DEPARTMENT OF REMOTE SENSING
BHARATHIDASAN UNIVERSITY
Tiruchirappalli – 620 023

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Academic year 2024-2025 onwards

REGULATIONS & SYLLABUS

Two year M.Tech.
Remote Sensing and GIS

DEPARTMENT OF REMOTE SENSING
BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI-23
(For the Candidates admitted from the academic year 2024-2025 onwards)
M.Tech Remote Sensing and GIS

Sem	Course Code	Course title	L	T	P	C	Marks		
							Int	Ext	Total
I	24MTRS-01	Surveying and Geodesy	-	-	-	4	25	75	100
	24MTRS-02	Photogrammetry	4	-	-	4	25	75	100
	24MTRS-03	Principles of Remote Sensing and Data Products	4	-	-	4	25	75	100
	24MTRS-04	Remote Sensing & GIS in Geology and Geomorphology	4	-	-	4	25	75	100
	24MTRS-05	Geographic Information System	4	-	-	4	25	75	100
	24MTRS-06	**Practical** - Photogrammetry and Satellite Remote Sensing	-	-	8	4	40	60	100
	24MTRS-07	**Practical** - Remote Sensing & GIS interpretation in Geology and Geomorphology	-	-	8	4	40	60	100
	24MTRS-08	Mathematics and Statistical Methods	-	-	-	4	25	75	100
II	24MTRS-09	Digital Image Processing	4	-	-	4	25	75	100
	24MTRS-10	Hyperspectral Remote sensing	4	-	-	4	25	75	100
	24MTRS-11	**Practical** - Digital Image Processing and Geographic Information System	-	-	8	4	40	60	100
	24MTRS-12	Planetary Remote Sensing	-	-	-	4	25	75	100
	24MTRS-13	LiDAR and Unmanned Aerial System	-	-	-	4	25	75	100
	24MTRS-14	Elective – I - Thermal and Microwave Remote Sensing	4		-	4	25	75	100
	24MTRS-15	Elective - II	4		-	4	25	75	100
III	24MTRS-16	Remote Sensing & GIS in Coastal studies	4	-	-	4	25	75	100
	24MTRS-17	Remote Sensing & GIS in water resources	4	-	-	4	25	75	100
	24MTRS-18	Remote sensing & GIS in Disaster Management	4	-	-	4	25	75	100
	24MTRS-19	**Practical** - Remote sensing & GIS interpretation for mineral, hydrocarbon, water resources and Geohazards	-	-	8	4	40	60	100
	24MTRS-20	Elective - III	4	-	-	4	25	75	100
	24MTRS-21	Elective - IV	4	-	-	4	25	75	100
	24MTRS-22	Mini project	-	-	-	4	40	60	100
	24MTRS-23	Industrial cum geological field visit	-	-	-	2	40	60	100
IV	24MTRS-24	Major Project	-	-	-	10	150	150	300
		Online course	-	-	-	2	-	-	-
		Total Credit	**-**	**-**	**-**	**102**	**-**	**-**	**2600**

L – Lecture Hour; T – Tutorial; P – Practical; C - Credit

M.Tech –Remote Sensing and GIS

List of Electives

1. Thermal and Microwave Remote Sensing
2. Mapping Methods, GPS & Cartography
3. Computer programming for Geoinformatics - Python and R programming for GIS
4. Internet & WEB GIS - Full Stack Development for WEBGIS
5. Programming for spatial data processing
6. Geoinformatics in Climate Change Studies
7. Geoinformatics in Urban studies
8. Geomatics for Agriculture and Forestry
9. Geoinformatics in Marine Geology and Oceanography
10. Geoinformatics in Integrated Coastal Zone Management
11. Geoinformatics in Infrastructure Development
12. Geomatics for Transportation Planning and Management
13. Database management System (DBMS)

DEPARTMENT OF REMOTE SENSING
BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 023
M.Tech. (REMOTE SENSING AND GIS) - 2 Year

REGULATIONS & SYLLABUS

1. ELIGIBILITY

For admission: A Candidate of this university or any recognized University with

M.Sc. in Geology, Applied Geology, Marine Geology, Mineral Exploration, Hydrogeology, Marine Science, Environmental Science, Oceanography, Geography, Applied Geography, Physics, Applied Physics, Applied Mathematics, Statistics, Information Technology, Computer Science, Computer Applications, Geoinformatics, Geo- Engineering or equivalent.

B.E./ B.Tech. in Civil Engineering, Mining Engineering, Computer Science and Engineering, Information Technology, Electronics and Communication Engineering, Geoinformatics/Geological technology/Geotechnology or equivalent

B.E./BSc/B.Tech. in Agriculture, Agricultural Engineering, Forestry, Fisheries/Fisheries informatics or equivalent.

Total Numbers of Seats : **20 Nos.**

2. DURATION (4 Semesters (24 months))

The Course is for a period of 2 years with Four Semesters viz. Two odd Semesters and Two even Semesters. The Odd Semesters shall be from June / July to October / November and the even semester shall be from November / December to April / May. There shall be not less than 90 working days which shall comprise 540 teaching Clock hours for each semester. (Exclusive of the days for the conduct of Examinations).

Time Schedule:

2.1 I Semester

(i)	Total hours	= 6 hours x 5 days x 18 weeks	= 540 hrs
(ii)	Theory (6 Papers)	= 6 x (66 hours / Paper)	= 396 hrs
(iii)	Practical (2 Papers)	= 2 x (72 hours / Paper)	= 144 hrs

2.2 II Semester

(i)	Total hours	= 6 hours x 5 days x 18 weeks	= 540 hrs
(ii)	Theory (6 Papers)	= 6 x (72 hours / paper)	= 432 hrs
(iii)	Practical (1 Paper)	= 1 x (72 hours / Paper)	= 72 hrs
(iv)	Library / Seminar	= 2 x (18 hours/Library/Seminar)	= 36 hrs

2.3 III Semester

(i)	Total hours	= 6 hours x 5 days x 18 weeks	= 540 hrs
(ii)	Theory (5 Papers)	= 5 x (72 hours / paper)	= 360 hrs
(iii)	Practical (2 Papers)	= 1 x (72 hours / Paper)	= 72 hrs
(iv)	Mini Project	= 1 x (72 hours / Paper)	= 72 hrs
(iv)	Library / Seminar	= 2 x (18 hours/Library/Seminar)	= 36 hrs

2.4 IV Semester

(i)	Total hours	= 6 hours x 5 days x 18 weeks	= 540 hrs.
(ii)	Major Project	= 30 hours x 18 weeks	= 540 hrs

3. COURSE OF STUDY

The course of study for M.Tech. shall comprise instructions / Practicals / Seminars / Mini Project / Major Project in the subjects according to Syllabus and text books prescribed from time to time. The fourth semester shall be exclusively allotted for Major Project.

There will be a field training of 5-7 days duration in the end of II semester and an instructional tour cum industry visit of 4-7 days duration in the end of III semester.

4. SCHEME OF EXAMINATION

(a) The Scheme of Examination shall be as follows:

There shall be a total of 24 Papers including Theory Papers, Practicals, Mini & Major Project and online course.

(b) Theory & Practicals:

There shall be a total of 6 Theory papers (Core papers) and 2 theory related practical papers for I Semester and similarly 4 theory papers (Core papers), 1 theory related practical papers and 2 Elective theory-cum- practical papers for the II Semester. There shall be 3 theory papers (Core papers), one theory related practical paper. Two Elective theory-cum-practical papers and a Mini project for III Semester.

(c) Project work:

Each candidate shall be required to take up a Mini project for a period 45 days during III semester and a Major Project during the Fourth semester. The Head of the Department shall allot candidates to various project guides / faculty members at the end of the Second Semester and the guides in turn will evolve schedules for mini and topic for the major projects and the students will take up the same under the supervision of the concerned guides / faculty members.

(d) Mini Project:

The Mini project is aimed at skill development for the students to prepare them to take up the major project. This would involve intensive coaching / training on visual interpretations of aerial and satellite data for preparation of Thematic Maps / Digital Image Processing / Computer programming / Statistical analysis and modelling / GIS analysis / field survey / lab analysis etc. Students will complete the mini project during 45 days of the III Semester and submit the mini project report through a seminar. This mini project will have the credit of 100 marks.

(e) Major Project:

Each candidate shall be required to take up a major project work from the IV Semester and submit the major project report at the end of the IV Semester. Two copies of the Project Report / Dissertation shall be submitted to the Head of the Department (covering various aspects viz., introduction, literature review, methodology, studies carried out and results and conclusions) on or before the date fixed by the HOD. Each candidate shall be required to appear for Viva-voce and the major project will have the credit of 300 marks.

5. EXAMINATIONS

(a) (i) There shall be examinations at the end of each Semester: for Odd Semesters in the month of October / November; for Even Semesters in April / May. In the case of IV Semester Examination will be in the form of Seminar and Viva-Voce.

(ii) A candidate who does not pass the examination in any subject(s) may be permitted to appear in such failed subject(s) in the subsequent examinations to be held in October / November or April / May. However, candidates who have arrears in practicals shall be permitted to take their arrear practical examinations only along with regular practical examination in the respective semesters.

(iii) A candidate should get registered for the I Semester Examination. If registration is not possible owing to shortage of attendance the candidate shall re-do the course by getting admission during the next year.

(iv) Candidates will register for II / III / IV Semester examinations only after registering for I Semester examinations.

(v) Candidates who have a shortage of attendance exceeding 50% in a Semester (other than the I Semester) have to redo the semester and / or semesters after completion of the course only.

(b) (i) The internal assessment marks for each paper will be on the basis of the weekly Tests / Seminars / Group discussions / Assignments.

(ii) The weightage for internal Assessment in each Theory paper will be 25%.

(c) For Mini project Report, the maximum mark will be 75 and for the corresponding Viva-Voce / Seminar 25.

(d) (i) For the major project, maximum marks will be 300 (mid semester review 75, end semester review 75 and final report and viva-voce 150).

(ii) There will be two mid semester reviews of which one must be compulsorily attended by the candidate to become eligible for the End Semester review evaluation. However, if a candidate has attended both mid semester reviews, the best out of two will be considered for awarding marks.

(iii) The end semester review of the major project is mandatory.

(e) **Viva-Voce:** Each candidate shall be required to appear for Viva-Voce and defend the Project / Dissertation.

(f) The results of all the examinations will be published through the College / University Department where the student underwent the course.

6. PASSING MINIMUM

A candidate shall be declared to have passed in each paper if he / she secures not less than 50% marks in the University examination and not less than 50% in the aggregate taking continuous internal assessment and end examination marks separately are mandatory.

(a) Evaluation: Double Evaluation – one by course teacher and the other evaluation at External or one Evaluation external Evaluation.

(b) i) The internal assessment marks for each paper will be on the basis of the weekly Tests / Seminars / Group discussions / Assignments.

ii) The weightage for in internal Assessment in each Theory paper will be 25% and for practical paper will be 40% (Internal Minimum requirement is 50% mandatory) (Theory papers: 13 out of 25 marks)

(c) i) For the major project, maximum marks will be 300 (mid semester review 75, end semester review 75 and final report and viva-voce 150).

A candidate shall be declared to have passed in the project Report / Dissertation if he / she gets not less than 40% each in the mini project, major project reviews and the final viva-voce, but not less than 50% in the aggregate of all.

A candidate who gets less than 40% in any of the above must redo that particular review / report / viva-voce in which the candidate got less than 40%.

Alternatively, if the candidates choose to redo the Project Report / Dissertation, he may do so and take Viva-Voce on the resubmitted Project Report / Dissertation.

7. CLASSIFICATION OF SUCCESSFUL CANDIDATES:

The marks to Grade Conversion shall be as follows:

Marks	Grade
100	H
90-99	S
80-89	A
70-79	B
60-69	C
50-59	D
40-49	RA - Re-Appearance*

*This is possible for Core Papers, for Electives the Candidate may either re-appear or choose alternative elective papers.

8. CONFERMENT OF THE DEGREE:

A candidate shall be eligible for the Conferment of the Degree only after he/she has

passed all the examinations prescribed therefore including the Practicals and Project / Dissertation.

9. RANKING:

i) ELIGIBILITY: A candidate, who passes the whole examination in the prescribed period of duration of the course in the first appearance in all the papers and also scores the highest total marks, is alone eligible for ranking.

ii) (a) Only one Rank will be considered.
(b) Students' strength of the course will be indicated

10. REVISION OF REGULATION AND CURRICULUM:

The University may from time-to-time revise, amend and change the regulations and the Curriculum, if found necessary.

11. PROGRAMME SPECIFIC OUTCOMES

Candidates successfully completing the 2-year M.Tech in Remote Sensing and GIS programme will be able to successfully apply Remote Sensing and GIS techniques in the fields of mineral exploration, geohazards mitigation, water resources and environmental management and will have the professional competency to independently execute any research studies / projects using the latest geomatics techniques.

SEMESTER - I

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-01	SURVEYING AND GEODESY	4	25	75	100

OBJECTIVE

To provide a comprehensive understanding of surveying techniques, GNSS, and geodesy, equipping students with the skills to apply modern geospatial technologies for precise measurements and environmental studies.

SYLLABUS

UNIT I **Fundamentals of Surveying -** Definition - Classifications - Basic principles - Equipment and accessories for ranging and chaining - Chain surveying - Compass surveying - Types - Bearing - System and conversions - Levelling - Plane table and its accessories - Plane table surveying - Theodolite surveying - EDM. **12 Hrs**

UNIT II **Introduction to Total station and GNSS** - Methods of Measuring Distance - Basic Principles of Total Station - Historical Development, Classifications, applications and comparison with conventional surveying – GNSS Basic Concepts - Components of GNSS, Types of GNSS receivers, Pseudo Range Measurement, Phase Difference Measurement, Sources of GNSS errors, Transformation of coordinates, GNSS Remote Sensing. **12 Hrs**

UNIT III **GNSS Surveying Techniques** - Point positioning and differential positioning, DGPS and SBAS; Relative positioning: Static - Rapid static and Pseudo kinematic; kinematic positioning - pure kinematic, semi kinematic and real time kinematic (RTK) methods of observations. Real time network (VRS) services - NAVSTAR - Global Positioning System, Global Navigation Satellite System (GLONASS), BeiDou Navigation Satellite System (BDS), Indian Regional Navigation Satellite System (IRNSS) and GALILEO Quasi-Zenith Satellite System (QZSS). GNSS applications to Global, Regional and Local issues: IUGG, IAG, IGS and IERS services. **14 Hrs**

UNIT IV **Introduction to Geodesy -** Definitions, history and importance of geodesy Geometry of the sphere: Geoid, Ellipsoid - definition and basic concepts, Geoid Reduction of observations, Classifications, Applications, Problem and purpose of Geodesy - Geodetic coordinate systems, Satellite coordinate systems - Rectangular or Cartesian coordinate system and relationship between them. **14 Hrs**

UNIT V **Geometric Geodesy & Geodetic Astronomy -** Geodetic datums - Definition and characteristics of geodetic datums - Datum transformations and datum shifts - Geometric geodetic measurements - Horizontal angle and azimuth measurements - Special star positions, Major constellation. Rising and setting of stars with respect to declination, hour angle and azimuth. Culmination, Prime vertical Crossing and Elongation. Variation in celestial co-ordinates. Sidereal time, Universal time, Zone time and atomic time. Determination of Astronomical azimuth, latitude and longitude. Star catalogues, Ephemerides and Almanacs.

14 Hrs

UNIT VI **Current Contours - Applications of Geodetic Measurements (Not for Final Exam only for Discussion) -** Geodetic applications in climate change monitoring and environmental studies - Geodetic applications of astronomical observations - Geodesy in navigation and positioning systems - Geodetic software and tools - Emerging topics in Geodesy.

COURSE OUTCOMES

- Master the fundamentals and equipment of traditional surveying methods.
- Understand the principles and applications of Total Station and GNSS technologies.
- Apply GNSS surveying techniques for accurate positioning and navigation.
- Grasp the concepts and importance of geodesy and coordinate systems.
- Explore the applications of geodetic measurements in various fields, including environmental monitoring and navigation systems.

REFERENCES

1. Dr. B. C. Punmia, Ashok K. Jain and Arun K Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, Sixteenth Edition, 2016.
2. K. R. Arora, Surveying Vol I & II, Standard Book house, 2019.
3. T. P. Kanetkarand S. V. Kulkarni, Surveying and Levelling, Parts 1 &2, Pune Vidyarthi Griha Prakashan, Pune, 2010, 24th edition.
4. R. Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.
5. Torge, W (2001). Geodesy. 3rd ed. Walter de Gruyter. Berlin. New York.
6. Vanícek P and Krakiwsky E. (1986). Geodesy: The Concepts. 2nd ed. Elsevier.
7. Seeber G, Satellite Geodesy, Walter De Gruyter, Berlin, 2003, Revised Edition.

8. Kaplan, E D and Hegarty C J (2006). Understanding GPS: Principles and Application. 2nd ed. Artech House Inc., MA 02062
9. Alfred Leick (2004). GPS Satellite Surveying. 3rd ed. John Wiley and Sons Inc.,
10. Kennedy M (2002). The Global Positioning System & GIS: An Introduction, Taylor & Francis.
11. GuochangXu (2007). GPS Theory, Adjustments and Applications. Springer and Verlag, Heidelberg
12. Hofmann-Wellenhof, B., H. Lichtenegger, and J. Collins. *GPS Theory and Practice*. Springer, 1994. ISBN: 9780387824772.
13. Petr Vanicek and Edward J. Krakiwsky, Geodesy: The concepts, North-Holland Publications Co., Amsterdam,2014, 2nd edition
14. Parkinson, B. W., J. Spilker, et al. *Global Positioning System: Theory and Applications*. Vol. 1. American Institute of Aeronautics & Ast, 1996. ISBN: 9781563471063
15. David J. Getling, "Geodesy for Geomatics and GIS Professionals", CRC Press, 2018, ISBN: 978-1138393325
16. Satheesh Gopi, Sathishkumar, N. Madhu., “Advanced Surveying, Total Station GPS and Remote Sensing”, Pearson education, 2nd Edition, 1996.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-02	PHOTOGRAMMETRY	4	25	75	100

OBJECTIVE

To understand the fundamental principles and applications of photogrammetry, including the use of aerial and terrestrial photography, stereoscopic methods, digital photogrammetry, and modern survey tools for accurate mapping and analysis.

SYLLABUS

UNIT I **Basics of Aerial photography and Photogrammetry:** History and definition - geometry of aerial photographs, principal point, conjugate principal point, nadir point, iso-centre, fiducial marks, overlap and side lap - Types of Photographs, Classification – Photogrammetric Films - Use of Filters - Photographic Resolution - Radiometric Characters of Aerial Photographs - Types based on - Camera Axis, Altitude, Film, Lens and angle of Coverage - Parts of Simple Camera - Aerial Cameras - Camera Calibration - Lens System - Distortions and Aberrations - Spectral Sensitivity of Aerial Cameras. **14 Hrs**

UNIT II **Elements of Photogrammetry-I:** Scale - Determination of Scale In Vertical Photo Over Flat and Variable Terrain, Average Photo Scale, Scale in Tilted Photographs - Relief Displacement - Tilt Displacement - Scale Distortions -Due to Lens, Flying Height, Relief, Tilt, Pitch, Yaw & Roll - Stereo Models -Parallax - Mosaics : Stereoscopic vision and depth perception of human eye - Monoscopy - Stereoscopy - Pseudoscopy - stereoscopic model - Base height Ratio - Vertical Exaggeration - Stereoscopic Parallax, stereoscopic methods of parallax measurement and Height measurement using parallax. **14 Hrs**

UNIT II **Elements of Photogrammetry – II:** Photo Mosaics: Photo indexing - Photo mosaic (uncontrolled, semi controlled & Controlled mosaics) - Flight planning - Aerial triangulation and bundle block adjustment - Collinearity and coplanarity condition - Space resection - Two-dimensional Coordinate transformations - Terrestrial and Close-Range Photography: Terrestrial Cameras - Photo Theodolite - Stereometric Cameras - Utilities of Terrestrial and Close-Range Photogrammetry. **12 Hrs**

UNIT III **Digital Photogrammetry:** Definition and scope - Analog photogrammetry, fundamental concept of stereoplotters - Digital aerial cameras - Three-line pushbroom aerial

sensor - DPWS (Digital Photogrammetric Workstation) - Hardware and software components of digital photogrammetry - Stereo viewing techniques - Concepts of interior, relative, absolute orientations - Georeferencing - Aerotriangulation - single frame and block triangulation, pass points, tie points; ground control points - DEM generation - Orthophoto generation - Applications of digital photogrammetric products - Concept of DEM, DTM, TIN, GRID and DSM. **14 Hrs**

UNIT-V. Photo Interpretation Keys & Elements and Other acquisition systems: 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, Landuse, Shape & size of objects). Other acquisition systems – UAV – terrestrial imaging, Oblique Photography, Close Range Photogrammetry, terrestrial and mobile LIDAR. **12 Hrs**

UNIT VI – Current Contours: Recent trends and applications of photogrammetry with the case study - UAS technology - large scale mapping and 3D modelling – digital photogrammetric software.

COURSE OUTCOMES

- Comprehensive Knowledge of Photogrammetry
- Skill in Photo Interpretation
- Proficiency in Stereoscopic Methods
- Expertise in Digital Photogrammetry
- Application of Modern Survey Tools

REFERENCES

1. American Society of Photogrammetry, 1983: Manual of Remote Sensing (2nd Edition), ASP, Falls Church, Virginia.
2. Curran, P. 1985: Principles of Remote Sensing, Longman, London.
3. Barrett, E.C. and Curits, L.R. 1976: introduction To Environmental Remote Sensing, Halstged Press, Wiley, New York.
4. Lillisand, T.M. and Kiefer, P.W. 1986: Remote Sensing and Image interpretation, John Wiley & Sons, New York.
5. Lintz, J. and Simonett L.S. (Eds), 1976: Remote Sensing of Environment, Addition-Wesley, Readings, Mass.

6. Lo. C.P. 1986: Applied Remote Sensing, Longman, London.
7. Richason, B.F.Jr.(Ed), 1978; introduction to Remote Sensing of the Environment, Kendall / Hunt, Dubuque, Iowa.
8. Sabins, F.F.Jr., 1978: Remote Sensing Principles and interpretation, Freeman, Sanfrancisco.
9. Schanda,E. (Ed), 1976 : Remote Sensing for Environmental Science, Springerverlag.
10. Wolf, P.R.1974: Elements of Photogrammetry Mcgraw Hill Book Co., Tokyo.
11. Moffit H.F. and Edward, M.M, 1980: Photogrammetry, 3rd Edition, Harper and Row Publishers, New York.
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15. Bhatt. A.B., Aerial Photography & Remote Sensing
16. Qiheyans, Map Projection transformation, Principles and its Applications.
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18. David Paine; Aerial Photography and Image interpretation for Resource Management, John Wiley & Sons, N.Y.
19. Manfred Schroeder and Reinhard Koch, “Photogrammetry: Principles, Methods, and Applications” 2nd edition, 2016.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-03	PRINCIPLES OF REMOTE SENSING AND DATA PRODUCTS	4	25	75	100

OBJECTIVE

To understand the principles, technologies, and applications of remote sensing, including optical, thermal, and microwave sensing, and to explore the advancements and future trends in remote sensing.

SYLLABUS

UNIT I **Introduction to Remote Sensing -** History and Concepts - Advantages of Remote Sensing over Conventional Surveys – Aerial vs Satellite Remote Sensing. Physics of Remote Sensing - Energy Sources - Radiation Principles - Energy interaction with Atmosphere - (Atmospheric Windows, Scattering, Absorption) – Energy interaction with earth surface - (Absorption, Transmission, Scattering & Reflection) Spectral Reflectance of Earth Surface Features in Different Wave Length Regions of EMR - Principles of Image interpretation - Elements of Image interpretation - Techniques of Visual interpretation **14 Hrs**

UNIT II **Optical Remote Sensing -** Resolutions - (Spectral, Spatial, Temporal and Radiometric Resolutions) - Platforms (Aerial and Satellite) - Sensors (imaging and non-imaging Sensors) - Data Acquisition – (Signal Detection, Recording, Scanning Mechanisms and Orbiting Mechanisms of Satellites) - Opto-mechanical scanners - Pushbroom and whiskbroom scanning - Panchromatic, multi spectral hyperspectral scanners. **14 Hrs**

UNIT III **Thermal Remote Sensing** - Basics of Thermal Remote Sensing - Thermal radiation principles - Temperature from Radiance Values - Thermal Sensors, Scanners, Optomechanical CCD Arrays - Aerial thermal images - Image characters, spatial and radiometry - Sources of image degradation - Radiometric and geometric errors and correction - Interpretation of thermal image. **12 Hrs**

UNIT IV **Microwave Remote Sensing and LIDAR** - Basic Concepts of Microwave Remote Sensing - Passive sensors - radiometers – active sensors – imaging and non-imaging – RADAR: Polarization property of microwaves – SLAR: System components and Geometric characteristics of SLAR imagery, spatial resolution, Synthetic Aperture Radar (SAR), LIDAR: basic concepts. **14 Hrs**

UNIT V **History of Space Imagery** - Sensors, Geometry and Radiometry of LANDSAT, SPOT, IRS Series, IRS P Series, CARTOSAT, TERRA – MODIS, ASTER, IKONOS, ERS, ORB View, Shuttle Mission, Meteorological and other Satellites. **12 Hrs**

UNIT VI **Current Contours - Recent Developments in Remote Sensing Technology (Not for Final Exam only for Discussion)** - Development of Remote Sensing in India – Future Remote Sensing Missions

COURSE OUTCOMES

- Gain foundational knowledge of remote sensing principles, energy interactions, and advantages over conventional surveys.
- Develop expertise in optical resolutions, platforms, sensors, and data acquisition techniques.
- Learn the principles of thermal radiation, sensor functions, and image interpretation and correction
- Understand microwave sensing concepts, polarization, sensor types, and radar system characteristics
- Become familiar with the history, characteristics of satellite missions, and recent advancements in remote sensing technology.

REFERENCES

1. American Society of Photogrammetry, 1983: Manual of Remote Sensing (2nd Edition), ASP Falls Church, Virginia
2. Curran, P. 1985: Principles of Remote Sensing, Longman, London.
3. Barrett, E.C. and L.R.Curits, 1976: introduction To Environmental Remote Sensing, Halstged Press, Wiley, New York.
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11. Hord R.Michel, 19866: Remote Sensing Methods and Application, John Wiley and Sons.
12. Drury S.A, 1990: A Guide to Remote Sensing - interpreting Images of Earth, Oxford Science Publications, Oxford.
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15. Iain H Woodhouse, “Introduction to Microwave Remote Sensing”, Speckled Press, 1st edition, 2017, ISBN-13: 978-0415271233
16. Dale A Quattarochi and Jeffrey C Luvall, “Thermal Remote Sensing in Land surface Processes”, e-book, 2005 Taylor & Fancis, ISBN 0 203 502175

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-04	REMOTE SENSING & GIS IN GEOLOGY AND GEOMORPHOLOGY	4	25	75	100

OBJECTIVE

To understand the applications of geospatial technology in geological and geomorphological mapping and analysis, including the study of various landforms and natural processes using remote sensing and GIS.

SYLLABUS

UNIT I **Spectral Properties of Rocks and Minerals: S**pectral properties of rocks and minerals, elemental composition – Spectral reflection curves for important Rocks, Minerals - physical properties - optimal spectral windows – minerals in visible, NIR, MIR, SWIR, TIR and Microwave regions **12 Hrs**

UNIT II **Geological Structure and Applications:** Significance of Geological structures - Role of aerial photographs - Photo interpretation characters of photographs and satellite images - structural mapping - Fold, fault, Lineaments - Intrusive rocks - rock exposure - Fractures and Joints - Rose diagram - Digital image processing for structural mapping - Image Characters of igneous rocks, sedimentary and metamorphic rocks - Geophysical survey, surface investigation, subsurface investigation. **12 Hrs**

UNIT III **Denudational, Tectonic, Volcanic Geomorphology:** Process of Weathering - Types of Denudational Landforms - Tectonic processes - Concepts of landscape evolution - Tectonic settings - Types of Tectonic landforms - Origin of Volcanoes - Spatial Distribution of Volcanoes Around the World - Types of Volcanic Landforms - Expressions and Manifestations of Denudational – Tectonic - Volcanic landforms (in field, Aerial Photographs and Satellite Image). **14 Hrs**

Unit IV **Fluvial and Coastal and Marine Geomorphology:** Drainages (Classification, Morphology and Types) - Life Cycle of River Systems - Constructional and Destructional Landforms of river - Classification of Shorelines - Coastal Zone Processes and landforms - Types of Coral reefs and significance - Development and evolution of landforms in oceanic settings - submarine canyons - Geosynclines - Island arcs - Manifestations of Fluvial and Coastal and Marine Landforms (in field, Aerial Photographs and Satellite Images). **14 Hrs**

UNIT V **Aeolian and Glacial Geomorphology:** Processes in Arid region - Origin of deserts - causes of aridity and desertification – types of aeolian landforms - Process of glaciation - classification of glaciers - Glacial landforms - glacial erosion and deposition

processes - Manifestations of Aeolian and Glacial Landforms (in field, Aerial Photographs and Satellite Images). **14 Hrs**

UNIT VI Current Contours – Biogeographic-Landforms (Not for Final Exam only for Discussion) - Landform Types - Their Expressions (In Field, Air Photo and Satellite Images).

COURSE OUTCOMES

- Learn to use geospatial tools for lithological, structural, and geomorphological mapping.
- Understand the spectral properties of rocks and minerals for geological and mineral exploration.
- Gain knowledge of denudational, tectonic, and volcanic landforms and their identification using remote sensing.
- Study river systems, coastal zones, and marine landforms through various mapping techniques.
- Explore the origins and types of desert and glacial landforms using remote sensing and field methods.

REFERENCES

1. John J. Qu , Wei Gao, Menas Kafatos , Robert E. Murphy, Vincent V. Salomonson, "Earth Science Satellite Remote Sensing, Springer 2007.
2. Gupta .R.P, "Remote sensing Geology, Springer, 2003.
3. Drury .S.A, "Image interpretation in Geology, Chapman and Hall, London. 1993.
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Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-05	GEOGRAPHIC INFORMATION SYSTEM	4	25	75	100

OBJECTIVE

To understand the fundamentals, data handling, analysis techniques, and advanced applications of Geographic Information Systems (GIS).

SYLLABUS

UNIT I **Basics of GIS** - Definition - Evolution of GIS - Geospatial, spatial and non-spatial data - Components of GIS - Computer Hardware, Software Modules and Organisational Context of GIS - Data Structure in GIS - Types of Data (Points, Lines and Polygons) - Data sources - Ground and remote sensing survey - Data Structures (Raster data structures and Vector data Structures) – Database Structures. **12 Hrs**

UNIT II **GIS Data Input, Verification, Storage and Output -** Spatial Data Input Processes and Devices (Sources of data, - Different Types of Data Entry methods, viz., Manual input, Run length code, Digitization, Automated Scanning. – Vector to Raster conversion - Raster to Vector conversion - Input devices) - Entry of non-spatial data – Linking of Spatial & Non-spatial data – Element generation - Geodatabase creation - Data Verification (Errors of different types) - Correction (Rubber Sheet Transformation, Bilinear interpolation, Cubic Convolution.) - GIS capabilities for Data correction – Data output (Types of Output, GIS Capabilities for output, Output devices) - File formats for raster and vector. **14 Hrs**

UNIT III **Raster and vector data Interpolation and Analyses** - Raster data analysis: Local, neighborhood and regional operations - Map algebra - Vector data analysis: Topological analysis, point-in-polygon, line-in-polygon, polygon-in-polygon - Proximity analysis: Buffering, Thiessen polygon - Non topological analysis: Attribute data retrieval and analysis – Concepts of SQL – ODBC - Basic Principles of Interpolation – Methods of Interpolation - Global Methods of Interpolation, Local Interpolation (Trend Surface Analysis) – Local Interpolation (Splines) - Optimal Interpolation (Kriging). **12 Hrs**

UNIT IV **Surface Analysis, 3D Visualization and Network Modelling** - Need for Three Dimensional Models - Methods of DEM & TIN - Products of DTM (Contour Maps, Shaded Relief Map, Maps Related to Slopes, Line Sight Maps, Drainage Analysis, Volume Estimation.) Usefulness of DEM/DTM. Overlay analysis, Capabilities (Point Operations, Regional Operations, Neighbourhood Operations) - Networking and Dynamic Segmentation – Applications, Minimum Distance Model, Maximum Covering Model (P-median model), Urban Transportation Planning Model. **14 Hrs**

UNIT V Data Classification & Advanced GIS - Principles – Types of Classification (Exogenous, Arbitrary, Idiographic & Serial) – Multivariate Analysis. Artificial Intelligence - Expert Systems - Object Oriented GIS - Web based GIS: Definition, merits - Architecture - Map server - Spatial data infrastructure - Spatial data standards - Free and open source - Proprietary GIS software. **14 Hrs**

UNIT VI Current Contours – GIS - Case studies (Not for Final Exam only for Discussion) - Recent scientific and technological development, advancement, Industrial application and Job opportunities.

COURSE OUTCOMES

- The concepts of GIS, including data types, components, and data structures.
- Develop proficiency in GIS data input, verification, storage, and output processes.
- Gain knowledge in raster and vector data analysis, including interpolation methods and proximity analysis.
- Understand three-dimensional modeling, surface analysis, and network modeling techniques.
- Explore classification methods, AI integration, web-based GIS, and the use of open-source and proprietary GIS software.

REFERENCES

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3. Gautham, N.C 1970: Urban Landuse Study Through Aerial Photo binterpretations Techniques, Pink Publishing House, Mathura.
4. American Society of Photogrammetry, 1983: Manual of Remote Sensing (2nd Edition), ASP Falls Church, Virginia.
5. Campbell, J 1984: introductory Cartography, Printers Hall Englewood Cliffs, N.J
6. Dent B.D 1985: Principles of Thematic Map Design, Addition - Wesley, Reading, Mass.
7. Freeman, H and GG.Pieroni 1980: Map Data Processing, Academic Press, New York.
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9. Tomlinson, RF Calkins, HS and D.F.Marble 1976: Computer Handling of Geographic Data, UNESCO, Geneva.
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Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-06	PRACTICAL - PHOTOGRAMMETRY AND SATELLITE REMOTE SENSING	4	40	60	100

Photogrammetry

1. Stereo Vision Test using Test Cards and Anatomy of Pocket, Prism and Mirror Stereoscopes. **4 Hrs**
2. Decoding, Marking and Transfer of Principal Points, Baseline Drawing, Flight Line Marking, Fixing Photos for 3D Observation, Marking North and Tracing of details from Aerial Photographs and transfer the same from Air Photos to Base Map. **4 Hrs**
3. Determination of Scales of Aerial Photographs. **4 Hrs**
4. Height and Slope Measurements. **4 Hrs**
5. Study of Various Visual Remote Sensing Equipment **4 Hrs**
6. Ground Radiometric Survey, Collection of Spectral Reflectance from Terrestrial **4 Hrs**
7. Objects and Analysis, Ground Truth Collection. **4 Hrs**
8. Interpretation of Multiband (B & W) & FCC data **4 Hrs**
9. DEM, DSM, DTM and Orthogeneration **4 Hrs**
10. Feature Extraction by Stereoplotting and Monoplotting **4 Hrs**

Satellite Remote Sensing

1. Spectral reflectance observation - spectroradiometer. **4 Hrs**
   i. Vegetation
   ii. Soil
   iii. Water bodies
   iv. Built-up land
2. Map reading Survey of India toposheets. **2 Hrs**
3. Base Map preparation from SOI toposheets. **4 Hrs**
4. Visual image interpretation keys for different landuse and land cover types using different satellite data **4 Hrs**
5. Land use/land cover map **4 Hrs**
6. Soil Map **2 Hrs**
7. Geomorphology map **4 Hrs**
8. Watershed delineation **4 Hrs**
9. Wetland and wasteland mapping **4 Hrs**

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	24MTRS-07	PRACTICALS - REMOTE SENSING & GIS INTERPRETATION IN GEOLOGY AND GEOMORPHOLOGY	4	40	60	100

GEOLOGY

1. Ground Spectro Radiometric survey of Rocks and Minerals. **4 Hrs**
2. Igneous Rocks Mapping using Aerial Photographs and Satellite Imagery. **4 Hrs**
3. Sedimentary Rocks Mapping using Aerial Photographs and Satellite Imagery. **4 Hrs**
4. Metamorphic Rocks using Aerial Photographs and Satellite Imagery. **4 Hrs**
5. Mapping of Trend lines and folds using Aerial Photographs and Satellite Imagery **4 Hrs**
6. Mapping of Trendlines and folds using 3D analysis **4 Hrs**
7. Mapping of Lineaments using Aerial Photographs and Satellite Imagery **4 Hrs**
8. Mapping of Lineaments using 3D analysis **4 Hrs**
9. Mapping of subsurface structures using Geophysical data. **4 Hrs**
10. Soil, Landuse/ Land cover mapping using Aerial Photographs and Satellite Imagery **4 Hrs**

GEOMORPHOLOGY:

1. Interpretation of Aerial Photographs and Satellite Imagery for Tectonic Geomorphic Mapping. **4 Hrs**
2. Interpretation of Aerial Photographs and Satellite Imagery for Denudational Geomorphic Mapping. **4 Hrs**
3. Interpretation of Aerial Photographs and Satellite Imagery for Fluvial Geomorphic Mapping. **4 Hrs**
4. Interpretation of Aerial Photographs and Satellite Imagery for Coastal Geomorphic Mapping. **4 Hrs**
5. Interpretation of Aerial Photographs and Satellite Imagery for Aeolian Geomorphic Mapping. **4 Hrs**
6. Interpretation of Aerial Photographs and Satellite Imagery for Glacial Geomorphic Mapping. **4 Hrs**
7. Interpretation of Aerial Photographs and Satellite Imagery for Volcanic Geomorphic Mapping. **4 Hrs**
8. Geomorphic mapping using DEM overlay. **2 Hrs**
9. 3D GIS based visualization of satellite images and mapping of Geomorphic landforms. **2 Hrs**

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
I	24MTRS-08	MATHEMATICS AND STATISTICAL METHODS	4	25	75	100

OBJECTIVE

To understand the principles and applications of calculus, algebra, trigonometry, and statistics, including differential equations, data analysis, sampling, and regression techniques.

SYLLABUS

UNIT I **Mathematics I -** Elements of Calculus – Differential and integrations – Linear ordinary differential equation – Solutions of differential equations – Partial differential equation – boundary value problems – Numerical methods for partial differential equations. **12 Hrs**

UNIT II **Mathematics II -** Trigonometry: Angles – Measurement of angles – Radian measure – Degree measure – Trigonometric ratios – Reciprocal relations – Trigonometric ratios of specific angles – Use of Trigonometric tables. Algebra: Basic algebraic operations – Polynomials – Monomials – Binomials – Trinomials – Linear Polynomials – Quadratic Polynomials – Cubic Polynomials – Zeros or roots of the Polynomials – Roots of quadratic equations – Solving Simultaneous linear equations. **14 Hrs**

UNIT III **Basic Statistics-I -** Frequency Distributions, Cumulative Frequency Distributions and Frequency Curves, Measures of Central Tendencies (Mean, Median and Mode) - Measures of Dispersion (Range, Variance and Standard Deviation). **12 Hrs**

UNIT IV **Statistics II -** Sampling: Theory of Sampling - Population and Sample - Sampling Survey Methods - Estimation of Mean and Proportion in Simple Random Sampling. Statistical Inference: Testing of Hypothesis and Tests of Significance for Mean, Proportion and Variance. **14 Hrs**

UNIT V **Statistics III -** Regression Analysis: Linear Correlation Coefficient - Linear Regression - Non- Linear Regression - Multiple Correlations and Multiple Regressions - Factor and Factor Varimax analysis. Concepts of Modeling: Fundamentals of Modeling – Types of Modeling – Parametric – Stochastic – Predictive types and illustrations. **14 Hrs**

UNIT VI **Current Contours - Multivariate Analysis (Not for Final Exam only for Discussion) -** Random Vectors and Matrices - Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components: Population principal components – Principal components from standardized variables.

COURSE OUTCOMES

- Computation of measures of central tendency and variation
- Computation of different types of Correlation
- Computation of different types of Regression
- Estimation of mean, proportion and their standard errors in SRS
- Tests of significance based on mean, proportion and variance

REFERENCES

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8. Margaret Armstrong: Basic Linear Geostatistics, Springer verlag

9. Taxali, 1987: PC Software Made Simple, Tata McGrawhill Publications

SEMESTER II

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	24MTRS-09	DIGITAL IMAGE PROCESSING	4	25	75	100

OBJECTIVE

To understand the principles and techniques of digital image processing, including data acquisition, image correction, enhancement, classification, and pattern recognition.

SYLLABUS

UNIT I **Fundamentals of Image Processing -** Satellite systems and data - Acquisition - Storage - Orbits - Digital Image formats (Band Sequential, Band inter Leaved and its Characteristics) - Data products – Image processing system (Software and Hardware Components, Software Documentation) - Factors to be considered - Image display systems - Image sampling and quantization - Basic relationship between pixels. **12 Hrs**

UNIT II **Data Model and Image Corrections** – Sensor model - Pixel characters - Image formation - Histogram - Types - Univariate & multivariate image statistics - Geometric and Radiometric correction - Need for Correction - Error Models and Corrections (Due to sensor, haze, sun angle and skylight) - Earth Curvature and Projection Methods - Satellite Pass System and Image Warpening - Skew Corrections - Resampling interpolation Methods - Panoramic Distortion - Error Accumulation and Corrections - Data Accuracy - Image Registration - Image Differencing & ratioing. **14 Hrs**

UNIT III **Image Enhancement Techniques –** Spectral signatures - Image characteristics -Enhancement of Single Band Data – Image Reduction and Magnification - Contrast Stretching – Filtering (Sobel and Laplacian Filters, High and Low Pass Filter) - Histogram Equalisation - Edge Enhancement - Enhancement of Multiband Data Band - Ratioing Techniques - Generation of Different Types of Colour Composites - Principal component analysis - Image Fusion. **16 Hrs**

UNIT IV **Image classification –** Training sites - Supervised, Unsupervised and Hybrid classifiers - Baye's Theorem – Parametric classification - Decision tree - Other Non-parametric classifiers - Sub-pixel and super-pixel classification - Hyper-spectral image analysis - Accuracy assessment **14 Hrs**

UNIT V **Pattern Recognition and Feature extraction -** Basic Concepts (Pattern Recognition, Linear and Non-Linear Discriminant Functions) - Textural and contextual analysis - Decision concepts: Fuzzy sets - Expert system concepts - Artificial Neural Network - Object based methods - Automated Knowledge based classification. **16 Hrs**

UNIT VI **Current Contours: (Not for Final Exam only for Discussion):** Application; case studies.

COURSE OUTCOMES

- Learn about satellite data acquisition, storage, and digital image formats.
- Understand sensor models, image statistics, geometric and radiometric corrections, and image registration.
- Gain skills in image enhancement, including contrast stretching, filtering, and color composite generation.
- Master supervised, unsupervised, and hybrid classification methods, along with accuracy assessment techniques.
- Learn pattern recognition and feature extraction techniques, including neural networks and fuzzy sets.

REFERENCES

1. American Society of Photogrammetry, 1983: Manual of Remote Sensing (2nd Edition), ASP Falls Church, Virginia
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Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	24MTRS-10	HYPERSPECTRAL REMOTE SENSING	4	25	75	100

OBJECTIVE

To understand the principles, sensors, preprocessing techniques, and applications of hyperspectral remote sensing for analyzing spectral data across various fields.

SYLLABUS

UNIT I Principles of hyperspectral Remote Sensing: Introduction: Definition, Multispectral vs. hyperspectral remote sensing Spectral Signatures in the visible, near infrared and shortwave infrared regions of EMR for soil, water and vegetation - Limitations, issues and characters of Hyper spectral Data-Hyperspectral data cube – imaging spectroscopy-Causes of reflection and absorption of EMR: electronic and vibrational processes of absorption and identification of various minerals and materials - specific spectral absorption feature of water (H2O), hydroxyl (OH), Carbonate (CO3), Organics, Ices, vegetation – continuum removal and Spectral Feature Comparison. **16 Hrs**

UNIT II Hyperspectral data and Imaging sensors: Principles of operation, specifications of various sensors: Airborne (CASI, AVIRIS, HYDICE, DAIS.) - Space borne (Hyperion, Modis,CHRIS, MERIS, Hyperspectral sensors of Chandrayan missions, Mars Reconnaissance Orbiter Compact Reconnaissance Imaging Spectrometer for Mars (CRISM)) - Ground based (Spectro radiometer) - capability of spectrometer(spectral range, spectral band width, spectra l sampling, and signal-to-noise ratio (S/N)) spectral library, JHU (John Hopkins University)Laboratory, Jet propulsion laboratory, USGS (United States Geological Survey) Spectral laboratory- Factors controlling the quality and information in spectra. **16 Hrs**

UNIT III Preprocessing of Hyperspectral Data: Atmospheric Correction: Atmospheric effects, atmospheric scattering and absorption processes-Atmospheric correction models: empirical models (Flat Field Correction, Internal Average Relative Reflectance); Physics /absolute atmospheric correction models (ATREM, ATREM-EFFORT, ACORN and FLAASH). Noise Estimation and dimensionality reduction in Hyperspectral Data: Data Redundancy, problems with dimensionality, Principal Component Analysis, Minimum Noise Fraction (MNF), Pixel Purity Index (PPI)n-Dimensional Visualizer and end members collection. **14 Hrs**

UNIT IV Classification of Hyper spectral images: Spectral Angle Mapper - Spectral Correlation Mapper- Support Vector Machine - Spectral Feature Fitting - Spectral unmixing (Linear Constrained Unmixing)- Matched filtering, Mixture Tuned Matched Filtering technique -Spectral Derivative Analysis: first-order and second-order derivative spectra and application. **14 Hrs**

UNIT V Applications: Applications of hyperspectral image analysis in mineral exploration, planetary exploration with reference to moon, vegetation and forestry, quantification of biophysical parameters, soil mapping and water quality studies. **12 Hrs**

UNIT VI Current Contours: (Not for Final Exam only for Discussion) - Chandrayaan hyperspectral sensors and its significance; recent scientific development in hyperspectral remote sensing; discuss about research papers published in hyper spectral remote sensing.

COURSE OUTCOMES

After the completion of the course students will be able to:

- Understand the principles of Hyperspectral Remote Sensing
- Know about the various pre and post processing of hyperspectral data
- Familiarization to classification of hyperspectral data
- Application of hyperspectral remote sensing in water, mineral and oil resources mapping
- Application of Hyperspectral data in environmental studies

REFERENCES

1. Marcus Borengasser and William C.Hungate and Russel Watkins, “Hyper spectral Remote Sensing: Principles and application” CRC,1stEdition,2008.
2. Qihao Weng, Series Editor, “Hyperspectral Remote Sensing Fundamentals & Practices”, Taylor & Francis, CRC Press.
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4. John A. Richards and Xiuping Jia, “Remote sensing digital Image Analysis - An introduction” fifth edition, Springer Verlag., 2012 ISBN 978 3 642 30061 5.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	24MTRS-11	PRACTICAL - DIGITAL IMAGE PROCESSING AND GEOGRAPHIC INFORMATION SYSTEM	4	40	60	100

Digital Image processing

1. Generating False Colour Composite (FCC). **2 Hrs**
2. Extracting area of Interest (AOI). **2 Hrs**
3. Generating Histogram of various bands. **2 Hrs**
4. Georeferencing the satellite image. **2 Hrs**
5. Geometric correction of satellite image. **2 Hrs**
6. Digital enhancement techniques using image stretching, Band ratio and NDVI. **2 Hrs**
7. Different Filtering techniques. **4 Hrs**
8. Image Fusion and data merging. **2 Hrs**
9. Principal Component Analysis (PCA). **4 Hrs**
10. Supervised and Unsupervised Classification. **4 Hrs**
11. ANN and Fuzzy Image classification. **4 Hrs**
12. Accuracy Assessment and Change detection study. **4 Hrs**

Geographic Information System

1. Georeferencing of Digital Map. **2 Hrs**
2. Digitization and Database Creation. **2 Hrs**
3. Projection and transformation of spatial data. **2 Hrs**
4. Data Conversion – Vector to Raster, Raster to Vector. **2 Hrs**
5. Geo-database creation and query cell development. **2 Hrs**
6. Generation of DEM: from contours, spot heights, GRID and TIN **4 Hrs**
7. Vector Analysis – Buffering, Overlay and Network analysis. **4 Hrs**
8. Raster Analysis – Measurement - Arithmetic overlaying, Logical overlaying, Class interval selection, choropleth maps. **4 Hrs**
9. Map compilation & Layout **2 Hrs**
10. Spatial Data Modelling, Interpolation and Spatial variability analysis. **4 Hrs**
11. Weighted Thiessen polygon and proximity analysis. **4 Hrs**
12. Customisation and scripting. **2 Hrs**
13. Case studies: Flood mapping and Groundwater potential zone mapping. **4 Hrs**

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	24MTRS-12	PLANETARY REMOTE SENSING	4	25	75	100

OBJECTIVE

To understand the origin, characteristics, and processes of the universe, solar system, and planets, as well as the remote sensing techniques used in planetary exploration.

SYLLABUS

UNIT I **Universe -** Origin of Universe - Big Bang theory, Evidences for Big bang, Universal expansion and Hubble's Law, Doppler effect - General characters of Galaxy, Milky Way Galaxy - Origin of Solar System: Nebular theory – Evidences for Nebular theory - Nebular composition - Meteorites vs. Photosphere - formation and internal differentiation of the planets - General Characteristics of the Solar System - Significant features of Terrestrial and Jovian planets - Mercury, Venus, Earth, Mars, Earth Moon, Jupiter, Major Jupiter Moons, Saturn, Major Saturn Moons, Uranus, Neptune – Asteroids – Comets – Meteoroids. **14 Hrs**

UNIT II **Remote Sensing techniques applicable to planetary exploration:** Gamma-Ray Spectroscopy, X-ray Fluorescence spectrometry, Ultraviolet Spectrometry, Photometry, Laser Altimeter, Mars Orbiter Laser Altimeter (MOLO), Lunar Orbiter Laser Altimeter (LOLA), NEAR Laser Rangefinder (NLR), Reflectance spectroscopy, Emission spectroscopy, Vacuum ultraviolet spectroscopy and Color Photometry. **12 Hrs**

UNIT III **Planetary interiors -** Interior of terrestrial planets - Interior of the Jovian (Gas) Planets – Planetary Process: Planetary volcanic Process, Source of Heat, Volcanic process of Earth, Volcanism on Moon, Volcanic process in Mercury, Venus and Mars, Active volcanism in IO, Europe and Ganymede, cryovolcanoes. **14 Hrs**

UNIT IV **Moon -** Introduction to Moon – Implication of Apollo missions – Origin of Moon – Evolution of Moon – Surface composition of Moon – spectral character major rock forming minerals of Moon - Polar region of the Moon – Evidences for the presence of Water in Moon - space weathering – Regolith, Volcanism on the Moon – Age and Lunar stratigraphy – Morphological features of Moon - Impact cratering processes: Morphology of simple craters and complex craters: Lunar Missions: Luna series, Apollo series, Clementine, Lunar Prospector, Kaguya (SELENE), Chang'e series, Chandrayaan-1&2, Lunar Reconnaissance Orbiter, The Lunar Crater Observation and Sensing Satellite (LCROSS), Gravity Recovery and Interior Laboratory (GRAIL) and various other missions. **16 Hrs**

UNIT V **Mars -** Introduction to Mars – Origin of Mars – Crustal evolution of Mars crust – Interior Characteristics of Mars - Martian Timescale – Volcanoes of Mars - Impact Craters, Martian Meteorites. Mars atmosphere - Mars Exploration Missions - Mariner series,

Mars series, Mars Odyssey, Mars Pathfinder, MSL Curiosity, Mars Reconnaissance Orbiter, Mangalyaan/ Mars Orbiter Mission and ExoMars - Future Lunar and Mars Missions. **16 Hrs**

UNIT VI Current Contours - Planetary Exploration Missions (Not for Final Exam only for Discussion) - Various Missions to other planets, Morphology and composition of other planets and satellites

COURSE OUTCOMES

After the completion of the course students will be able to understand:

- •The origin of universe
- •The role of remote sensing in planetary exploration
- •The other planets with reference to earth
- •The morphology and composition of Moon and Mars
- •The Significance of various planetary missions

REFERENCES

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Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	24MTRS-13	LIDAR AND UNMANNED AERIAL SYSTEM	4	25	75	100

OBJECTIVES

To understand the principles, components, and applications of laser and LiDAR technology in terrain mapping, including airborne, terrestrial, and bathymetric laser scanning, as well as the use of Unmanned Aircraft Systems (UAS) in data acquisition.

SYLLABUS

UNIT I **Laser and Spaceborne Laser Profilers –** LASER - Components of Laser: Active Material, Energy Source, Reflection Mirror - Laser Production- Laser Classification - Eye Safety - Class I to Class IV Lasers - Comparison of various methods of deriving terrain height - Laser Ranging - Principles of Laser Ranging: Pulse Laser, Continuous Wave Laser - Types of LiDAR: Range Finder LiDAR, Doppler LiDAR, DIAL - Space Borne Laser Missions - Geo Science Laser Altimeter System (GLAS), LiDAR In- Space Technology Experiment (LITE). **16 Hrs**

UNIT II **Airborne Laser Scanners -** Components of Airborne Laser Scanning System - GPS, IMU, Laser Scanner, Position and Orientation System (PoS) - Types of Scanning Mechanism and Ground Measuring Pattern - Synchronization of Laser Scanner and PoS- Laser Scanners Specification and Salient Features - Concept of Multi return - 3D Cloud Points - Reflectivity of Ground features - Range Correction Factor. **14 Hrs**

UNIT III **Lidar data Processing and Applications** - Pre Processing: Direct Georeferencing, Combining Inertial and Navigation Data - Determination of Flight Trajectory -Data processing - Co-ordinate Transformations - Geolocating Laser Foot Prints - Strip Adjustment - Digital Surface Model to Digital Elevation Model – Filtering - Ground Point Filtering - Flight Planning - Quality Control Parameters - Preparation of flight plan - Airborne Laser Scanner Error Sources - LiDAR data format: ASCII vs Binary, LAS Format - Software used for LiDAR data processing and management – Merits of Airborne Laser Terrain Mapping – Overview of LiDAR Applications - 3D city models - Road and Building Extraction - Forestry applications - Power Line Mapping. **16 Hrs**

UNIT IV **Terrestrial and Bathymetric Laser Scanner -** Terrestrial Lidar: Static and Mobile (Vehicle Mounted) LiDAR - Terrestrial Laser Scanner Specification - Applications of Terrestrial Laser Scanning -Bathymetric Laser Scanner - Specification - Depth of Penetration: Secchi Depth - Applications of Bathymetric Laser Scanner. **12 Hrs**

UNIT V **Unmanned Air Craft Systems (UAS) -** History - UAS Platform Types and Characteristics, Examples of UAS Categories - UAS sensors, UAS cameras and software - Image acquisition process – Photogrammetric process - Imagery Geo-location, Ground

Control Requirement, Aerial Triangulation, DEM Production, DOM Production - Application of UAS. **14 Hrs**

UNIT VI Current Contours (Not for Final Exam only for Discussion) - Recent scientific and technological development, advancement, Industrial application, Job opportunities.

COURSE OUTCOMES

After the completion of the course students will be able to understand:

- The laser technology and its application
- The LiDAR data processing and photogrammetry
- The principles and application of Drone mapping
- The image processing and interpretation of high resolution UAS data

REFERENCES

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Sem	Code	Course Name	Credit	Marks		
				I	E	T
II	24MTRS-14	ELECTIVE – I	4	25	75	100

Sem	Code	Course Name	Credit	Marks		
				I	E	T
II	24MTRS-15	ELECTIVE - II	4	25	75	100

SEMESTER III

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	24MTRS-16	REMOTE SENSING & GIS IN COASTAL STUDIES	4	25	75	100

OBJECTIVES

To explore coastal studies and management using remote sensing, GIS, and oceanographic techniques, focusing on environmental monitoring and resource management.

SYLLABUS

UNIT I **Coastal Studies -** Coastal processes - Oceanic circulation - Upwelling and sinking - Waves - Reflection, diffraction and refraction - Wave generated currents – Catastrophic waves - Tides - Tidal forces - Bathymetry - Sediment drift – Navigation - Physical properties of seawater - Chemistry of seawater - Biological parameters - Oceanographic instruments - Collection of water samples - Current measuring devices - Deep Sea coring devices. **16 Hrs**

UNIT II **Remote Sensing Application for Coastal Studies -** Various satellite and sensors for ocean and coastal applications - Application of CZCS – Chlorophyll and suspended sediment estimation - Retrieval of physical oceanographic parameters - Sea surface temperature – Significant wave height - Wind speed and wind direction - Coastal bathymetry – Sea level rise. **14 Hrs**

UNIT III **Coastal Zone Management -** Introduction - Major issues/problems - Thematic maps on coastal resources - Wetland classification - Mapping of shoreline changes - Creation of CZIS - Coastal aquifer modelling - Integrated coastal zone management - Resolving conflict on resources utilization - CRZ Mapping. **14 Hrs**

UNIT IV **Remote Sensing and GIS in Oil Exploration** – Remote Sensing for oil Exploration in exposed basins – detection of obscured Structures, buried structures and basement structures for oil Exploration. **16 Hrs**

UNIT V **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. **12 Hrs**

UNIT VI **Current Contours (Not for Final Exam only for Discussion) –** GIS case studies related to coastal Management, new trends in current technology.

COURSE OUTCOMES

- Understand coastal processes along with the physical and chemical properties of seawater.
- Learn remote sensing applications including monitoring chlorophyll levels, sea surface temperature, and coastal bathymetry.
- Explore integrated coastal zone management strategies
- Understand remote sensing for detecting geological structures in oil exploration.
- Explore offshore oil exploration methods and technologies, including the use of SAR data for oil seepage detection and LIDAR applications.

REFERENCES

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Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	24MTRS-17	REMOTE SENSING & GIS IN WATER RESOURCES	4	25	75	100

OBJECTIVES

To study water resources management using remote sensing and GIS techniques, focusing on surface water and groundwater modeling, quality assessment, and integrated watershed management.

SYLLABUS

UNIT I **Components of water resources** - Hydrological Cycle: Rainfall, Infiltration, Runoff and Evapo transportation – Global distribution of Surface Water bodies **–** Surface Water Budgeting/Quantification using satellite Infrared data – Spectral Response Pattern of Water. **14 Hrs**

UNIT II **Surface Water Modelling –** Drainage basin - Delineation and codification of watershed – Hydrological modelling - Rainfall - Runoff modelling - Drainage mapping and analysis: from satellite data, Automated Drainage mapping using DEM, Drainage Morphometric analysis - Water quality & quantity mapping and monitoring using Remote Sensing.

16 Hrs

UNIT III **Groundwater Modelling -** Basic Principles of Groundwater Hydrology - Aquifer Systems: Characteristics, Mapping of Crystalline Aquifer Systems, Lithological, Regolith and Fracture Pattern mapping and modelling, Geophysical Surveys and GIS based Geospatial modelling of Crystalline Aquifer System - Characteristics of Sedimentary Aquifer Systems, Artesian and suberising conditions - Geomorphic Aquifer System mapping through satellite Raw and Digitally processed data - Quantification of Groundwater in aquifers; Ground water quality: Rock - water interaction, pollution - Geospatial Modelling of Groundwater Systems – Stochastic – Flow – Linear – Finnet - element Modelling - Sea water intrusion. **16 Hrs**

UNIT IV **Natural and Artificial Recharge -** Site Selection for Natural and Artificial Recharge on Geological criteria - Detection of Site-Specific Mechanism for recharge through GIS Applications. **14 Hrs**

UNIT V **Integrated Watershed Development and Management -** Conjunctive analysis of Surface and Groundwater – GIS based Watershed wise Water budgeting – Integrated Watershed Planning – Water Resources Information System. **12 Hrs**

UNIT VI **Current Contours (Not for Final Exam only for Discussion) -** Remote sensing and GIS in water resources – Case studies

COURSE OUTCOMES

- Surface water modelling and drainage basin analysis using satellite data.
- Groundwater hydrology and aquifer characterization with GIS-based modelling.
- Techniques for natural and artificial recharge site selection.
- Integrated watershed planning and water budgeting using GIS.
- Discussion on current trends and case studies in remote sensing and GIS for water resources.

REFERENCES

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Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	24MTRS-18	REMOTE SENSING & GIS IN DISASTER MANAGEMENT	4	25	75	100

OBJECTIVES

To explore disaster management strategies using remote sensing and GIS for various natural hazards including seismic events, cyclones, floods, droughts, and coastal erosion.

SYLLABUS

UNIT I Neo – Seismotectonic, Landslides and Slope Stability Management – 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 - 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. **16 Hrs**

UNIT II Cyclones, Flood and Tsunami disaster Management - Historical data and post cyclone remote sensing data analysis – Cyclone damage assessment – detection of zones prone for cyclone damage and its causative factor – remedial strategies - Flood Vulnerability mapping using historical flood data and post flood Remote Sensing data – Detection of causative factors of flood – Remedial strategies - Tsunami inundation mapping using field & Satellite data – Elucidation of interface dynamics between Tsunami & coastal land systems – Mitigation strategies – Tsunami vulnerability mapping. **14 Hrs**

UNIT III Drought, Desert and Volcanic disaster Management - Mapping of drought area using historical data and remote sensing data – detection of causative factors for drought and remedial measures - Mapping of desertic terrain using satellite data – detection of migrating dune region – detection of reasoning for migration – remedial strategies - Mapping of active volcanic terrain using optical and thermal remote sensing and ground data – Slope analysis using SRTM DEM – Detection of vulnerable zone – Remedial strategies. **14 Hrs**

UNIT IV Soil erosion, Reservoir siltation and Glacial disaster Management - Mapping of soil erosion prone areas and the reservoir prone for siltation - Detection of causative factors for soil erosion- remedial strategies - Mapping of Glaciers and its movement – Terrain analysis using SRTM DEM - Demarcation of vulnerable zone due to glacial melt and migration – strategies for protection. **16 Hrs**

UNIT V Coastal erosion and Saltwater intrusion Management - Mapping of coastal erosion zone using historical groundwater data and satellite images – detection of causative factors – remedial strategies - Detection of saltwater front using historical ground water data

– reasons for salt water intrusion - remedial strategies - Coastal Vulnerability Index – Global warming and impact of sea level rise since last LGM **12 Hrs**

UNIT VI Current Contours - Long term Mitigation measures (Not for Final Exam only for Discussion) - Needs and approach towards prevention - components of disaster mitigation - Disaster legislation and policy - Insurance - Cost effective analysis - Utilisation of resources - Training - Education - Public awareness -Role of media.

COURSE OUTCOMES

- Mapping of seismic and geomorphic anomalies for risk assessment and mitigation planning.
- Assessment of cyclone damage and flood vulnerability using remote sensing data.
- Mapping of drought-prone areas and desert terrain using satellite imagery for remedial actions.
- Analysis of soil erosion, reservoir siltation, and glacial movements for disaster preparedness.
- Identification of coastal erosion and saltwater intrusion zones, and development of mitigation strategies using historical data and satellite images.

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1. J.P.Singhal., "Disaster Management", Laxmi Publications, 2019, ISBN-10:9380386427, ISBN-13:978-9380386423.

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5. Gupta Anil K, Sreeja S, Nair., "Environmental Knowledge for Disaster Risk Management", NIDM, 2012.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	24MTRS-19	PRACTICAL - REMOTE SENSING & GIS INTERPRETATION FOR MINERAL, HYDROCARBON, WATER RESOURCES AND GEOHAZARDS	4	40	60	100

1. Interpretation of Remote Sensing & Geophysical Data for Mineral Targeting. **8 Hrs**
2. Interpretation of Remote Sensing & Geophysical data for Oil Exploration. **8 Hrs**
3. Interpretation of Remote Sensing Data for Water Bodies mapping **8 Hrs**
4. Analysis of Aerial Photographs and Satellite Imagery for Drainage Morphometry and Water Shed Demarcation **8 Hrs**
5. Mapping of Lithologically, Structurally, Geomorphologically controlled Aquifer System **8 Hrs**
6. Microwave Remote sensing in Flood & Tsunami inundation mapping **8 Hrs**
7. Remote sensing and GIS in Coastal Erosion **8 Hrs**
8. Remote sensing and GIS in soil erosion **4 Hrs**
9. Remote sensing and GIS in reservoir siltation **4 Hrs**
10. Thermal Remote Sensing in Volcanic hazards mapping **8 Hrs**

Sem	Code	Course Name	Credit	Marks		
				I	E	T
III	24MTRS-20	ELECTIVE - III	4	25	75	100

Sem	Code	Course Name	Credit	Marks		
				I	E	T
III	24MTRS-21	ELECTIVE-IV	4	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	24MTRS-22	MINI PROJECT	4	40	60	100

a) The Mini project is aimed at skill development for the students to prepare them to take up the major project. This would involve intensive coaching / training on visual interpretations of aerial and satellite data for preparation of Thematic Maps / Digital Image Processing / Computer programming / Statistical analysis and modelling / GIS analysis / field survey / lab analysis etc.

b) Students will complete the mini project during 45 days of the III Semester and submit the mini project report through a seminar. This mini project will have the credit of 100 marks.

c) For Mini project Report, the maximum mark will be 75 and for the corresponding Viva- Voce / Seminar 25.

A candidate shall be declared to have passed in the project Report / Dissertation if he / she gets not less than 40% each in the mini project, major project reviews and the final viva-voce, but not less than 50% in the aggregate of all.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	24MTRS-23	INDUSTRIAL CUM GEOLOGICAL FIELD VISIT	2	40	60	100

SEMESTER IV

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	24MTRS-23	MAJOR PROJECT	10	150	150	300

Optional Elective Papers

1. THERMAL AND MICROWAVE REMOTE SENSING

OBJECTIVES

To understand the principles and applications of Thermal and Microwave Remote Sensing in various environmental and scientific contexts.

UNIT I **Thermal Remote Sensing** - Principles – Definition - Radiant temperature - Black body radiation - Thermal Emissivity of materials - Thermal energy interaction with atmosphere and terrain elements - Kinetic and radiant temperature - Thermal energy detectors - Thermal radiometers - Thermal scanners and data collection. **12 Hrs**

UNIT II **Interpretation and Application of Thermal data** - Day time and night time thermal data behaviour and manifestation of objects - Thermal inertia - Thermography and heat loss - geometric characteristics of thermal scanner imagery (scale distortion, relief displacement, flight parameters distortion) - Radiometric calibrations - SST and LST mapping - application of thermal remote sensing in urban, climate, soil moisture and environmental studies. **14 Hrs**

UNIT III **Microwave Remote Sensing** - Light theory, wave description of simple harmonic waves - Complex wave description, energy and power of waves - Brightness or intensity - Polarization property of microwaves - Wave equation for polarized waves, wave combination - Interference - Coherence, phase as a relative distance measure - Interference pattern - microwave propagation - Maxwell equation - Signal loss through lossy media. **14 Hrs**

UNIT IV **Active and Passive Microwave Remote sensing** - Radar basics - Radar frequency bands - Radar systems - SLAR operations- Antennas (receivers), Spatial resolution-geometric characters of SLAR imagery (Slant Range and distortion, relief displacement, parallax) - Doppler principle & processing system parameters and fading concepts - influence of earth surface features over Radar energy (geometry, electrical property, soils, vegetation, water.) - interpretation of Radar imagery - Radiometry - Emission laws – Brightness temperature - Antenna temperature - Power - Temperature correspondence, interaction with atmospheric constituents - Interaction with earth features, missions. **16 Hrs**

UNIT V **Microwave Data processing and techniques** - SAR image processing software - Measurement and discrimination - Header extraction - Slant range to ground range - Multi-looking from SLC - Filtering technique - Geometric correction, factors affecting geometrical correction - Backscattering coefficient - Speckle processing – Image interpretation, SAR image fusion - Hybrid classification of optical microwave - Polarimetry, interferometry, altimetry, scatterometry. **16 Hrs**

UNIT VI Current Contours - Applications of Thermal and Microwave Remote Sensing (Not for Final Exam only for Discussion): - Thermal Remote sensing Applications in agriculture, forestry, hydrology and case studies. Microwave Remote Sensing Applications in agriculture, forestry, ocean, geology, hydrology, cryospace studies, land use mapping and ocean related studies.

COURSE OUTCOMES

- Learn about the difference among reflection, scattering and emission from earth materials
- Understand and the principles of thermal and microwave remote sensing
- Know the applications of thermal and microwave remote sensing
- Learn about application of microwave remote sensing in earthquake field.
- Understand the LIDAR and ALTM applications
- Learn about application of microwave data in subsurface lithological mapping

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2. MAPPING METHODS GPS AND CARTOGRAPHY

OBJECTIVE

To understand the fundamentals and applications of surveying, mapping, GPS technology, map projections, and computer-assisted cartography.

SYLLABUS

UNIT I **Basic Principles -** Conventional Surveying and mapping (Chain survey, Plane Table survey, Surveying with Theodolite), Toposheet reading- Definition and Nature of Cartography - History - Cartographic problems. **12 Hrs**

UNIT II **GPS Mapping -** Introduction- Satellite, Control and user segments- signal components- Errors in GPS_observations – GPS positioning- Differential GPS - GPS Mapping methods (Conventional- Static- Kinematic- Semi Kinematic (Stop & Go) Rapid, Static, Mobile Mapping) – GPS applications. **14 Hrs**

UNIT III **Map Projection -** Types of Map projections - Conical, Polyconic, Cylindrical, Equal area or Lamberts cylindrical, Mercator's, zenithal, Gnomonic projections for world map, Continental map - Recent projections. **14 Hrs**

UNIT IV **Computer Assisted Cartography-I -** Input data types (point, line, polygon and Raster data) - Data source (Toposheet, Aerial Photo, Magnifier, Stereoscope, Video Camera, Digitiser board, Scanners) - Modelling Devices (Computer, Photo writer, Plotter). **16 Hrs**

UNIT IV **Computer Assisted Cartography -II -** Cartographic processes (Contouring, Density slicing, 3D Projection, Area Calculation, Volume Estimation) - Storage Devices - Output devices - Special Merits of Digital Cartography. **16 Hrs**

UNIT VI **Current Contours Map compilation (Not for Final Exam only for Discussion) -** Map Design & Layout - Lettering & Toponomy - Mechanics of map construction.

COURSE OUTCOMES

- Master conventional survey methods like Chain, Plane Table, and Theodolite surveys.
- Apply GPS for accurate positioning and mapping, including Differential GPS.
- Understand various map projections and their applications.
- Utilize digital tools for data input, processing (e.g., contouring), and output.
- Discuss map design, layout, and construction mechanics in cartography.

REFERENCES

1. Campbell, J 1984: Introductory Cartography, Printers Hall Englewood Cliffs, N.J

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9. P.J.G. Teunissen & A. Kleusberg (Eds) 1998: GPS for Geodesy, Springer Verlag, Germany

3. PYTHON AND R PROGRAMMING FOR GIS

OBJECTIVE

To master Python and R programming for geospatial data analysis and visualization.

SYLLABUS

UNIT I **Introduction -** Overview - Installation of Python and relevant libraries - Introduction to development environments -Data structures - Variables, data types - Basic operations - Control structures - Lists, tuples, dictionaries, and sets - Geospatial libraries in Python. **12 Hrs**

UNIT II **Geospatial Libraries of Python -** Importing, reading, and writing geospatial data - Geospatial data manipulation and attribute handling -Plotting and visualizing geospatial data - Customizing plots and creating maps - Geospatial analysis and processing - Spatial operations - Geometric calculations and measurements – Automating geospatial tasks. **14 Hrs**

UNIT III **Web Mapping and Geospatial Services -** Introduction to web mapping libraries (Folium, Leaflet) - Interacting with web maps and geospatial services - Creating interactive geospatial visualizations. - Geomatics software development. **14 Hrs**

UNIT IV **Introduction to R Programming -** Overview - Installation of R and relevant packages - Introduction to RStudio and the R development environment - R Basics and data structures - Variables, data types, and basic operations in R – Control structures (conditionals, loops) - Vectors, matrices, data frames, and lists in R. **16 Hrs**

UNIT V **Geospatial Data manipulation in R -** Introduction to geospatial packages (e.g., sf, sp) - Importing, reading, and writing geospatial data - Geospatial data manipulation and attribute handling - Data visualization packages (e.g., ggplot2) in R - Plotting and visualizing geospatial data - Customizing plots and creating maps - Geospatial data analysis - Spatial operations (e.g., buffering, overlay). **16 Hrs**

UNIT VI **Current Contours (Not for Final Exam only for Discussion) -** Creation of Simple project using python and R programming based on the learning provided.

COURSE OUTCOMES:

On completion of the course the student is expected to be able to

- Understand the fundamentals of Python programming language and its syntax.
- Apply Python programming techniques to process, analyze, and visualize geospatial data.
- Build geospatial applications and tools using Python for specific geomatics domains, such as remote sensing, GIS, or spatial analysis.
- Understand the fundamentals of the R programming language and its libraries.
- Apply R programming techniques to process, analyze, and visualize geospatial data.

REFERENCES

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3. Chris Garrard, "Geoprocessing with Python", CRC Press, 2016, ISBN: 978-1498775261.
4. Chris Garrard, "Automating GIS Processes with Python", CRC Press, 2nd edition, 2019, ISBN: 978-1138505581
5. Joel Lawhead and Erik Westra, "Learning Geospatial Analysis with Python", Packt Publishing, 2020, ISBN: 978-1839213309.
6. Roger S. Bivand, Edzer J. Pebesma, and Virgilio Gómez-Rubio, "Applied Spatial Data Analysis with R", Springer, 2nd edition, 2013, ISBN: 978-1461476177.
7. Robin Lovelace, Jakub Nowosad, and Jannes Muenchow, "Geocomputation with R", CRC Press, 2nd edition, 2020, ISBN: 978-1138304512.
8. Yongwan Chun and Daniel A. Griffith, "Spatial Statistics and Geostatistics: Theory and Applications for Geographic Information Science and Technology", Sage Publications, 2013, ISBN: 978-1412991644.

4. FULL STACK DEVELOPMENT FOR WEBGIS

OBJECTIVE

To master web GIS technologies and programming for spatial data management and application development.

SYLLABUS

UNIT I **Spatial Data structures and database management -** Spatial Data structures and Formats, Basic file formats (vector, raster) – JSON, GeoJSON, Geodatabase, Projections and EPSG Co-ordinate Systems, Attribute Tables – Spatial and Attribute Table linkage - Spatial Database administration – Data management and optimization - PostgreSQL- QGIS with Postgres- OGC Web Map services - WMS, WFS, WCS, WPS – Styling, tiling & caching. **14 Hrs**

UNIT II **Web GIS Architecture -** Internet and GIS, Web GIS Architecture and Components – Web Server – GIS Server / Application Server – Database Server, Open Server Standards - Protocols: HTTP, FTP, SMTP- Frontend & Backend programming: HTML, CSS, XML, Service Oriented Architecture - REST/ SOAP service Protocols, Middleware - Web Services - GIS data sharing – WebMap services and Open Source / Free Software. **14 Hrs**

UNIT III **HTML and CSS Programming -** HTML: HTML Elements - Formatting and Fonts – Anchors – Backgrounds – Images – Hyperlinks –Lists – Tables – Frames - HTML Forms – CSS: Introduction to CSS – Basic syntax and styles - InlineStyles-Embedding Style Sheets - Linking External Style Sheets – Margins and Padding – Positioning using CSS. **16 Hrs**

UNIT IV **WEB PROGRAMMING – JAVASCRIPT -** JavaScript: Data types and Variables, Operators, Expressions, and Statements – Functions Objects - Array, Date and Math related Objects - Document Object Model - Event Handling – Controlling Windows & Frames - Form handling and validations. **16 Hrs**

UNIT V **Geoserver -** Geo Server– Web Administration – Geo server data directory – loading and working with data – shape file – PostGIS file – other web format data – styling the layers – publishing map services – Spatial functions- security – demos and case studies on Map and Geo server. **12 Hrs**

UNIT VI **Current Contours - Capstone Project (Not for Final Exam only for Discussion) -** Creation of Full stack Web GIS application based on the learning provided.

COURSE OUTCOMES

On completion of the course the student is expected to be able to

1. To introduce the Web GIS Architectures, Services for the GIS Spatial data.
2. To understand the markup languages, Cascaded Style Sheets concepts for the GIS Spatial Data.
3. To study the concepts of Java Scripts in programming the GIS Spatial Data.

4. To implement the complete GIS solution using the GeoServer concepts using case studies

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3. Stefano Iacovella, Brian Youngblood, "GeoServer Beginner’s Guide", Second Revised Edition 2017. ISBN-13: 978-1849516686
4. Eric Pimpler, Mark Lewin, “Building Web and Mobile ArcGIS Server Applications with JavaScript”, Second Edition. 2017. ISBN 9781787280526.
5. Chad Cooper, “Mastering ArcGIS Enterprise Administration", 2017. ISBN: 9781788297493, 1788297490.

5. GEOINFORMATICS IN CLIMATE CHANGE STUDIES

OBJECTIVES

To explore the multifaceted aspects of climate change and its impacts through scientific and geospatial perspectives.

SYLLABUS

UNIT I Climate Change

Definition – Climate Systems (Atmosphere, Hydrosphere, Lithosphere, Land surface, Biosphere) Definition - Paleoclimate, Sources of climate change (Natural Climate, Variations, Human induced variations) – Climate change past and future – drivers of climate change – Impacts of Climate change. **14 Hrs**

UNIT II Greenhouse Effect and Global Warming

Global carbon budget – Soil carbon – Carbon cycle – Biophysical and Human component carbon cycle – High arctic carbon sink – Greenhouse effect (Greenhouse gas emissions) Effects of global warming (a Terrestrial and agnatic Ecosystems, Biogeochemical cycling, $C0_2$ concentrations, Nitrogen deposition, Ecological impacts, global dimming, Disease incidence, over water and lake productivity)**.** **16 Hrs**

UNIT III Data Analysis: Multitemporal data analysis of Coastal, Riverine, Glacier and Mountain System. **14 Hrs**

UNIT IV Mitigation Measures in climate change: Adaptation and mitigation: Mitigating climate change - blue carbon- geoengineering - renewable energy and other alternate systems - adaptation indigenous knowledge - sectoral adaptations - coastal ecosystems - coastal communities - mainstreaming climate change into development practices. **14 Hrs**

UNIT V Climate Change impact geospatial models: Variations in duration and quantity of rainfall bring profound impacts on water resources, human life, economics and ecosystems. Extreme events such as floods droughts and cyclones affect lives and livelihoods. **12 Hrs**

UNIT VI Current Contours - Climate Change Scenarios (Not for Final Exam only for Discussion): Potential Consequences, Risks, and Uncertainties of Climate Change, some of the potential consequences of climate change, disruption of the global food supply that could have major negative impacts on humanity. uncertainties in how the future may unfold, the important concept of risk as a means of dealing with uncertainty, and the different levels of risk associated with different consequences.

COURSE OUTCOME

After the completion of the course students will be able to

- Understand some of the potentially serious consequences of climate change.
- Explore the uncertainties associated with these and other consequences.
- Examine the concept of risk and the interplay of probability and severity of impact in determining risk.

- Consider the work of a climate scientist advocating for action to combat the effects of climate change.
- Development of models based on the Paleoclimate
- Prediction of the impact on the extreme events
- Predict and generate future conditions under various climate scenarios or management/preventive action alternatives

REFERENCES

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2. Kumarasamy, K. Dr., Kamaraj, E.C. Dr., Anand, P.H. Dr. Samuvel Selvaraj, R Dr, and Kumar, V., Kalanilaiyal, Grace Publications, Kumbakonam, 2001.
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4. Clayton, K.M., Geomorphology Texts Rivers from and Process, Commonwealth Printing Press Ltd., Hong Kong, 1985.
5. Radhakrishna B.P., Coastal Geomorphology in India, Geological Society of India, Bangalore, 1987.
6. David H.K.Amiran, and Andrew W. Wilson, Coastal Deserts - Their Natural and Human Environments, The University of Arizona Press, Tucson, Arizona, 1973

6. GEOINFORMATICS IN URBAN STUDIES

OBJECTIVES

Explore the principles and applications of urban planning and environmental management within the context of modern urbanization.

SYLLABUS

UNIT I **Introduction to Urban Planning -** Concepts of Urbanization and Urban Areas Evolution of City Building- Urban Design in classical and pre-industrial period –History Theories of City Development and Planning Theories Urban Growth and System of Cities City–Metro and Mega Cities: Problems and Issues-Human Settlement Planning, Urban Development Policies and Programmes. **14 Hrs**

UNIT II **Urban Ecology and Environment** Components of natural and built environment, Ecosystems and their relevance to environment, resources and human settlements, Modifications in natural environment, causes and consequences. Impact of urbanization and industrialization on nature, and urban ecosystem. Integrated resource planning approach. Sustainability and environmental criteria for location of human settlements, Ecological parameters for planning at different levels: site planning, settlement planning and regional planning. Pollution types, sources and remedies. **16 Hrs**

UNIT III **Remote Sensing for Urban Studies -** Remote Sensing in Urban Planning -Scope and Limitations – Scale and Resolution requirements – Spectral characteristics of Urban Features– High Resolution, Thermal, Hyper spectral and Microwave Remote Sensing for Urban area analysis– Aerial and Ground based Sensors– UAVs –Laser Scanners Urban Modelling – Urban Landuse and Land cover Classification – Change Detection –UrbanHeatIslandUrbanAirqualitymapping-Noisepollutionmodeling-3DCityModeling– Flood Modelling in Urban Areas-Geoinformatics for Smart Cities. **16 Hrs**

UNIT IV **Urban Infrastructure Planning -** Transport, Energy/Utilities, protection of the environment and safety; Water Supply and Sanitation- Solid Waste Disposal and Management-Fire and Electrification, and Social Infrastructure Governance. **12 Hrs**

UNIT V **Urban Information System:** Classification of information and data; Information collection - LIM/LIS; Large Scale Mapping - FMB – sources, Digital Surface Model (DSM) - Geoinformatics in Plan Formulation and Review– Population Estimation– Property Tax Assessment and Management -Urban Renewal Planning – Architecture and Urban Design on Disaster life cycle-case studies. **14 hrs**

UNIT VI **Current Contours: (Not for Final Exam only for Discussion) -** Smart Cities Concepts: challenges facing urban environments-frames and attributes of a smart city.

COURSE OUTCOMES

At the end of the course the student will be able to understand

- The basics of urban mapping and Plan preparation.
- The application of remote sensing in urban mapping.
- The role of remote sensing in preparation of urban plans.
- The modeling techniques for modeling and prediction of future landuse scenarios

REFERENCE

1. Netzband, Maik; Stefanov, William L.; Redman, Charles (Eds.), Applied Remote Sensing for Urban Planning, Governance and Sustainability, Springer, 1st Edition, 2007
2. Rashed, Tarek; Jürgens, Carsten (Eds.), Remote Sensing of Urban and Suburban Areas, Springer, 1st Edition, 2010
3. Jean-Paul Donnay, Michael John Barnsley, Remotesensingandurbananalysis,1st Edition, Taylor& Francis e-Library,2005
4. Qihao Weng, Dale A. Quattrochi (Eds), Urban Remote Sensing,1st edition, CRC Press, 2000.

7. GEOMATICS FOR AGRICULTURE AND FORESTRY

OBJECTIVE

To explore the applications of remote sensing and GIS in agriculture, soil mapping, damage assessment, forestry, and climate impact studies.

SYLLABUS

UNIT I **Crops Acreage and Yield Estimation -** Spectral properties of crops in optical & TIR region, microwave backscattering behavior of crop canopy - Crops identification and crop inventory - Crop acreage estimation - Vegetation indices and biophysical model - Yield modelling - Crop condition assessment - Command area monitoring and management - Microwave RS for crop inventory - Case studies. **14 Hrs**

UNIT II **Soil Mapping -** Soil classifications - Soil survey, types and methods - Hydrological soil grouping - Factors influencing soil reflectance properties - Characteristics of saline & alkaline soils - Principle component analysis and orthogonal rotation transformation - Soil mapping - Watershed management - Problem soil identification - Land evaluation - Case studies. **14 Hrs**

UNIT III **Damage Assessment - D**etection of pest and diseases - Flood mapping and assessments of crop loss - Drought assessment - Land degradation - Soil erosion and sedimentation - Soil loss assessment - Soil conservation - Agriculture damage prediction modelling. **12 Hrs**

UNIT IV **Forestry -** Forest taxonomy - Inventory of forest land - Forest types and density mapping - Forest stock mapping- Factors influencing degradation of forest - Delineation of degraded forest - Forest change detection and monitoring - Forest fire mapping & damage assessment - Biomass estimation - Carbon storage - ALTM for forest studies - Urban forestry issues. **16 Hrs**

UNIT V **Climatic Impact of Agriculture and Forestry -** Concepts of integrated surveys - Global effects and climatic changes: Land degradation and desertification, extreme events - Effect on forest produces health, forest hazards, sustainable forest management and practice - Biodiversity issues - Invasive biotics - Mitigation and adaptation - RS &GIS for drawing out action plans. **16 Hrs**

UNIT VI **Current Contours (Not for Final Exam only for Discussion) -** Watershed approach - Landuse planning for sustainable development - Precision farming - Case studies.

COURSE OUTCOMES

On completion of the course the student is expected to be able to

- Understand the spectral properties of agricultural crops and their applications.
- Understand the spectral properties of soil and applications.

- Understanding the RS and GIS application to damage assessment due to disaster.
- Understand the spectral properties of forest species and application to forest management.
- Understand the climate impacts on agriculture and forestry management.

REFERENCES

1. John G. Lyon, Jack MCcarthy, “Wetland & Environmental application of GIS”, 1st Edition, 1995.
2. Margareb Kalacska, G. Arturosanchez, “Hyper spectral RS of tropical and subtropical forest”,1st Edition, 2008.
3. Shunlin Liang, "Advances in land RS: System, modeling inversion and applications”,1st Edition, 2008.
4. Joe Boris dexon, “Soil mineralogy with environmental application”, Library of congress catalog, 2004.
5. James B, “Introduction to Remote sensing”, 3rd Edition, Campbell, 4th edition Guilford Press, 2008.
6. David H. White, S. Mark Howden, “Climate Change: Significance for Agriculture and Forestry”, Springer, 1994

8. GEOINFORMATICS IN MARINE GEOLOGY & OCEANOGRAPHY

OBJECTIVE

To explore oceanography through the lens of geoinformatics, focusing on physical features, resources, and environmental management.

SYLLABUS

UNIT I **Introduction -** Origin of seas and oceans – Ocean Morphology – Oceanic crust and Ocean margins – Sea Bottom Topography – Continental Margin, Shelf, Slope, Sub marine canyon – Ocean basin floor – Abyssal hills, plains & gaps – Mid oceanic rise & ridges. **14 Hrs**

UNIT II **Physical Features of the Ocean -** Ocean circulation: Waves, Currents, Tides, Turbidity, Submarine Sedimentation processes – oceanic sediments & microfossils – Marine stratigraphy, Correlation & Chronology – Tectonic history of oceans. **14 Hrs**

UNIT III **Ocean Resources -** Classification of marine mineral deposits – Origin and depositional system of marine resources – Beach placers, Shelf deposits, Deep Ocean phosphatic, Polymetallic nodules, Sulphate deposits, Hydrocarbon deposits – Sea water as resource. **16 Hrs**

UNIT IV **Physical & Chemical Oceanography -** Concepts of sea level changes – Physical & Chemical properties of sea water – Marine Pollution – Pathways, Residence time, Pollutants in marine environment. **12 Hrs**

UNIT V **Geoinformatics in Ocean Studies -** Mapping of sea surface elevation & temperature using sea satellite data – pigment & chlorophyll mapping – turbidity mapping – mapping of sea level change of assessment of its impact over coastal based system. **16 Hrs**

UNIT VI **Current Contours - Coastal Zone Management (Not for Final Exam only for Discussion)** Introduction - Major issues/problems - Thematic maps on coastal resources - Wetland classification -Mapping of shoreline changes.

COURSE OUTCOMES

On completion of the course the student is expected to be able to

- Study morphology, crust, margins, and topography.
- Explore circulation, waves, currents, tides, sedimentation.
- Analyze mineral deposits, hydrocarbons, seawater as a resource.
- Investigate sea level changes, seawater properties, pollution.
- Use satellite data for mapping sea surface features, chlorophyll, turbidity.
- Address issues, map resources, monitor shoreline changes.

REFERENCES

1. Chouhan. T.S., Applied Remote Sensing and Photo Interpretation, Vigyan Prakashan.
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3. J.P.Kennet (1982) Marine geology. Printice Hall Inc., New Jersy, 813p.
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5. J.Weisberg & H. Parish (1974). Introductory Oceanograpghy. McGraw Hill
6. B.W.Pipkin, D.S.Gorslin, R.E.Casey & D.E. Hammord (1972). Laboratory exercises in oceanography. W.H.Freeman & Co., San Francisco, 255p.
7. J.J. Bhatt. Ocenaography – Exploring the Planet Ocean. D. Van. Nostrand Company, New York, 1994.
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11. Eric. C. Bird Coasts: an introduction to coastal geomorphology, III ed. Basil Black well Publ. 1984.
12. Karsten Manager, “Shoreline Management Guidelines”, DHI Water & Environment, Denmark, 2004.

9. GEOINFORMATICS IN INTEGRATED COASTAL ZONE MANAGEMENT

OBJECTIVE

To understand the principles, issues, and the necessity of Integrated Coastal Zone Management (ICZM), integrating natural and anthropogenic processes with remote sensing and GIS applications.

SYLLABUS

UNIT I **Principles, Issues and Need of Integrated Coastal Zone Management -** Coastal ecosystem – Natural and anthropogenic processes and their interface dynamics – coastal issues – need for ICZM – Concepts and principles of ICZM. **14 Hrs**

UNIT II **Natural Morphodynamic processes -** Tectonic movements – Coastal geometry – Reverine dynamics – wave dynamics and physical oceanographic process – long term, short term and seasonal changes in the coastal systems – disaster vulnerability mapping – remote sensing and GIS applications. **14 Hrs**

UNIT III **Anthropogenic processes -** Anthropogenic processes (construction, urbanization, harbour development, pollution) and their input in coastal ecosystem and issues. **12 Hrs**

UNIT IV **Coastal Management Applications Sensors / Platforms -** Use of Remote Sensing in Coastal Management, Spatial, spectral. Radiometric and temporal resolutions, sensors, ETM, IKONOS, SPOT XS, sea WIFS, ERS, along track scanning radiometer (ATSR), OCEANSAT, RADARSAT, accuracies with different Sensors, limitations. **16 Hrs**

UNIT V **Integrated Coastal Zone Management Applications -** The ICZM development process: demonstration, consolidation, extension, Coastal Bio diversity, wetland management, Mangrove eco system, coastal environmental impact assessment, Resource allocation conflict, sustainable development, case studies using Remote Sensing and GIS. **16 Hrs**

UNIT VI **Current Contours - Coastal Management (Not for Final Exam only for Discussion) -** Creation of CZIS - Coastal aquifer modelling - Integrated coastal zone management - Resolving conflict on resources utilization - CRZ Mapping.

COURSE OUTCOMES

On completion of the course the student is expected to be able to

- Understand ICZM principles and coastal ecosystem dynamics.
- Analyze natural processes like tectonic movements and wave dynamics.
- Assess anthropogenic impacts such as urbanization and pollution on coastal areas.
- Utilize remote sensing for disaster vulnerability mapping and coastal management.

- Implement ICZM strategies for biodiversity conservation and sustainable development.

REFERENCES

1. Gupta R.P, Remote Sensing Geology, Springer - Verlag - New York – London, 1991
2. Gary L.Prost, Remote Sensing for Geologists - A Guide to Image interpretation, Gordon and Breach Science Publishers, The Netherlands, 1997.
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12. Edwards, A.J. (Ed.) Applications of Satellite and Airborne Image data to coastal management. Coastal region and Small Island papers N0.4 (UNESCO, Paris), 1999.
13. Green, E.P., Mumby, P.J., Edwards, A.J. and Clark, C.D. (Ed. A.J.Edwards). Remote Sensing handbook for tropical coastal management. Coastal management source books.3. UNESCO, Paris. X + 316, 2000.
14. Clark,J, Handbook for Coastal zone Management. NY and London, Lewis Publishers Kenchington R. et.al (Eds) ICZM Training manual, Bangkok: UNEP post J, 1996.
15. Lundin CG, Guidelines for integrated coastal zone management. World banm environmentally sustainable development series, 1996.

10. GEOINFORMATICS IN INFRASTRUCTURE DEVELOPMENT

OBJECTIVE

To explore the application of geoinformatics across diverse sectors to enhance resource management and development strategies.

SYLLABUS

UNIT I **Basic Principles -** Types and branches of infrastructure / physical resources – Current status of data holding departments – Current data types and formats – issues – need for geoinformatics for infrastructure development – possible data formats and data structure – data collection mechanisms. **12 Hrs**

UNIT II **Geoinformatics in Agriculture resources -** Data formats, data collection, data structure, database creation and data mining models in Agriculture resources (water resources sector – Agriculture sector - Horticulture sector - Sericulture sector - Irrigation sector). **16 Hrs**

UNIT III **Geoinformatics in Literacy, health and Animal Husbandry resources -** Data formats, data collection, data structure, database creation and data mining models in Literacy, health and animal husbandry resources (Education Sector-Drinking water sector-Animal Husbandry sector –Aquaculture sector). **16 Hrs**

UNIT IV **Geoinformatics in Infrastructural resources -** Data formats, data collection, data structure, database creation and data mining models in infrastructural resources (Housing sectors– Transport sectors – Urban sectors – Electricity sectors – Energy sectors – Communication sectors). **14 Hrs**

UNIT V **Geoinformatics in Industrial Resources -** Data formats, data collection, data structure, database creation and data mining models in industrial resources (Major industries sector – Cottage industries sector- non forming sector and Tourism sector). **14 Hrs**

UNIT VI **Current Contours: Infrastructure Management (Not for Final Exam only for Discussion) -** Recent trends in Infrastructure Management based on Gis, and case studies

COURSE OUTCOMES

On completion of the course the student is expected to be able to

- Analyze infrastructure data needs and formats for effective management.
- Implement geoinformatics in agriculture, horticulture, sericulture, and irrigation sectors.
- Utilize geoinformatics for data management in education, health, and animal husbandry.
- Apply geoinformatics for infrastructure sectors like housing, transport, and urban planning.

- Implement geoinformatics in industrial sectors including major industries, cottage industries, non-farming sectors, and tourism.

REFERENCES

1. Committee on Review of Geographic Information Systems Research and Applications at HUD: Current Programs and Future Prospects, GIS for Housing and Urban Development, Board on Earth Sciences and Resources, 2003. p128.

2. Maik Netzband, William Stefanov, Charles Redman (Eds.) Applied remote sensing for urban planning, governance and sustainability, Springer, 2007 - 278 p

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4. Pham Huy Giao, Mai Trong Nhuan, van der Meer, F.D., Tong Duy Thanh, Tran Nghi, and Nguyen Hong Minh (eds.) Proceedings of the international workshops: Towards systematic and innovative geotechnical geoenvironmental, geological and geophysical contributions for a sustainable infrastructure development of Vietnam, Vietnam National University Publishing House, 2004. 293 p.

11. GEOMATICS FOR TRANSPORTATION PLANNING AND MANAGEMENT

OBJECTIVE

To explore the integration of engineering surveys, remote sensing, GIS, and intelligent transportation systems (ITS) in optimizing urban and regional transportation planning and management.

SYLLABUS

UNIT I **Engineering Surveys and Geometric Design -** Roadways and railways - Necessity for planning - Classification of roads and railways – Alignment surveys and investigations using conventional and remote sensing techniques (preliminary, reconnaissance and final location surveys) - Types of highway pavements - Design principles on highway geometric elements. **12 Hrs**

UNIT II **Urban Transportation Systems and planning -** Urban transportation: Policy alternatives - Transportation and the environment – Urban transport planning processes - Socio-demographic data and travel surveys - Transportation modelling – Traffic congestion - Plan evaluation and implementation - Planning and financing - Critiques of transportation modelling and forecasting. **14 Hrs**

UNIT III **Remote Sensing in Transportation -** Study of geographic pattern of urban development using remote sensing data products - Urban sprawl- Parking studies using aerial photos - Traffic analysis - Accident analysis - Site suitability analysis for transport infrastructure - Population distribution studies - Improvisation of rural road network - Regional Road network connectivity - Vehicle tracking - Incident identification and management. **16 Hrs**

UNIT IV **Gis and Transportation Analysis -** Transportation analysis in GIS: Introduction - Network flows - shortest path algorithms transportation databases: Creation and maintenance - Facility location - Vehicle routing - Highway and railway alignment - Highway maintenance. **14 Hrs**

UNIT V **Intelligent Transportation Systems -** Land use transport interaction models - Transport environment interaction models – Intelligent Transportation Systems (ITS) - Development - Architecture - Mobile Mapping. **16 Hrs**

UNIT VI **Current contours (Not for Final Exam only for Discussion) -** Integration with GIS - Applications - Case studies.

COURSE OUTCOMES

On completion of the course the student is expected to be able to

- Understand various highway geometric elements and surveys carried out for highway
- alignment.
- Understand the factors involved in urban transportation planning.

- Apply remote sensing techniques for transportation problems.
- Apply GIS for transportation analysis.
- Gain knowledge on latest developments in transportation planning.

REFERENCES

1. Harvey J. Miller, Shih-Lung Shah, “Geographic Information Systems for Transportation Principles and Applications”, Oxford University Press, 2001.

2. John Stillwell, Graham Clarke, “Applied GIS and Spatial Analysis”, John Wiley & Sons Ltd, 2004.

3. Papacostas, C.S, Prevedouros, P.D., “Transportation Engineering and Planning”, Prentice-Hall India, 2015.

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6. Igor Ivan, Itzhak Benenson, Bin Jiang, Jiri Horak and James Haworth, “Geoinformatics for Intelligent Transportation System”, Springer International Publishing AG, 2015.

7. Barry Boots, Atsuyuki Okabe and Richard Thomas, “Modelling Geographical Systems – Statistical and computational applications”, Kluwer Academic Publishers, 2014.

12. DATA BASE MANAGEMENT SYSTEM (DBMS)

OBJECTIVE

To gain comprehensive understanding of database management principles and various data models, focusing on relational databases and security measures

SYLLABUS

UNIT I **Basic Principles of Data base management -** Basic concepts- Database architecture (three levels) –views – components of DBMS – Advantages and disadvantages of DBMS – Classification of DBMS users – DBMS facilities (Data definition language, data manipulation language – File organization (sequential, index sequential, direct files) – advantages and disadvantages. **14 Hrs**

UNIT II **Data models -** Hierarchical Model: Tree concept – Data definition – Data manipulation – Implementation of Hierarchical model –Design of a Hierarchical database – exercises. Network Model: DBGT set – Set construct and Restrictions – Data description in network model – Schema and subschema – Database manipulation – Design of network database. Relational Model: Tuples – Attributes – Relations – Keys – Integrity rules – Relational Algebra – relational Calculus – Implementation 0f relational model – Comparison of models - Database design – Dependencies (Functional, Multi-value, join dependencies) – Normalisations – Exercise on design of a relational database. **16 Hrs**

UNIT III **Database Security and Reliability -** Problems of data security – Authorization (Security and Cryptography – Encryption – Integrity – Threats) – auditing and control – reliability – recovery – Disaster recovery – Database archival. **12 Hrs**

UNIT IV **Data Management -** Programming concepts for data management: Query languages (SQL) – Components of SQL (Data definition language, data manipulation language, data control language) – Integrity constraints – Relational algebra – error handling. **14 Hrs**

UNIT V **Advances in DBMS -** Distributed database – Networks – Data distribution – Query processing - Consistency – recovery – Problems in distributed systems – Security and Protection – Object oriented data bases – Object approach – Advantages and disadvantages of object databases – Knowledge bases – Comparison – Deductive databases – Database machines. **16 Hrs**

UNIT VI **Current Contours (Not for Final Exam only for Discussion) -** Practical session related to DBMS and SQL-queries

COURSE OUTCOMES

On completion of the course the student is expected to be able to

- Understand database architecture, file organization, and DBMS components.
- Implement hierarchical, network, and relational data models for database design.

- Ensure data security through encryption, integrity checks, and auditing.
- Master SQL for querying and managing relational databases effectively.
- Explore advanced topics like distributed databases, object-oriented databases, and deductive databases in practical applications.

REFERENCES

1. Bipin C.Desai, An Introduction to Database systems, First Edition, Galgotia Publications pvt.lts., 1998.
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3. Majumdar and Bhattacharya, Database management system, Fourth Repring, Tata Mc Graw Hill Publication, 1999.