill Publication, 2002

2. Won Kim, Introduction to Object-Oriented Databases, MIT Press, 1990

References

1. Stefano Ceri; Giuseppe Pelagatti, Distributed Databases: Principles and Systems, Universities Press, 2000

2. Jan L Harrington, Object Oriented Database Design Clearly Explained, Harcourt, 2000

3. Elmasri,Ramez; Navathe, Shamkant B, Fundamentals of Database Systems, Pearson, 2000

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CWR 308 STATISTICS FOR GEOINFORMATICS **(L, T, P) = 3(3, 0, 0)**

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Meaning, Scope and Importance of Statistics, Collection of data - sampling methods; random and systematic method; source of data - primary and secondary, Organization of data - array, frequency, class intervals, histograms, and distribution, Presentation of Data: Tables, Diagrams	8
UNIT II	Grouped data and ungrouped data, Geographical data: discrete and continuous series, scales of measurement, Measures of Central Tendency - mean, median, mode, quartiles, Moments, Skew ness, Kurtosis, Measures of Dispersion – absolute dispersion, relative dispersion	7
UNIT III	Correlation: meaning, scatter diagram, standard deviation, variance, Measures of correlation – Karl Pearson"s method (two variables ungrouped data), Spearman"s rank correlation methods. Mean centre of population and temporal shift, Bi-variate & Multiple correlation and regression, Correlation analysis Scatter Diagram & Residual mapping, T-test, Z-Score, Root Mean Square Error, Principal Component analysis	7
UNIT IV	Surface Modelling: Spatial autocorrelation, Role of Interpolation, Methods of Interpolation – Global and Local Deterministic Methods, Moving Averages, Inverse Distance Interpolation, Optimal Interpolation using Geostatistics	7
UNIT V	Variogram and its use for Interpolation, Interpolation by Kriging – Ordinary Kriging, Block Kriging, Non-Linear Kriging, Stratified Kriging, Co-Kriging, Universal Kriging, Probabilistic Kriging iv. Factor and cluster analysis	7

REFERENCE BOOK

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

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CWR 310 GEOINFORMATICS IN GEOHAZARDS (L, T, P) = 2 (2, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Remote Sensing in Neo – Seismotectonics: Mapping of Lineament anomalies – Geomorphic anomalies (Tectonic, Denudational, Fluvial, Coastal & Aeolian) – Resistivity anomalies – Gravity & other Geophysical anomalies – Ground water anomalies – historic seismic data analysis – GIS integration and risk assessment, RS & GIS integration in geohazards and disasters	8
UNIT II	Remote Sensing & GIS in Landslides and Slope Stability: Mapping of Landslides morphology – Landslides Classification – Geological and triggering parameters – GIS based LHZ (Integrated slope mapping, Integrated Terrain analysis, Parametric ranking method, BIS and other methods) – Factor of safety – Risk assessment – Mitigation Strategies.	7
UNIT III	Remote Sensing & GIS in Tsunami disasters: Tsunami inundation mapping using field & Satellite data – Elucidation of interface dynamics between Tsunami & coastal land systems – Mitigation strategies – Tsunami vulnerability mapping, Development of early warning systems	7
UNIT IV	Remote Sensing & GIS in Flood disasters: Flood Vulnerability mapping using historical flood data and post flood Remote Sensing data – Detection of causative factors of flood – Remedial strategies, Active sensors in flood mapping	7
UNIT V	Remote Sensing & GIS in Other Disasters: Mapping and mitigation of disasters (Cyclone - drought - Volcanic - Glacial - Desert - Coastal erosion -Salt water intrusion - Soil erosion and Reservoir Siltation.)	7

Text/reference books

1. Chouhan.T.S., Joshi, K.N., Applied Remote Sensing and Photo Interpretation, Vigyan Prakashan, 1996. 2. Chouhan, T.S., Joshi, K.N., Readings in Remote Sensing Applications, Scientific publishers, 1992.

3. Ramasamy, SM., Remote Sensing in Geology, Rawat Publishers

4. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi, 2005. 5. Ramasamy, SM., C.J. Kumanan, The Indian Context – Allied Publishers, Chennai.

6. Ramasamy, SM., C.J. Kumanan, Sivakumar, Bhoop Singh, Geomatics in Tsunami, New India Publishing Agency, New Delhi.

7. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi, 2007.

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CWR 312 Principles of Management **C (L,T,P) = 2 (2,0,0)**

UNIT	COURSE CONTENTS	Hours
I	OVERVIEW OF MANAGEMENT: Definition - Management - Role of managers - Evolution of Management thought - Organization and the environmental factors – Trends and Challenges of Management in Global Scenario.	8
II	PLANNING: Nature and purpose of planning - Planning process - Types of plans – Objectives - - Managing by objective (MBO) Strategies - Types of strategies - Policies - Decision Making - Types of decision - Decision Making Process - Rational Decision Making	7
III	ORGANIZING: Nature and purpose of organizing - Organization structure - Formal and informal groups organization - Line and Staff authority - Depart mentation - Span of control - Centralization and Decentralization - Delegation of authority - Staffing - Selection and Recruitment - Orientation - Career Development - Career stages – Training - - Performance Appraisal.	7
IV	DIRECTING: Creativity and Innovation - Motivation and Satisfaction - Motivation Theories - Leadership Styles - Leadership theories - Communication - Barriers to effective communication - Organization Culture - Elements and types of culture - Managing cultural diversity.	7
V	CONTROLLING Process of controlling - Types of control - Budgetary and non-budgetary control Q techniques - Managing Productivity - Cost Control - Purchase Control – Maintenance Control - Quality Control - Planning operations.	7
	Total	**36**

TEXT BOOKS:

1. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition.

2. Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.

REFERENCE BOOKS:

1. Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach", Thomson South Western, 10th edition, 2007.

2. Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management - A global A Global, Innovative, And Entrepreneurial Perspective.

CWR 320 GEOINFORMATICS IN HYDROCARBON AND ENERGY RESOURCES (L,T,P) = 3 (3,0,0)

UNIT	COURSE CONTENTS	Hours 36
I	Basic Principles: Hydrocarbon - (Definition, organic and inorganic theories of Hydrocarbon genesis) – Migration and Entrapment – Diversity in Occurrences – Basin Analysis and Basin History – Field Geological and Geophysical methods of Oil Exploration	8
II	Remote Sensing based oil exploration: Remote Sensing for Oil Exploration in Terrestrial basins – detection of obscured Structures, buried structures and basement structures for Oil Exploration	7
III	Integrated Remote Sensing and GIS in Oil Exploration: Integrated Hyperspectral Remote Sensing & GIS – Analysis of deep seated Geological Structures and faults– Establishment of connectivity of faults at the surface through DEM based Multimode Multidepth Geophysical and Borehole Data – Detection of zone of degasification using soil tonal anomalies through Hyper-spectral data – Geochemical Anomalies – Identification of Locales for Hydrocarbon Exploration	7
IV	Offshore Oil Exploration: Mode of Occurrence – Exploration Methods – ETOPO Data and sea bed tectonic studies – SAR data and oil seepage detection – LIDAR applications – GIS based integrated techniques.	7
V	Coal & Geothermal Exploration: Coal Exploration: Origin of Coal – Sedimentology of coal bearing strata – Mode of occurrence – Structures associated with coal seams – Clit mapping – Methane rich coal detection - Classification of Coal – Chemical analysis of coal – Integrated Remote Sensing and GIS in Coal Exploration. Geothermal Exploration: Geothermal Resources – Thermal Remote Sensing Data Analysis – Water temperature Analysis – Heat flow Analysis – Neotectonic Analysis – Data integration.	7
	Total	**36**

Suggested readings

1. Chouhan. T.S., Joshi, K.N., Applied Remote Sensing and Photo Interpretation, Vigyan Prakashan, 1996. 2. Chouhan, T.S., Joshi, K.N., Readings in Remote Sensing Applications, Scientific publishers, 1992.

3. Ramasamy, SM., Remote Sensing in Geology, Rawat Publishers

4. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi.

5. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi.

6. Deman, MCJ, Smith G.S and H.T.Verstappen (eds.) Remote Sensing for resources development and environmental management, A.A.Ballkema Publishers, Totterdam, Netherlands.

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7. Paine, D.P 1981: Aerial photography and image interpretation for resource management, Wiley and Sons, New York. 1986.

8. Levorsen A.I., Geology of Petroleum, CBS Publishers and Distributors, Delhi, Second Edition, 1985.

9. Joseph E. Robinson, Computer Applications in Petroleum Geology, Hutchinson Ross Publishing Company, 1982.

10. Bhagwan Sahay, Petroleum Exploration and Exploitation Practices, Allied Publishers Limited, Anna Salai, Chennai, 1994.

11. Chandra D. and Singh R.M, Petroleum (Indian Context), TARA Book Agency,Rathayatra-Gurubagh Road, Kamachha, Varanasi, 2003..

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CWR 322 GEOINFORMATICS IN LAND INFORMATION SYSTEM (L,T,P) = 3 (3,0,0)

UNIT	COURSE CONTENTS	Hours 36
I	Land rights evolution, Stages of land records automation, Modern systems of land records, Land Tenure, Land records, Land Information System, Legal cadastre: description of legal and fiscal interests in land, land ownership records	8
II	Local government, Public, Land-related business and NGOs, LIS in development planning, Record of Rights, LIS for infrastructure development	7
III	Satellite sensor, HRS, Aerial sensor, UAV, LIDAR, Digital photogrammetry, Geodetic / geographic control frameworks, DGPS survey, GNSS, DEM, DSM	7
IV	Primary data sources, Cadastral sheet, ROR, Digital conversion of ROR sheets, quality, errors, Maintenance and updation of digital land records, benefits and limitations, E-governance and Decision support system, Development of spatial decision support system	7
V	Land planning, infrastructure development and maintenance, Environmental protection and resource management, emergency services, social service programs, basis for land markets, development, and other economic activity, Web based LIS, NLRMP, LIS in property tax & revenue assessment, LIS in utility services and amenities	7
	Total	**36**

SUGGESTED READINGS:

1. Peter F. Dale (Author), John D. McLaughlin (2000) Land Administration (Spatial Information Systems and Geostatics Series) Oxford University Press
2. Martin Ralphs (2003) GIS in Land and Property Management, Taylor & Francis
3. AnnickJaton (Author), Kim Lowell (Editor), AnnickJaton , Spatial Accuracy Assessment: Land Information Uncertainty in Natural Resources, Amazon Digital Services

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Semester III

CWR 321 RESEARCH METHODOLOGY (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing	8
UNIT II	Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.	7
UNIT III	Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non-probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size	7
UNIT IV	Data Analysis – Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package in Research.	7
UNIT V	Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.	7

REFERENCE BOOKS:

1. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000
2. Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.
3. C.R.Kothari, Research Methodology, Wishva Prakashan, New Delhi, 2001.
4. Donald H.McBurney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002.
5. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
6. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.

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CWR 323 GEOINFORMATICS IN NATURAL RESOURCE MANAGEMENT (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Classification & types of resources, Factors influencing on availability of resources, Uses and distribution. Ecological & social dimension of Natural resources. Overexploitation & sustainable development of resources, renewable and non-renewable resources	8
UNIT II	Land as a resource, Land use classification using machine learning methods, land degradation, Landscape analysis. Soil & their types, soil erosion and desertification, wetland ecology. Mineral resources, mining impact on land resources, satellite-based mapping of land & soil resources.	7
UNIT III	Surface and subsurface water resources, distribution on the earth, Mapping for surface water bodies. Hydro-geomorphic mapping of water resources, concept of water harvesting, Sustainable water resources management, water contamination, RS and GIS in water borne hazards zonation and mapping	7
UNIT IV	Growing energy needs, renewable and non-renewable energy sources, Uses of alternate energy sources. Energy conservation, Case studies (Geoinformatics in site suitability analysis for energy resources), Green energy and its concepts	7
UNIT V	Forest vegetation, status and distribution, major forest types and their Characteristics in India. Deforestation, Forest Impact analysis on mining, construction & growth activities. Forest and wildlife issues, Forest management & climate change. Remote sensing for forest resources management, Role of LIDAR in forest mapping	7

RECOMMENDED READINGS

1. Francois Ramade 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
2. Jensen, John R. 2009. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.
3. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
4. Thomas B. Daugherty.2000. Delmar Cengage Learning, Science - 422 pages.
5. Susan Ustin. 2004. Manual of Remote Sensing, Volume 4, Remote Sensing for Natural Resource Management and Environmental Monitoring, 3rd Edition, 768 pages.

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CWR 325 GEOINFORMATICS APPLICATIONS IN WATER RESOURCES MANAGEMENT (L, T, P) = 3 (3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Introduction: Hydrologic cycle, components of hydrologic cycle - processing and parameterization in hydrology; Water resource scenario in India, Hydrological modeling. GIS applications in water resources development and management. Sustainable water harvesting	8
UNIT II	Floods and flood management. Spectral properties of water. Floods types; causes and mitigation measures, flooding potential zonation mapping, flood hazard assessment, flood risk analysis using RS and GIS, RS and GIS in Cyclone mapping and mitigation, digital surface modeling, flood hazard simulation and modeling	7
UNIT III	Ground water resources: Groundwater, hydro geomorphology, Ground water potential assessment, groundwater prospect zones mapping, ground water modeling, ground water information system, planning and management of ground water. Groundwater quality mapping. Ground and surface water interactions, Advanced methods for ground water mapping	7
UNIT IV	Irrigation management: Mapping and monitoring of catchments and command areas, land irrigability, soil irrigability mapping, irrigation canal alignment, crop norm violation, agriculture water demand estimation for different crops, tank information system, wet land mapping, siltation mapping, optimum usage planning and management of irrigation water, soil salinity and water logging	7
UNIT V	Watershed management: Watershed- Drainage and water body mapping, morphometric analysis, classification, delineation and coding of watersheds, reservoir sedimentation - watershed development planning, watershed prioritization, Watershed Information System; mapping drought-prone areas.	7

Text Reference Books

1. John G Lyon, 2003, GIS for Water Resources and Watershed Management, CRC Press LLC.
2. K.Kovar & H.P. Nachtnebel, 1996, Application of Geographic Information Systems in Hydrology and Water Resources Management, International Association of Hydrological Sciences.
3. Lynn E.Johnson [2002] Geographic Information Systems in Water Resources Engineering, CRC Press LLC.
4. Jain S.K and Singh V.P., 2003, Developments In Water Science –Water Resources Systems Planning and Management, Antony Rowe Ltd.
5. U.M.Shamsi, 2002, Water, Waste water and Storm Water Systems, American Society of Civil Engineers.

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CWR 331 GEOINFORMATICS IN AGRICULTURE (L, T, P) = 3(3, 0, 0)

UNIT	COURSE CONTENTS	TOTAL CONTACT Hrs. 36
UNIT I	Crops: Introduction - Agriculture Ecosystems, Yield parameters, spectral properties of crops, identification of crops and acreage estimation, vegetation indices, production forecasting through digital analysis, monitoring and condition assessment - case studies, crop phenological studies, time series analysis for crop health monitoring	8
UNIT II	Soils: introduction - Soil survey methods, soil classification, Land evaluation, Saline, alkaline soils, soil mapping, soil identification and mapping of problem soils, sedimentation and erosion, soil conservation - case studies.	7
UNIT III	Field-scale applications of RS and GIS: soil moisture content assessment, crop phenologic stage identification, crop biomass and yield production estimation, crop disease, weed and insect infestation detection and monitoring, farms mapping, cropping system analysis using hyperspectral and multispectral datasets, agro-ecological zoning.	7
UNIT IV	Retrieval of agrometeorological parameters from satellites, floods and droughts assessment and monitoring, water and wind induced soil erosion assessment and monitoring.	7
UNIT V	Precision Agriculture: Definition and rationale: agronomy, environment, economics, Tools: variable rate technology (VRT), GPS, GIS, Yield monitoring and mapping, developing prescriptive maps for VRT management and applications, Crop health assessment and monitoring using UAVs	7

Text References Books

1. Pierce J.Francis and Clay David, 2007, GIS Applications in Agriculture, Taylor & Francis Group.
2. Steven, M.D. and Clark, J.A., Butterworths, 1990, Application of Remote Sensing in Agriculture, London.
3. Ripple, William J. (ed.). 1994. The GIS Applications Book: Examples in Natural Resources: A Compendium , American Society for Photogrametry and Remote Sensing, Bethesda, Maryland.
4. Young, Haines, David Green, and Steven Cousins (eds.), 1994. Landscape Ecology and GIS , Taylor & Francis, Bristol, P.A. 3. William Ripple,1986, Geographic Information Systems for Resource $60.00 Management, ACSM.

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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.

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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 of Techniques (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 Deltas 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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