BHARATHIDASAN UNIVERSITY

Department of Remote Sensing

TIRUCHIRAPPALLI- 620 023

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REGULATIONS & SYLLABUS

Six year Integrated M.Tech.in

Geological Technology and Geoinformatics

Revised 2024 - 2025

DEPARTMENT OF REMOTE SENSING
BHARATHIDASAN UNIVERSITY
TIRUCHIRAPPALLI - 620 023

Six Year Integrated Programme

M.Tech., GEOLOGICAL TECHNOLOGY AND GEOINFORMATICS

Sem	Course	Course title	L	T	P	C
I	MTILC-0101 (Languagecourse-1)	Ariviyal Tamil/ Adipadai Tamil-I	3	-	-	3
	MTILC-0102	English for Communication I	3	-	-	3
	MTISC-0103 (Science Course-1)	Mathematics–I–Theory & Tutorial	3	2	-	4
	MTISC-0104	Physics–I–Theory & Practical	4	-	2	5
	MTISC-0105	Chemistry–I–Theory & Practical	4	-	2	5
	MTISC-0106	Biology for Engineers	4	-	2	5
	Total		21	2	6	25
II	MTILC-0201	Ariviyal Tamil / Adipadai Tamil–II	3	-	-	3
	MTILC-0202	English for Communication II	3	-	-	3
	MTISC-0203	Mathematics–II–Theory & tutorial	3	2	-	4
	MTISC-0204	Material Science	3	-	-	3
	MTIEC-0205	Engineering Mechanics	3	-	-	3
	MTISC-0206G (CoreCourse-1)	Introduction to Geological technology	3	-	-	3
	MTIGC-0207 (General Course-1)	Value Education (UGC Syllabus)	2	-	-	2
	MTIGC-0208	Environmental Science	2	-	-	2
	MTIEC-0209	Computer Lab–C,C++, etc.	-	2	2	2
	MTIEC-0210	Engineering Graphics Lab	-	-	2	1
Total			**22**	**4**	**4**	**26**

Sem	Course	Course title	L	T	P	C	Pre-Requisite	Co-Requisite
III	MTIGT0301	Physical Geology and Geodynamics	3	-	-	3		
	MTIGT0302	Surveying and Cartography	2	-	2	3		
	MTIGT0302P	Practical: Surveying and Cartography	-	-	4	3	302	
	MTIGT0303	Aerial Remote Sensing and Photogrammetry	3	-	-	3		
	MTIGT0304	Principles of Remote Sensing	3	-	-	3		
	MTIGT0305	Practical: Aerial and Satellite Remote Sensing	-	-	4	2		
	MTIGT0306	Crystallography and Mineralogy	4	-	-	4		
	MTIGT0307	Practical: Crystallography& Mineralogy	-	-	4	2		
	MTIGT0308	Paleontology	3	-	-	3		
	MTIGT0309	Probability and Statistics	5	-	-	4		
Total			**23**	**-**	**14**	**30**		

IV	MTIGT0401	Digital Image Processing	3	-	-	3		
	MTIGT0402	Practical: Digital Image Processing	-	-	4	2		
	MTIGT0403	Igneous and Metamorphic Petrology	4	-	-	4	303, 304	
	MTIGT0404	Practical: Igneous and Metamorphic Petrology	-	-	4	2		403
	MTIGT0405	Sedimentary petrology	4	-	-	4		
	MTIGT0406	Practical: Paleontology and Sedimentary Petrology	-	-	4	2	308	405
	MTIGT0407	Elective-I – Geostatistical and Geomathematical concepts	3	-	-	3		
	MTIGT0408	Elective–II Mining Geology	3			3		
	MTIGT0409	Transform techniques and partial differential equations	4	-	-	4		
Total			**21**	**-**	**12**	**27**		

V	MTIGT0501	Geographic Information Systems	3	-	-	3		
	MTIGT0502	Practical: Geographic Information Systems	-	-	4	2		
	MTIGT0503	Stratigraphy and Indian Geology	3	-	-	3	301	
	MTIGT0504	Structural Geology	3	-	-	3	304, 401	
	MTIGT0505	Practical: Structural Geology	-	-	4	2		504
	MTIGT0506	Geomorphology and Geodynamics	3	-	-	3	301	
	MTIGT0507	Practical: Geoinformatics in Geomorphology	-	-	4	2		506
	MTIGT0508	Elective–III – Geophysics	3	-	-	3		
	MTIGT0509	Elective–IV - Geochemistry	3	-	-	3		
Total			**18**	**-**	**12**	**24**		

Sem	Course	Course title	L	T	P	C	Pre-Requisite	Co-Requisite
VI	MTIGT0601	Economic Geology	3	-	-	4	306, 403	
	MTIGT0602	Geoinformatics in Mineral Exploration	3	-	-	4	304, 501	601
	MTIGT0603	Practical: Economic Geology& Mineral Exploration	-	-	4	2		601, 602
	MTIGT0604	Geoinformatics in Water Resources	3	-	-	4	403, 405, 504, 506	
	MTIGT0605	Practical: Geoinformatics in Water Resources Management	-	-	4	2		604
	MTIGT0606	Elective- V Computer Applications in Geotechnology	3	-	-	3		
	MTIGT0607	Elective-VI Marine Geology and Geoinformatics in Sea bed Exploration	3	-	-	3		
	MTIGT0608	Geological Field Training	-	-	4	2		
Total			**15**	**-**	**12**	**24**		

VII	MTIGT0701	Petroleum Geology	3	-	-	3	304, 401, 405, 501, 503	
	MTIGT0702	Engineering Geology	3			3		
	MTIGT0703	Practical: Engineering Geology	-	-		3		701
	MTIGT0704	Geoinformatics in Disaster Management	3	-	-	3	504, 506	
	MTIGT0705	Spatial analysis and applications / Spatial data modelling	3	-	-	3		
	MTIGT0706	Elective–VII Geoinformatics in Environmental Impact Assessment	3	-	-	3		
	MTIGT0707	Elective–VIII Geoinformatics in Soil science	3	-	-	3		
	MTIGT0708	Mini project in Geological Technology and Geoinformatics	-	-	4	2		
Total			**18**		4	**23**		

VIII	MTIGT0801	Major Project in Geological Technology and Geoinformatics	-	-	**30**	**12**		
Total			-	-	**30**	**12**		
Total credits			**191**					
L – Lecture Hour; T – Tutorial; P – Practical; C - Credit								

Total credits required for B.Tech. Programme: 180

Sem	Course	Course title	L	T	P	C	Pre-Requisite	Co-Requisite
IX	MTIGT0901	Hyperspectral Remote Sensing	4	-	-	4	304, 401	
	MTIGT0902	Thermal and Microwave Remote Sensing	4	-	-	4	304, 401	
	MTIGT0903	Practical: Hyperspectral, Thermal & Microwave Remote Sensing	-	-	4	2		901, 902
	MTIGT0904	Geoinformatics in Urban Planning	4	-	-	4	401	
	MTIGT0905	Geoinformatics in Coastal Dynamics and Coastal Management.	4	-	-	4	501, 506	
	MTIGT0906	Elective–IX Object Oriented Programming in GIS & Open source GIS	4	-	-	4		
	MTIGT0907	Elective–X Geoinformatics in Desert Geotechnology	4	-	-	4		
	Total		**24**	**-**	**4**	**26**		
X	MTIGT1001	Satellite Meteorology	4	-	-	4	303, 304, 403	
	MTIGT1002	Computer Programming in Geological Technology	4	-	-	4	501	
	MTIGT1003	GIS Based 3D Visualization in Geological Technology	4	-	-	4	501	
	MTIGT1004	Remote Sensing Application in Planetary Studies	4	-	-	4		
	MTIGT1005	Practical: Research methodology in GIS	-	-	4	2		
	MTIGT1006	Elective–XI Sustainable development	4	-	-	4		
	MTIGT1007	Elective–XII Geoinformatics in Climate Change	4	-	-	4		
	Total		**24**	**-**	**4**	**26**		
XI	MTIGT1101	Sedimentary Basins of India	4	-	-	4		
	MTIGT1102	WEB GIS & Mobile Mapping	4	-	-	4	501	
	MTIGT1103	Database Management Systems	4	-	-	4	501	
	MTIGT1104	Query Based Information System and Spatial Decision Support System	4	-	-	4	501	
	MTIGT1105	LIDAR and Unmanned Aerial System	4	-	-	4	303	
	MTIGT1106	Elective–XIII – Current trends in GIS	4	-	-	4		
	MTIGT1107	Mini Project in Geological Technology and Geoinformatics	-	-	4	2		
	MTIGT1108	Industrial cum geological field visit	-	-	4	2		
	Total		**24**	**-**	**8**	**28**		
XII	MTIGT1201	Major Project in Geological Technology and Geoinformatics	-	-	**30**	**10**		
	Total credits					**90**		

TOTAL CREDITS REQUIRED FOR M.TECH. PROGRAMME: 270

LIST OF OPTIONAL ELECTIVES

Semester IV (Electives – I & II)

1. Geostatistical and Geomathematical concepts
2. Mining Geology
3. Statistics in Geotechnology
4. Micro Paleontology

Semester V (Electives – III & IV)

5. Geophysics
6. Geochemistry
7. Industrial Geology
8. Sequence Stratigraphy

Semester VI (Electives – V & VI)

9. Computer Applications in Geotechnology
10. Marine Geology and Geoinformatics in Sea bed Exploration
11. Mineral processing Technology
12. Applied Hydro geochemistry

Semester VII (Elective – VII & VIII)

13. Geoinformatics in Environmental Impact Assessment
14. Geoinformatics in Soil Science
15. Geoinformatics in Earthquakes
16. Geoinformatics in Quaternary Geology

Semester IX (Electives – IX & X)

17. Himalayan Geology and Geotectonic
18. Object Oriented Programming in GIS & Open source GIS
19. Nuclear and Isotope Geology
20. Geoinformatics in Desert Geotechnology

Semester X (Electives – XI & XII)

21. Sustainable development
22. Geoinformatics in Climate Change
23. Geodesy
24. Geoinformatics in Glacial Geotechnology

Semester XI (Elective - XIII)

25. Current Trends in GIS
26. Geoinformatics in Operations Research
27. Object Oriented Information System
28. Geology of Tamil Nadu

DEPARTMENT OF REMOTE SENSING
BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 023
6 Year Integrated M.Tech. Geological Technology and Geoinformatics

REGULATIONS & SYLLABUS

1. ELIGIBILITY

For admission: A Candidate who has passed the Higher Secondary Examination (Plus Two) conducted by the Board of Secondary Education of Tamil Nadu, or CBSE or an examination equivalent thereto with any combinations of Physics, Chemistry, Zoology, Botany, Mathematics, Computer Science.

Total Number of Seats shall be 40.

2. DURATION

The Course is for a period of 6 years with Twelve Semesters viz. (Annexure-I) Six odd Semesters and Six 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).

There is an option that after completion of 8^{th} Semester (4^{th} Year) the student can go with B.Tech. Degree or continue to do M.Tech. Degree. Facility has also been provided for the high learners/fast leaners to get B.Tech. degree in 3 years (Annexure-II) or M.Tech. Degree in 5 years (Annexure-III), but the students will have to take additional courses and get the required credit for B.Tech. (180 Credit) and M.Tech. (270 Credit).

3. COURSE of STUDY

The course of study for M.Tech. shall comprise Theory / Practicals / Seminars / Major Project in the subjects according to the Syllabus and text books prescribed from time to time. The VIII and XII semesters shall be exclusively allotted for Major Project.

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

4. SCHEME of EXAMINATION

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

There shall be a total of 57 papers for B.Tech. and 80 papers for M.Tech. degree including Theory papers, practical and Projects / Dissertations (Annexure-I)

(b) Choice Based Credit System (CBCS):

The CBCS, is in vogue at the University from time to time, will be practiced. The number of credits for each subject is indicated in the annexure-I.

(c) Project work:

Each candidate shall be required to take up Major project during VIII semester for B.Tech. Degree and during the XII semester for M.Tech Degree . The Head of the Department shall allot candidates to various project guides / faculty members at the end of the VII Semester & XI semester and the guides in turn will evolve schedules for topic for the major projects and the students will take up the same under the supervision of the concerned guides / faculty members.

(ii) Major Project:

Each candidate shall be required to take up a major project work from the beginning of VIII Semester and submit the major project report at the end of the VIII Semester for B.Tech. Degree and from the beginning of XII Semester and submit report at the end of XII Semester for M.Tech. Degree. Two typed 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 12 (Marks 300).

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 VIII & XII Semester Examinations 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 practical 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 subsequent 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) Evaluation: Double Evaluation – one by course teacher and the other evaluation at External or one Evaluation external Evaluation.

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

ii) The weight age for internal Assessment in each Theory paper will be 25% and for practical paper will be 40% (Internal Minimum requirement is 50% mandatory)

(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.

(iv) The candidate should be completed all the papers up to VII Semester to continue M.Tech

(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% in both CIA (continuous internal assessment) and End semester examination** marks separately. A candidate **who gets less than 50% in any of the above must redo** that particular course.

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

A candidate **who gets less than 50% in any of the above must redo** that particular review / report / viva-voce in which the candidate got less than 50%.

Alternatively, if the candidate chooses 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 Six year Integrated M.Tech in Geological Technology and Geoinformatics 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.

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SEMESTER II

Course Code: MTIGT

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
II	MTISC- 0206G	Introduction to Geotechnology	3	25	75	100

Objectives:

- To know the content and familiarize the courses of this entire programme
- To study the basics and concepts of major disciplines in Geological Technology
- To understand the importance of Geoinformatics and its applications
- To learn the importance of Geological Technologies in natural resourcesmapping and natural disaster mitigation
- To learn the importance of Geoinformatics in understanding geological controls.

Syllabus:

Unit:1. Earth System Processes:

Earth Sciences: Definition, Branches of Earth Sciences/Geology, Scope and importance of Earth Sciences and Geological Technology.

Earth System Processes: Origin, interior & age of the Earth - Plate tectonics - Formation of Continents & Oceans - Mountain building activities - origin of rivers - Physiography of the Earth. **6 hrs**

Unit:2. Lithology, Structure, Geomorphology:

Lithology: Rock forming minerals - Igneous, Sedimentary & Metamorphic Rocks - Stratigraphy.

Structure: Folds, faults, geotectonic and their significance.

Geomorphology: Various Geomorphic Processes - Regional Geomorphology of India - Geological Ecosystems. **12 hrs**

Unit:3. Natural Resources and Disasters:

Natural Resources: Mineral Provinces of India and exploration strategies - Earth System Processes and their controls - Hydrocarbon provinces of India and exploration strategies- Water Resources and exploration strategies. Soil, Forest & Biomass and Marine resources.

Natural Disasters: Geodynamic Processes and Natural Disasters (Seismicities - Landslides - Floods - Tsunami - Other Natural Disasters). **12 hrs**

Unit:4. REMOTE SENSING BASED MAPPING: Introduction to Aerial Remote Sensing - Satellite Remote Sensing– Basics of Digital Image Processing - GPS based mobile mapping principles - Image interpretation principles for Geological technology. **12 hrs**

Unit:5. GEOINFORMATICS: Geospatial Information Systems (GIS) - Definition & Concepts - Input Sources (Satellite, Aerial & Ground based) - Computer based Geospatial data base generation - data modeling on Natural Resources, Eco Systems & Natural Disasters - Information Systems. **6 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Origin of Himalayas; Role of Earth System Processes in the formation / development of natural resources as well as inducing natural disasters; CARTOSAT - Ortho & Stereo data, Visualization of satellite data and GIS Layers through Open-source portals like BHUVAN & Google Earth.

Text Books:

1. Parbin Singh, 2008: A text book of Engineering & General Geology; S.K. Katarria & Sons, New Delhi.
2. Mahapatra, G.B., 2007: A text book of Geology, CBS publishers & distributors, New Delhi.

References:

1. M.S. Krishnan, Geology of India & Burma, Higginbothams (P) Ltd., Chennai. 1968.
2. George Joseph, Fundamentals of Remote Sensing, 2nd Edition, Cambridge University Press. 2005.
3. Arthur Holmes, Principles of Physical geology, Thomas Nelson & Sons, USA 1964.
4. Gokkhale and Rao. Ore deposits of India, Thomson press, New Delhi, 1972.
5. Krishnaswamy, S. India's mineral resources, Oxford and IBH publishing, New Delhi. 1979.
6. Edwin H. Pascoe, A manual of the Geology of India and Burma, Controller of Publication, Govt. of India, New Delhi. 1973.
7. Sinha. R.K., A Treatise on Industrial Minerals of India, Allied Publishers Pvt. Ltd., Chennai, 1967.
8. Alfred Harker, Petrology for students, University Press, Cambridge.
9. Read, H.H. Rutley's Elements of Mineralogy, Thomas Murby & Co. London. 1947.
10. Alexander N. Winchell, Elements of Optical Mineralogy, Vol.I & II, Wiley Easter Pvt. Ltd., Publishers New Delhi. 1968.

11. Lillesand, T.M. and Kiefer, P.W, Remote Sensing and Image Interpretation, John Wiley & Sons, New York. 1986.
12. Burrough, P.A. Principles of Geographical Information Systems for Land Resources Assessment, Clarandone Press, Oxford. 1986.
13. Frank Press Raymond Siever: Understanding Earth (3rd ed). W.H. Freeman and Company. New York, 2000.
14. B. J. Skinner and S.C. Porter: The Dynamic Earth -An Introduction to Physical Geology 3rd edition. John Wiley & Sons, New York. 1995
15. P. McL. D. Duff: Holme's Principles of Physical Geology (4th ed). Chapman & Hall.London. 1996.

Course outcomes:

After the successful completion of this course, the students are able to:

- Create subject interest amongst the students joined in this programme and gain knowledge on variety of sub disciplines that they can choose for their future.
- Understand the scope and importance of the Geological Technology and Geoinformatics subjects.
- Provide a brief exposure to the course works of entire 6-year programme.
- Brief exposure to the advanced and computerized tools in Geoinformatics and their applications to Geology, Natural Resources and Natural Disasters.
- Understand the concepts of mapping using Remote Sensing Satellites, Aerial Photography and Digital Image Processing.
- Know the concepts of Geospatial / Geoinformatics Technology based database generation, modeling and information systems.

SEMESTER III

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0301	Physical Geology and Geodynamics	3	25	75	100

Objectives:

- To study the basic principles and understand the scientific methods of Geology.
- To understand the solar system, origin, evolution and age of the Earth
- To understand the internal structure and it's dynamics of the Earth.
- To understand the types of weathering of rocks and minerals those occur as a result of depositional landforms.
- To study the role of plate tectonics which form seafloor spreading, continental drifting, hotspots and maintaining of Isotasy

Syllabus:

Unit: 1. Perspectives of Geology: Geology and the Scientific Method, **Earth Materials**: Minerals, Rocks, and Fossils, **Branches of Geology-**Relative and absolute dating, Determining Chronological Order and the Geologic Time Scale **-** Relation of Geology with other Sciences (Physics, Chemistry, Biology and Social Sciences) **12 hrs**

Unit: 2. **Solar System and Earth: Solar system-** Origin of the Earth and Age of the Earth (various hypothesis, concepts and theories. Density and Movement of the Earth **-**Gravitational field of Earth **12hrs**

Unit: 3. **Interior of the Earth:** Structure of the Earth Interior (Crust, Mantle and Core) **-** Earthquakes (Origin and Effects, Earthquake Belts, Epicenter, Seismograph, Magnitude Scale, measurement expression of earthquake strength, seismic zones of India) **-**Volcanoes (Types and causes, types of eruption and diapirism) **12hrs**

Unit: 4. Weathering; Weathering of minerals and rocks/Types of weathering-Physical/ Mechanical Weathering, Chemical Weathering, and biological weathering. Weathering: types and products – Fluvial landforms: factors affecting stream erosion and deposition, fluvial erosional and depositional landforms – Drainage patterns – Landforms formed due to the action of ground water **12hrs**

Unit: 5. Plate Tectonics Continental drift: Wegener's hypothesis, evidences and objections – Sea floor spreading: Hess's concept and evidences – Plate tectonics: types of plate boundaries, evidences for plate movement, characteristic features of plate boundaries, driving forces of plate motion, Hotspots: A Plate Tectonic Enigma. Isostasy- Orogeny, orogenic cycles, epiorogeny-mountain belts

Unit: 6. **Current Contours: (Not for Final Exam only for Discussion):** A). Stratigraphic terms B) Geological Time C) Geological Systems. Correlation of formation in India and world. The International Commission on Stratigraphy is the largest and oldest constituent scientific body in the International Union of Geological Sciences (IUGS). International Stratigraphic Guide. Correlation of world stratigraphy.

Text Books:

1. Diane H. Carlson, Charles C. Plummer, Lisa Hammersley Physical Geology (15th Edition).
2. P.J. Wyllie, The Dynamic Earth, John Wiley and Sons. 1971.
3. J.A. Jacobs, Physics and Geology, R.D. Russel and J.T.Wilson,
4. Duff. P. Mcl. D, Principles of Physical Geology - Holmes, 4th Ed. Chapman and Hall, London. 1992.
5. Girija Bhushan Mahapatra, A Text Book of Geology, CBS Publishers & Distributors, 4596/1A, 11 Daryaganj, New Delhi, 1987.
6. Girija Bhushan Mahapatra, Text Book of Physical Geology, CBS Publishers & Distributors, 4596/1A, 11 Daryaganj, New Delhi, 1994

References:

1. International Series in the Earth Sciences, Mc Graw Hill Book Co., 1959.
2. B.F. Windley, The Evolving Continents, John Wiley & Sons, 1978.
3. Allen Cox, Plate Tectonics**,** Freeman and Company, 1973.
4. Porters and Skinner - Principles of Geology, Printice Hall,
5. Marie Morisawa, Rivers Forms and Process, Geomorphology Texts, Longman Group Limited, 1985.

Course outcomes:

- After the completion of the course students will be able to understand:
- The perspectives of Geology and related subjects.
- The Solar system, the formation of earth and its hypothesis.
- Internal structure of the Earth and its dynamic activities.
- "Uniformitarianism" Present is the key to the past.
- Plate Tectonic theories ant its causes.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0302	Surveying and Cartography	3	25	75	100

Objectives:

- To study the principles and concepts of Geodesy and satellite geodesy
- To study the principles and history of cartography
- To understand the methods of conventional and electronics surveying
- To understand the concepts of map projection
- To learn the techniques of map preparation and compilation
- To understand the advantage of digital cartography

Unit 1: Surveying: Concepts of surveying, leveling, Chain survey - Plane Table Survey - Theodolite Surveying – Electronic Theodolite Survey - EDM, Total station and Integrated Total station. **6hrs**

Unit 2: GPS Basics: Introduction – Satellite, Space, Control and User Segments – Signal Components – Errors in GPS observations – GPS positioning – Differential GPS. Development of global surveying techniques, positioning and navigation with satellites, Reference systems: coordinate systems, time systems, satellite orbits: orbit description, orbit determination, orbit dissemination, satellite signals GPS – reference systems, GPS services, GPS segments, GPS signal structure, GLONASS - reference systems, GLONASS segments, GLONASS signal structure, Galileo - reference systems, Galileo services, Galileo segments, Galileo signal structure, IRNSS and GNSS - signals, services and segments, satellite based augmentation systems (SBAS) - GAGAN, WAAS, EGNOS, MSAS applications..

DGPS Mapping: Electronic - inertial - Doppler and global positioning system - basic principles, static and kinematic positioning - applications Conventional – Static – Kinematic – Semi kinematic- Rapid static Mobile mapping (CORS networks) **6hrs**

Unit 3: Introduction to Cartography: Definition - Nature of Cartography - History - Cartographic problems. Cartographic Characters: Scales & their functions - Directions & Co-ordinates & their functions - Geographic Co-ordinates - Physiography - Features in Toposheets (Spot height, Triangulation points, relative heights, contours, streams, cultural features) Types of Map. **6 hrs**

Unit 4: Map Projection: Properties and Types of Map projections - Conical, Polyconic, Cylindrical, Equal area or Lamberts cylindrical, Mercator's, zenithal, Gnomonic projections for world map,

Continental map - Recent projections. **Map compilation:** Map Design & Layout - Lettering & Toponomy - Mechanics of map construction. **8hrs**

Unit 5: Digital Cartography: Input data types (point, line, polygon) - Data source (Toposheet, Aerial Photo, satellite data} Input devices – (Magnifier, Stereoscope, Video Camera, Digitizer, Scanners) - Modeling Devices (Computer, Photo writer, Plotter) - Cartographic processes (Contouring, Density slicing, 3D Projection and transformation, Area Calculation, Volume Estimation) - Storage Devices - Output devices - Special Merits of Digital Cartography. **8hrs**

Unit 6: Advanced surveying and Mapping (Not for Final Exam only for Discussion): GPRS survey, Hydrographic survey (Eco sounding and multi beam SONAR SYSTEM) spectrum, Electromagnetic distance measurement, Total station, Digital self-leveling levels, scanners for topographical survey, - Airborne and space borne altimeters-UAV based surveying.

Course Outcomes:

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

- Conduct tacheometry and geodetic survey
- Handling of survey equipments and carry out survey projects
- Apply principles of theory of errors for correction of measurements
- compilation of map from surveyed data and satellite data
- GPS based kinematic and differential surveying
- Map projection and transformation processes
- Map design lettering, toponomy and layout
- Digital cartography and modeling
- Apply principles of theory of errors for correction of measurements
- Explain use of GPS, aerial photographs and procedure of aerial survey.
- To utilize Drone (UAV)based survey
- Utilize GPRS for sub surface survey
- Utilize total station and other modern survey instruments.
- Eco sounding survey using integrated SONAR
- Apply GIS in Digital cartography

Text Books:

1. Lahee, F.H, Field Geology, Sixth Edition, CBS Publishers & Distributors, Delhi, 1987.
2. Mishra R.P and Ramesh A, Fundamentals of Cartography, Concept publishing company, New Delhi, 1989.
3. Punmia B.C., Ashok Kumar Jain and Arun Kumar Jain, Surveying (Volume I, II

& III) 5th Edition (Through revised & Enlarged), Lakshmi Publications (P) Ltd., 113, Golden House, New Delhi – 110 002, 2005.

References:

1. Teunissen, P.J.G. and Kleusberg, A, (Eds.) GPS for Geodesy, Springer Verlag, Germany, 1998.
2. Gunter Seeber: Satellite Geodesy- Foundations, Methods and Applications, Walter de Gruyter, Berlin, New York 1993.
3. Arogyasamy, R.N.P. Courses in Mining Geology, Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi, 4th Edition.
4. Campbell, J, Introductory Cartography, Printers Hall Englewood Cliffs, N,J, 1984.
5. Robinson A.H., Morrison J.L., Mucehreke P.C., and Kummer A.J. Elements of Cartography, John Weily & Sons, 6th Edition. 1995.
6. Elliott D. Kaplan, Christopher J. Hegarty, Understanding GPS Principles and Applications, Artech House Inc., 685 Canton Street, Norwood, MA 02062, Second Edition, 2006.
7. Jeff Thurston and Thomas K. Poiker, Integrated Geospatial Technologies, A Guide to GPS, GIS and Data Logging, John Wiley 7& Sons, Inc., Hoboken, New Jersey, 2003.
8. Teunissen P.J.D and Kleusberg A., GPS for Geodesy, Springer, 2nd Edition, 1998.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0302 P	PRACTICAL - Surveying and Cartography	3	25	75	100

Objectives:

- To practice the principles and methods of surveying
- To learn chain, plane table, compass surveying
- To practice Theodolite and GPS survey
- To Prepare various thematic maps
- To perform area calculation and cross section preparation
- To prepare the Digital map

1. Chain survey - Plane Table Survey - Surveying with Theodolite – EDM-Electronic Survey. **12hrs**

2. GPS Mapping: Conventional – Static – Kinematic – Semi kinematic (Stop &Go)- Rapid static, Mobile mapping. **4hrs**

Cartography:

1. Preparation of Vector and raster Map **3hrs**
2. Preparation of Contours and DEM **3hrs**
3. Preparation of Thematic Maps **3hrs**
4. Toposheet reading /Base map preparation **3hrs**
5. Preparation of Cross sections **2hrs**
6. Preparation of block diagrams **2hrs**
7. Digital Map designing and development **2hrs**

Course Outcomes:

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

- Cadastral survey/geodetic survey
- Map with real world coordinate
- Cross section/3D block diagram
- GPS/EDM survey

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0303	Aerial Remote Sensing & Photogrammetry	3	25	75	100

Objectives:

- To study the principles and application of aerial remote sensing
- To study the principles and application of the 3D vision, stereoscopy, stereo model, parallax
- To learn digital photogrammetry and its processes
- To understand the photo interpretation techniques
- To study the application and principles of LIDAR

Syllabus:

Unit:1. **Aerial Photography:** Definition - History - Types of Photographs based on the camera axis, lens system, spectral properties -geometry of aerial photographs, principal point, conjugate principal point, nadir point, iso-centre, fiducial marks, overlap and side lap - Determination of scale of aerial photographs through ground distance, topographic sheets and relation between the flying height and focal length - Aerial frame camera -photographic filim - Average Photo scale - Distortions in aerial photographs due to film and print shrinkage, atmospheric refraction, image motion, Lens distortion - Displacement in aerial photographs due to Curvature of the Earth, Tilt, Topographic or relief displacement and height measurement -Radiometric characters. **12 hrs**

Unit:2. **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 - Photo Mosaics: Photo indexing - Photo mosaic (uncontrolled, semi controlled & Controlled mosaics) - Flight planning - Aerial triangulation. **16 hrs**

Unit:3. 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 - Application of digital photogrammetric products. **12 hrs**

Unit:4. Photo Interpretation Keys & Elements: Photo Interpretation Keys (Definition, its parts, Key sets, Types of Study) - Photo Interpretation Elements (Photo elements - Tone, Texture, Color, Shadow) - Geotechnical / Geomorphic elements (Landforms, Drainage, Erosional pattern, vegetative cover, Landuse, Shape & size of objects). **10 hrs**

Unit:5. LIDAR: Definition, components of Lidar Scanning system - Lidar data collection, range (distance) detection, Lidar foot print, Lidar swath width, Lidar point spacing, Lidar laser location, Lidar antenna orientation, Lidar post processing - Lidar returns, extraction of first, intermediate and last Return and its significance - DEM, DTM and DSM - Lidar intensity - Application of LIDAR mapping technology in topographic mapping, forestry mapping (biomass, canopy height, leaf area, 3d urban mapping, bathymetric mapping, etc. **10 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Cartosat sensors; Stereo photographs, application of Cartosat series. Advanced air borne sensors and its application; Drone photogrammetry and application; Industrial needs

Text Books:

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

11. Yongru Huang A, Digital Photogrammetry system for Industrial Monitoring
12. George Joseph, Fundamentals of Remote Sensing, Cambridge University Press,2nd Edition.
13. Shiv N. Pandey, Principles and Applications of Photogeology, Wiley Eastern Limited, India.1987.
14. Michel Kasser and Yves Egels, Digital Photogrammetry, Taylor & Francis Inc., 2002.

Course outcomes:

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

- Concepts of aerial remote sensing.
- Rectification processes of aerial photographs.
- Concepts of 3D vision.
- Reliable measurement from aerial photographs.
- Interpretation of aerial photographs for various aspects.
- Application and significant of digital photogrammetry.
- Scientific and industrial application of LIDAR.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0304	Principles of remote sensing	3	25	75	100

Objectives:

- To understand the fundamental concepts of Remote Sensing
- To acquire knowledge in the various types of Remote Sensing and its application potential
- To understand the characteristics of different satellites / sensors
- **Syllabus:**

Unit: 1. Principles of Remote Sensing: Definition - History & Concepts – Electromagnetic Radiation (Source, Mode of Energy transfer, Radiation Principles, Blackbody radiation, Radiation laws) **10 hrs**

Unit: 2. Electro Magnetic Radiation (EMR): EM spectrum - EMR interaction with atmosphere (absorption, scattering &atmospheric windows) - EMR interaction with earth surface (absorption & reflection) - Spectral Response pattern - Energy budgeting in Remote Sensing. **10 hrs**

Unit: 3. Sensors and Platforms: Resolutions (Spatial, Spectral, Temporal, Radiometric) – Platforms - Sensors - Scanning & Orbiting Mechanism of Satellites and Data Acquisition. Optical Remote Sensing: Basic concepts - Optical sensors and scanners. **12 hrs**

Unit: 4. Thermal & Microwave Remote Sensing: Thermal Remote Sensing: Basic concepts - Emissivity, kinetic and radiant temperature - Thermal sensors & scanners –Thermal conductivity – thermal capacity - Thermal Inertia. Microwave Remote Sensing: Basic concepts - Microwave sensors: Passive sensors - radiometers – active sensors – imaging and non-imaging – RADAR: Polarization – imaging geometry- Geometric characters – radar image distortions - Radargrammetry (SLAR / SAR) - LIDAR - Hyperspectral Remote Sensing: basic concepts. **20 hrs**

Unit: 5. Remote Sensing Satellites: LANDSAT and SPOT programme, – ESA programme – Copernicus programme – Sentinel series - IRS programme – Resourcesat & Cartosat series – RISAT series - Chandrayaan and Mangalyaan programmes- Meteorological Satellites -Shuttle Mission -Future Remote Sensing Missions. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Russian, Chinese and Japanese Space programmes - Recent Earth observation satellites and launchers- High resolution satellites – International Space Station (ISS)

- **Text Books:**
- 1. Curran, P.J. (1985). Principles of Remote Sensing, Longman
- 2. George Joseph and Jeganathan, C. (2018). Fundamentals of Remote Sensing, 3rd ed., Universities
- Press
- 3. Lillesand, T.M. and Kiefer, P.W. (2007). Remote Sensing and Image Interpretation, 3rd ed., John Wiley & Sons.
- 4. Sabins, F.F. (1996), JR., Remote Sensing Principles and Interpretations, 3rd ed., W.H.Freeman & Co Ltd
- **References:**
- 1. Burney, S.S, Application of Thermal Imaging, Adam Hilger Publications, 1988.
- 2. Drury, S.A. (1990). A Guide to Remote Sensing - Interpreting Images of Earth, Oxford Science
- Publications.
- 3. Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2008). Remote Sensing and Image interpretation, 6th ed., John Wiley & Sons.
- 4. Skou, N. and le Vine, D. (2006). Microwave Radiometer Systems: Design and Analysis, 2nded.
- 5. Woodhouse, I.H. (2005). Introduction to Microwave Remote Sensing, Taylor & Francis Ltd.,
- 6. Thermal Infrared Remote Sensing: Sensors, Methods, Applications. (2013). Kuenzer, C. and Dech, S. (Editors). Springer.

Course outcomes:

- Fundamental skills in the application potentials of different satellite sensors for earth observation
- Utility of different satellites sensors for earth related studies
- Acquiring the knowledge about the evolution of Remote sensing technology and its recent trend

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0305	Practical: Aerial and Satellite Remote Sensing	2	40	60	100

Objectives:

- To practice the mirror and pocket stereos cope
- Stereoscope Aerial photograph interpretation
- To practice 3D observation
- Satellite data decoding and visual interpretation
- To perform thermal and microwave data interpretation
- To prepare landuse/land forms map

Syllabus:

Unit:1. Stereo vision Test and Anatomy of Pocket & Mirror Stereoscopes. **6 hrs**

Unit:2. Decoding, Marking & Transfer of Principal Points, Base line drawing, Flight line marking, 3D Observation, Tracing details, Transfer the details to base map. **6 hrs**

Unit:3. Determination of scales of Aerial Photographs. **6 hrs**

Unit:4. Height and Slope measurements. **12 hrs**

Unit:5. Interpretation of Aerial Photographs (Stereo vision). **6 hrs**

Unit:6. Study of Various Visual Remote Sensing Equipments. **6 hrs**

Unit:7. Decoding of Different Satellite data. **4 hrs**

Unit:8. Interpretation of Black & White and False colour Multi Band Imagery. **6 hrs**

Unit:9. Interpretation of Thermal & Microwave Imagery. **6 hrs**

Unit:10. Transfer of Information from Imagery to Base Map. **6 hrs**

Unit:11. Landuse map preparation from Aerial Photographs and Satellite data **6 hrs**

Unit:12. Current Contours: (Not for Final Exam only for Discussion):

Advance 3D visualization, Radar (Microwave) scanning – LIDAR – SLAR.

Course outcomes:

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

- Stereo pair interpretation
- Thematic maps from Aerial and satellite data
- Land use / landforms map

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0306	Crystallography and Mineralogy	4	25	75	100

Objectives:

- To distinguish crystals and minerals based on their properties
- To know the economic importance and uses of crystals and minerals
- To learn the crystal symmetry elements, determine and classify the crystals
- To understand the physical, chemical and optical properties of minerals
- To study the silicate structures and mineral groups.

Syllabus:

Unit:1. **Elements of Crystallography**: Crystalline and Amorphous forms - Symmetry and Classification of Crystals - System of Crystal Notation - (Weiss and Millerian) - Forms and Habits. Crystal Systems (Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic & Triclinic); Twinning; Crystalline Aggregates - Columnar, Fibrous, Lamellar, Granular; Imitative shapes and Pseudomorphism. **12 hrs**

Unit:2. Crystal Properties: Space Symmetry Elements- Translation - Rotation- Reflection - Inversion Screw and Glide-point groups and Crystal classes - Derivation of 32 Crystal classes based on Schoenflies notation - Bravais lattices and their Derivation - An outline of Space Groups.X-ray Crystallography. Crystallographic Projections. **12 hrs**

Unit:3. **Physical Mineralogy**: Physical Properties: (Colour - Structure - Form - Luster - Transparency - Streak - Hardness - Specific Gravity - Tenacity - Feel - Taste - Odour) - Electrical, Magnetic and Thermal properties-Determination of Specific Gravity (Jolly's spring balance, Walker's steel yard, Pycnometer methods) - Empirical and Structural formula of minerals - Isomorphism, Polymorphism and Pseudomorphism - Atomic substitution and Solid solution in minerals - Non Crystalline minerals - Fluorescence in minerals - Metamict state. **16 hrs**

Unit:4. **Optical Mineralogy:** Optical Properties (Colour - Form - Cleavage - Refractive Index - Relief - Alteration - Inclusions - Zoning - Pleochroism - Extinction - Polarization colours - Birefringence - Twinning) - Optic sign (Uniaxial and biaxial)- Interference figures -

Primary and Secondary Optic axes - Optic axial angle measure-ments - Optic Orientation - Dispersion in Crystals - Optic anomalies. **12 hrs**

Unit:5. Mineral Groups: Ortho and Ring Silicates (Olivine group; Garnet group). Alumino-silicates (Epidote group, Zircon, Staurolite, Beryl, Cordierite and Tourmaline). Sheet Silicates (Mica group, Chlorite group and Clay minerals) - Chain Silicates (Pyroxene group, Amphibole group and Wollastonite). Frame work Silicates (Quartz - Feldspar - Feldspathoid - Zeolite and Scapolite groups) - Non-silicate (Spinel group, Carbonates and Phosphates). **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Preparation of Field Kit for testing and identifying minerals during field survey; preparation of mineral and crystal samples for making thin sections, x-ray crystallographic studies. Learn how minerals together form different types of rocks.

Text Books:

1. Dana, E.S, A Text Book of Mineralogy, Wiley Eastern, 1955.
2. Flint, Y, Basic Crystallography, Mid Publishers, 1970.
3. Phillips, F.C. Longman, An Introduction to Crystallography, 1956.
4. Bloss.F.B., Crystallography and crystal New york 1971
5. Read, H.H, Rutley's Elements of Mineralogy, CBS Publishers & Distributors, Delhi,1984.

References:

1. Berry Mason, L.G,Mineralogy, W.H. Freeman & co - 1961.
2. D. Perkins, (2002), Mineralogy, 2nd Edition, Pearson Education (Singapore) Pte. Ltd, Delhi, 483pp, ISBN 81-7808-831-2
3. W. D. Nesse, (2000), Introduction to Mineralogy, Oxford University Press, ISBN 0-19-510691-1
4. Naidu, P.R.J,. Optical Crystallography.
5. Wahlstrom, E.F, Optical Crystallography, John wiley, 1960.
6. Azaroff, L.V,Elements of X-ray Crystallography, 1968.
7. Deer, W.A, Howie, R.A and J.Zussman, LongmansAn Introduction to the Rock Forming Minerals, 1966.
8. Alexander N.Winchell,Elements of Optical Mineralogy, Part I and II,Wiley Eastern (p) Ltd, 1968.

9. Ernest, E.Walhstrom, Optical Crystallography, John Wiley & Sons.1960.
10. Kerr B.F,Optical Mineralogy. Mc Graw Hill, 5th Edition, New York-1995.
11. Mitra, S,Fundamentals of Optical Spectroscopic and X-ray Mineralogy.

Course outcomes:

After the successful completion of this course, the students are able to:

- Gain knowledge about the source minerals as raw materials for anything on the Earth and forthe survival of life
- Independently able to classify the crystals based on symmertical elements and face indices
- Understand various physical, chemical and optical properties of minerals so as todiscriminate them
- Provide ideas about the major existence of rock forming silicates at the surface of the Earth
- Understand the various properties of mineral groups
- Know the crystal and mineral forms and their habits.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0307	Practical: Crystallography and Mineralogy	2	40	60	100

Objectives:

- To distinguish crystals and minerals from other objects based on their properties
- To know the economic importance and uses of crystals and minerals
- To learn the crystal symmetry elements, determine and classify them
- To study and understand the physical, chemical and optical properties of minerals
- To study the properties of silicate structures and mineral groups.

Syllabus:

Unit:1. Study of Crystal symmetrical elements of type minerals in each class of systems using Acrylic and Wooden models. **12 hrs**

Unit:2. Megascopic identification of Quartz, Feldspar, Feldspathoid, Pyroxene, Amphibole groups. **12 hrs**

Unit:3. Megascopic Identification of other important Silicates: Tourmaline, Topaz, Beryl, Zircon, Rutile, Apatite, Calcite, Gypsum. Identification of Metamorphic Minerals: Garnet, Cordierite, Kyanite, Sillimanite, Andalusite, Sphene, Staurolite, Chondrodite. **12 hrs**

Unit:4. Microscopic study of Quartz, Feldspar, Feldspathoid, Pyroxene, Amphibole group of Minerals. **12 hrs**

Unit:5. Microscopic study of important Silicates: Tourmaline, Topaz, Beryl, Zircon, Rutile, Apatite, Calcite, Gypsum. Metamorphic Minerals: Garnet, Cordierite, Kyanite, Sillimanite, Andalusite, Sphene, Staurolite, Chondrite. **16 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Understand the silicate structures by constructing 3D models using simple materials (like soft foam ball, high bouncing balls and bicycle spokes); Separation of minerals from soil clumps or weathered rocks based on their physical / chemical properties; Universal stage operation and mechanisms.

Course outcomes:

After the successful completion of this course, the students are able to:

- Gain knowledge about the distinctive properties of crystals and minerals
- Independently able to classify the crystals and minerals based on symmetrical elements in field
- Understand various physical, chemical and optical properties of minerals so as to discriminate them and know their usages
- Know about the origin of rock forming silicates at the surface of the Earth
- Understand the various properties of mineral groups
- Know the crystal and mineral forms and their habits.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT 0308	Paleontology	3	25	75	100

Objectives:

- To study the fossils and their mode of preservation
- To understand Invertebrate fossils
- To learn about vertebrate fossils
- To study about microplaeontology
- To study about plant fossils

Unit I: Introduction: Definition of Palaeontology- Fossils and their modes of Preservation- Uses of Fossils: Indicators of Stratigraphy, Climate, Palaeogeography – Evolution and Migration of life forms-Indicators of Coal and Petroleum deposits - Life through Ages. Identification and illustration mega - micro – nannofossils.

9Hrs

Unit-II: Invertebrate Palaeontology: A brief study of morphology, classification, evolutionary trends and distribution of Phylum Mollusca, Brachiopoda, Arthropoda, Echinodermata, and Corals.

10Hrs.

Unit-III: Vertebrate Palaeontology: Vertebrate Palaeontology – Brief study of vertebrate life through ages. Evolution of reptiles and mammals (Man, Horse, elephant); Siwalik vertebrate fauna; Biodiversity and mass extinction events; evidence of life in Precambrian times. 10Hrs

Unit-IV: Micropalaeontology: Definition of Micropalaeontology - Types of Microfossils (Foraminifers, Ostrocods) Morphological Characters - Classification - Evolutionary trends and distribution - Application of Micropalaeontology in Environmental interpretation and Petroleum Geology - Field and Laboratory Techniques of sampling and separation of microfossils. 10Hrs

Unit-V: Plant Fossils and Palaeobotany: Fossilization of Plants - Classification – Geological Distribution and Characteristics of various Plant Fossils; Gondwana flora and their significance. Application of palynology; Gymnosperm: Angiosperm- Spores and

Pollen, their Fossilization

9Hrs

Unit-VI: Current Contours: (Not for Final Exam only for Discussion): Fossil and Fossilization: Use of fossils in oil and coal exploration – use of fossil in geographical distribution study– evolution – biostratigraphy. Economic importance of fossils.

Materials for Study and References Text Books:

1. Woods, H., Invertebrate Palaeontology, 1959.
2. Jain, P.C and Anantharaman, M.S., 2005. Palaeontology : Evolution and Animal Distribution. (6th edition), Vishal Publishing Co, New Delhi
3. Moore,R.C, Lalicker, C.G & Fisher, A.G (1997). Invertebrate fossils. (1st Indian edition), CBS Publishers & Distributors, New Delhi.

References:

1. Palaeobotany , Arnold, C.A. AnInt, to, PHI, 1950.
2. Invertebrate Palaeontology and Evolution - Clarksm, ENK., ELBS, 1985.
3. Colbert, E.N., The Evolution of Vertebrates,1955.
4. Kummel, B, History of the Earth, Eurasia, Pub- 1968.
5. Moore, R.C. et.al, Fossil Invertebrates**,** 1952.

Outcomes

- Students will understand mode of fossil preservation.
- Students will understand issues related to the completeness of the fossil record.
- Students will understand how to test scientific hypotheses in paleontology, including appropriate methods of data acquisition and analysis.
- Students will understand the stratigraphic and geographical distribution of fossils.
- The students will learn about fossils fuel and energy resources.
- During the course of study, students have learned about non-renewable energy resources like petroleum, coal and gas.
- They learn the applications of fossils in cement industries.
- They also understand marine, freshwater and terrestrial fossils.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
III	MTIGT0309	PROBABILITY AND STATISTICS	4	25	75	100

OBJECTIVES:

- Identify Objectives of Statistical Analysis.
- Apply Methods of Data collection & Analysis.
- To understand the Correlation and Regression Analysis
- To get the knowledge of probability distribution and statistics.
- To understand the testing hypothesis.

Unit I – Introduction to Statistical Methods - Statistics & managerial decisions - statistical data - operation research technique.

Unit II - Data Collection and Analysis - Collection and presentation of data in terms of tables-graphs- raw data-frequency distributions histogram-Cumulative frequency curve-Measures of central tendency and location-Partition Value-Comparison of various measures of central tendencies - Measures of dispersion- skewness &Kurtosis - comparison of various measures of dispersion-Moments as measures of Statistical properties - measures of skewness & kurtosis based on moments.

Unit III - Probability Distribution & Statistics - Introduction of Probability- sample, space & events- Basic rules of probability - permutation & combinations- conditional probability- Baye's theorem, - distributions: Binomial, Poisson, Exponential and Normal distribution with their properties and application- Random variables - discrete and continuous probability distribution functions- probability density functions- mean, medium, moment and moment generating functions of Binomial- Poisson- geometric & hyper geometric- Concept of joint probability distribution.

Unit IV - Correlation and Regression Analysis - Curve fitting - correlation and regression analysis-Autocorrelation- Multiple regressionstatistical Inference & estimation applied to Industrial problems.

Unit V - Statistical Tests and Testing of Hypothesis - Elementary theory and practice of sampling - standard error or means and variance - tests of significance - T test - F test - Z test and chi-square test along with their applications - Goodness of fit - testing of hypotheses and decision making, analysis of variance (ANOVA).

Unit VI - Current Contours (for Continuous Internal Assessment Only): Contemporary Developments - Related to the Course during the Semester Concerned.

Primary Books:

1. Quantitative Techniques for Managerial Decision by Srivastava, New Age
2. Statistics for Management by Lewis, Pearson
3. Quantitative Techniques in Management by Vohra, TMH
4. Applied Statistics & Probability for Engineers by Sharma, Willey
5. Introduction to Probability & Statistical Application by P.A. Meyer

OUTCOMES:

The students will be able to,

- Use the statistical methods.
- Use probability as a tool for Statistical Analysis.
- Use the probability distribution and its theorems.
- Use Correlation and Regression Analysis.
- Apply Statistical Tests.

SEMESTER IV

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0401	Digital Image Processing	3	25	75	100

Objectives:

- To study the principles and components of Image Processing
- To study the Image Pre processing techniques
- To understand the methods of Digital Enhancement techniques
- To understand the concepts of Image classification
- To learn the techniques of Data fusion
- To understand the advantage of advanced Digital Image processing

Unit I: Principles of Image Processing: Information system, encoding and decoding, modulation: Satellite data - acquisition, storage and retrieval - generation of data products - formats -Digital Image Processing system- different types, Hardware and software design considerations Digital Image formats - Image Processing systems - Basic Principles of Visual Interpretation. **6 Hrs.**

Unit II: Image Rectification & Restoration: Principles, color concept and color combination, classification of operations, source of image degradation, Geometric Errors (Sources of Errors, Correction Processes) - Radiometric errors (correction processes) Noise models. **16 Hrs.**

Unit III: Image Enhancement: Pre-classification processing - Histograms, Density slicing, Grey level maps, contrast stretching, filtering, band rationing, PC-analysis, edge detection, basic pattern recognition concepts, principles of spectral discrimination, Multiband Enhancement (Band ratioing, colour composites generation, Principal Component Analysis, NDVI) **16 Hrs.**

Unit IV: Image Classification: Supervised classification techniques - Training set - Statistical computation, Ground Truth verification, minimum distance rule, parallelepiped algorithm, maximum likelihood method, classification analysis - confusion matrix, error analysis, unsupervised classification technique - clustering, ANN, fuzzy set concept, synthetic pattern recognition, texture analysis, Support vector machines (SVMs) classification techniques. **16 Hrs**

UNIT V: Multi Mode Image Analysis: Image Registration – Change detection analysis- Ratioing – Multi sensor and Multimode data fusion.) Hyper spectral remote sensing data analysis, Imaging Spectroscopy, Data Processing techniques-N-Dimensional Scatter plots, Spectral angle mapping, Spectral mixture analysis, Image Texture and Segmentation -Thermal Image data Analysis - Microwave & LiDAR Data Processing. **16 Hrs.**

UNIT VI: Advanced Digital Image Processing: Advanced concepts – Virtual Geographic Information System (GIS), Digital Terrain Modeling (DTM), stereo image analysis, Orthorectification, Artificial Intelligence and expert systems. Google Earth Engine platform for satellite data processing. **10 Hrs.**

Course Outcomes:

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

- Image Preprocessing method and correction methods
- Apply principles of theory of errors for correction of raw data
- Image enhancement techniques for pre classification
- Image classification methods and pattern recognition
- Image classification and change detection
- Multi mode Image fusion and hyper spectral analysis techniques
- Virtual GIS and Artificial intelligence and expert system

Text Books :

1. Lillisand, T.M. and Kiefer, P.W, Remote Sensing and Image Interpretation, John Wiley & Sons, New York. 1986.

2. Curran, P. Principles of Remote Sensing, Longman, London. 1985.

3. William K.Pratt, Digital Image Processing, John Wiley & Sons, Inc., Third Edition, 2003.

References :

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

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

3. Richadson, B.F.Jr. (Ed), Introduction to Remote Sensing of the Environment, Kendall / Hunt, Dubuque, Iowa. 1978.

4. Kalhwang and Douglas Degroot, parallel processing for super computers and artificial intelligence, McGraw-Hill, 1980.

5. Rafael C. Gonzalez, Richard E. Woods Digital Image Processing, 1993

6. Paul J. Gibson and Clara H. Power, Introductory Remote Sensing, Digital Image

Processing and Applications, Routledge, 2000.

7. John A. Richards and Xiuping Jia, Remote Sensing Digital Image Analysis An Introduction, Springer-Verlag Berlin Heidelberg, Fourth Edition, 2006.

8. Hyperspectral Remote Sensing by Michael T Eismann, SPIE, 2012

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0402	Practical: Digital Image Processing	2	40	60	100

Objectives:

To practice the image composite / image rectification

- Image enhancement techniques
- To practice Image filtering, PCA and NDVI analysis
- To perform Satellite optical/ microwave/ thermal and hyper spectral image classification.
- To perform Image fusion techniques
- To perform stereo image analysis and LIDAR data processing

1. Generation of Histogram, cumulative frequency curve.
2. Generation of Linearly stretched & non linearly stretched images using calculator .
3. Generation of Filtered, Ratioed & Normalised ratioed Images using calculator.
4. Generation of PC1 PC2 and PC3 using Image processing software.
5. Image Processing of– various combinations of FCC, RCC.
6. Image Processing of – Linear, Non linear stretching, contrast and edge enhancement.
7. Image Processing of – Filtering, Ratioing and Normalised Ratioing using IP s/w.
8. Image Processing of – PC, NDVI analysis.
9. Image Processing of – Image Classification supervised and unsupervised.
10. Image Processing of Test Window – Image fusion Techniques.
11. Stereo image analysis.
12. ERDAS IMAGINE/ENVI/GEOMATICA/GRASS demo.
13. Knowledge Base Classification.
14. Change Detection Analysis.
15. Hyper spectral Data analysis.
16. Neural Network Classification.
17. Microwave/Thermal sensor Data Processing.
18. LiDAR Date processing.

Course Outcome:

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

- Image composite FCC, RCC
- Image enhancement techniques
- Image Filtering techniques
- PCA and NDVI
- Stereo Image interpretation
- Lidar data processing

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0403	Igneous and Metamorphic Petrology	4	25	75	100

Objectives:

- To study the forms, structures and crystallization of Igneous rock
- To learn about classification of Igneous rocks
- To Understand metamorphism, kinds and factors
- To study about zone, facies and phase rules of metamorphic rocks
- To learn about remote sensing applications in rock discriminations

Syllabus:

Unit-I Introduction to petrology: Heat flow, geothermal gradients through time, origin and nature of magma- differentiation, assimilation and magma mixing. Formation of Igneous rocks: Intrusive and Extrusive rocks - Crystallization of Unicomponent Magma - Binary component of Eutectic and mix crystal system and Ternary Silicate system. Forms of Igneous rocks - Intrusive and their relation to Geological Structures (Concordant and Discordant forms - Multiple Intrusions - Composite Intrusions) - Structure and Texture of Igneous Rocks- **14Hrs.**

Unit-II Classification of Igneous rocks – Tyrrell's Tabular Classification – Classification based on mineralogy, texture, colour index and chemical composition. Petrogenesis and occurrences classification of Granite, Syenite, Pegmatite, carbonatite, Monomineralic rocks, Anorthosite and Charnockites and Ultramafics. Fluid Inclusion studies of igneous rocks. **14 Hrs.**

Unit-III Definition of Metamorphism - Scope of Metamorphism – Controlling factors of Metamorphism- Temperature, pressure and chemically active fluid - Kinds of Metamorphism and its Products - Classification and Nomenclature of metamorphic rocks- Protolith of various metamorphic rocks - Metamorphic textures and Microstructures and their relation to Metamorphic conditions. **10 Hrs.**

Unit-IV Mineral Paragenesis of Metamorphic rocks - Stability of Metamorphic minerals - Mineralogical phase rule – depth zones - Grades and Facies and mineral index concepts of Metamorphism – Phase rules – Fluid inclusion studyMetamorphism in relation to Magma and Plate Tectonics / Orogeny - Metasomatism - migmatites – Anatexis - Metamorphic rock associations - slate - phyllite, schists and gneisses, khondalites, charnockites and eclogites. **14Hrs.**

Unit-V Mapping of Igneous and Metamorphic rocks using satellite imagery. Mapping through digital images processing – Supervised and unsupervised classification, density slicing, Principal Component Analysis (PCA), Band ratio technique. Mapping of mineral and rock using Hyperspectral image. **12Hrs.**

Unit-VI: Current Contours: (Not for Final Exam only for Discussion): Lithological Discrimination Using Satellite data. Formation of Igneous and metamorphic rocks- phase rule

Text Books:

1. Tyrell, G.W, Petrology, - Methuren and Co, Students edition, 1989.
2. Turner, F.J. and Verhoogen, J., Igneous and Metamorphic Petrology - Mc Graw Hill Book co., 1960.
3. Turner F.J., Metamorphic Petrology, Mc Graw Hill, 1980.
4. Principles of Igneous and Metamorphic petrology by Johnd. Winter
5. Introduction to Petrology, Authors: Elizabeth A. Johnson and Juhong Christie Liu

References:

1. Philipotts, A Igneous and Metamorphic Petrology,. Prentice Hall -(1992)
2. Bose, M.K., Igneous Petrology, World Press, 1997.
3. Daniel, Barker, S., Igneous Rocks - Prentice Hall, Englewood Cliffs, New Jersey-1983.
4. Williams, H, Turner, F.J. and Ghilbert, C.M., Petrography, W.H. Freeman and Co-1954.

Outcomes:

- Students will appropriatelylearn about the Earth.
- Students will understand the principles that govern the origin of igneous rocks.
- Students will learn about origin of metamorphic rocks.
- Students will use geological data and their understanding of the principles of geology to form and test hypotheses about the origin of metamorphic and igneous rocks.
- Students will read the primary geologic literature
- Student will also learn about the economic important minerals and its associated rocks
- Students will learn about the applications of remote sensing for mapping of different rock types.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0404	Practical: Igneous and Metamorphic Petrology	2	40	60	100

Objectives:

- Identification of igneous and metamorphic rocks of hand specimen by based on physical and chemical properties.
- Identification of mineral assemblages through microscope.
- Identification of igneous and metamorphic rocks through aerial photographs and satellite images.

Syllabus:

Unit:1. Study of physical and optical characters of rocks and minerals. **12 hrs**

Unit:2. Megascopic identification of Igneous rocks. **6 hrs**

Unit:3. Megascopic identification of Metamorphic rocks. **6 hrs**

Unit:4. Microscopic identification of Rock Fabrics, Mineral assemblages of Igneous rocks. **9 hrs**

Unit:5. Microscopic identification of Rock Fabrics, Mineral assemblages of Metamorphic rocks. **9 hrs**

Unit:6. Calculation of C.I.P.W. Norm and Niggli values of chemical composition of rocks. **12 hrs**

Unit:7. Interpretation of Igneous Rocks through Aerial Photographs. **10 hrs**

Unit:8. Interpretation of Igneous Rocks using Raw Satellite Images **3 hrs**

Unit:9. Interpretation of Metamorphic rocks using Aerial Photographs. **3 hrs**

Unit:10. Interpretation of Metamorphic rocks using Raw Satellite data **3 hrs**

Unit:11. Current Contours: (Not for Final Exam only for Discussion):

Process of diversification of igneous rocks: magmatic differentiation, assimilation, parital melting, magma mixing: Concept of petrographic province and igneous rock series Grapahical analyses of compositional variations in igneous rock suites.

Course outcomes:

After the completion of the course the student will be able to comprehend.

- Identifying of the minerals, rocks based on physical properties of hand specimen.
- Identifying of the minerals, rocks, assemblages of minerals, fabrics through microscopically (Petrography).
- Analyses of Aerial photos and satellite images for interpretation of the metamorphic terrain.
- Analyses of Aerial photos and satellite images for interpretation of the igneous terrain.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0405	Sedimentary Petrology	4	25	75	100

Objectives:

- To learn about the sedimentary rock cycles.
- To understand the classification sedimentary rocks and its physical properties.
- To study the types of weathering, erosion, transportation and deposition by various agents.
- To understand the marine and non-marine deposition and basin analysis.
- To study the aerial photos and images of sedimentary rocks.

Syllabus:

Unit:1. Sedimentary Rocks: Weathering and Sedimentary Cycle - Physical properties of particles- (Surface texture - Particle size of shape, Sphericity and roundness - Mass properties of Sedimentary particles) - Mineral Stability and their Significance - Porosity and Permeability. **10 hrs**

Unit:2. Nature and Origin of Sedimentary Rocks: Broad Classification and Composition of Sedimentary rocks -Textures, Structures and their Environmental Significance - Petrography of Clastic and Nonclastic rocks-Mineralogy and Chemical composition of Siliceous, Iron bearing rocks -Phosphorites and Evaporites - Nodules and Diagenetic Seggregates – Folk and Dunham's Classification - Lithification and Diagenesis. **2 hrs**

Unit:3. Transportation and Sedimentation: Aquatic, Aeolian process - Glacial and Gravitational processes -Grain size analysis of sediments - Graphical representation and their Geological significane - Heavy minerals and provenance - Palaeocurrent analysis (Collection of palaeocurrent data, Presentation and interpretation of palaeocurrent data) - Sedimentary facies. **16 hrs**

Unit:4. Environment of Deposition: Nonmarine, Transitional and MarineEnvironments - Products of Environment - Subsurface Environments - Subsurface pressure -Temperature -Fluids and Fluid flow in sedimentarybasins- Sedimentology.

Evolution of Sedimentary Basins: Tectonism and evolution of basins, Origin of Petroleum and Gas and Metallogeny - Sedimentary Models (Concepts and Laws), Geophysical models and Tectonic theory. **16 hrs**

Unit:5. Mapping of Sedimentary Rocks: Expression in the field -Expressions in Aerial Photographs -Expression in raw satellite images -Mapping of sedimentary rocks -using digitally processed images. **10 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Formation of sediments-Basin analysis- Sedimentary rocks- Meta sedimentary rocks- Stratigraphic correlation- Palaeo current-mineral-hydrocarbon and gas deposition- Coal and lignite deposition- Palaeo climatic condition-marine and non marine.

Text Books:

1. Pettijohn, F.J. Sedimentary Rocks, Harper & Bros. 3rd Ed. 1995.
2. Hatch F.H., Rastall R.H., Petrology of Sedimentary Rocks, Murby & co., 1941,
3. Krumbein W.C. and Pettijohn F.J., Manual of Sedimentary Petrology, 1938
4. Sedimentary Rocks in the Field THIRD EDITION Maurice E. Tucker Department of Geological Sciences University of Durham, UK
5. Sedimentary Petrology by Maurice E Tucker
6. Petrology, Igneous, Sedimentary, Metamorphic by Ehlers,
7. Petrology of Sedimentary Rocks by Boggs and Sam,
8. Sedimentary Petrology by Harvey Blatt,
9. Sedimentary Petrology by D N Verma
10. Sedimentary Petrology by Loren A Raymond Pettijohn, F.J. Sedimentary Rocks, Harper & Bros. 3rd Ed. 1995.
11. Hatch F.H., Rastall R.H., Petrology of Sedimentary Rocks, Murby & co., 1941,
12. Krumbein W.C.and Pettijohn F.J., Manual of Sedimentary Petrology, 1938

References:

1. Friedman, G.M. Sanders, Principles of Sedimentalogy, E.J.John Wiley and sons, New York. 1978.
2. Allen J.R.L. Principles of Physical Sedimentation, George Allen & Unwin, 1985.
3. Nichols. H. G. Sedimentary Environments, Blackwell. 1999.
4. Einsele, G. Sedimentary Basins, Springer Verlag. 1992.
5. Pettijohn F.J. Potter P.E., and Siever R. Sand and Sandstone, Springer- Verlag - 1990.

6. Wilson, J.L. Carbonate facies in Geological History, Springer Verlag, New York-1975.
7. Richard C. Shelley, Applied Sedimentology, Academic press, New York-1992
8. Sengupta. S. Introduction to Sedimentology, Oxford-IBH, 1997.
9. Reineck, H.E., and Singh J.P. Depositional Sedimentary Environments, Springer Verlag, 1980.
10. Bhattacharya, A. and Chakraborth. C. Analysis of Sedimentary Successions, Oxford-IBH, 2000.
11. Twenhofel W.H. and Tayler S.A., Methods of Study of Sediments, Mc. Graw Hill Book Co., 1941.
12. Twenhofel W.H., Principles of Sedimentation, Mc. Graw Hill Book Co-Petrology of R.L.Folk, 1961, Sedimentary rocks, Hemphills -1950.
13. Wilson, J.L. Carbonate Facies in Geological History, Springer Verlag, New York-1975.
14. .Miller H.B, Sedimentary Petrography, Vol.1.and II. George Allen and Unwin Ltd- 1962.
15. Collision, J.D. & Thompson, D.B. Sedimentary Structures. 2nd Ed. Unwin Hyman, London-1989.
16. Tucker M.E. & Wright V.P. Carbonate Sedimentology, Macwell Scientific Publication, London- 1990.

Course outcomes:

After the completion of the course the student will be able to understand

- The types of weathering mechanisms, physical properties and rock cycles.
- Origin of sediments and sedimentary rocks.
- Facies of deposition and palaeo currents.
- Evolution of sedimentary basins and its environmental studies.
- Mapping of sedimentary rocks based on images and aerial photos.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0406	Practical: Palaeontology and Sedimentary Petrology	2	40	60	100

Objectives:

- To understand morphology of different types of fossils
- To learn the evolution pattern of life over the geological periods
- To study the different types of plant fossils and understand the evolution plants
- To learn to identification of various types of sedimentary rocks
- To study the grain size of sedimentary rocks and analyze the types and environment of deposition

Syllabus:

Palaeontology:

Unit:1. Megascopic identification and description of the fossils:- Corals: Calceola, Zaphrenits, Favosites, Halysites; Brachiopoda: Spirifer, Productus, Terebratula, Rhynconella, Atrypa, Athyris, Orthis; Echinodermata: Pentrimites, Cidaris, Hemicidaris, Micraster, Holaster, Hemisaster, Stygmatophygus, Mollusca: Pelecypoda: Arca, Cardium, Meretrix, Cardita, Pecten, Trigonia, Megaladon, Pholodomya, Gryphea, Exogyra, Ostrea, Inoceramus, Alectryonia. Gasteropoda: Natica, Turbo, Trochus, Turritella, Cerethium, Conus, Voluta, Murex, Fusus, Physa **10 hrs**

Unit:2. Megascopic identification and description of the fossils:-Cephalopoda: Nautilus, Goniatites, Ceratites, Acanthoceras, Turrilites and Belemnites; Arthropoda: Trilobita: Paradoxides, Calymene, Phacops. Trinucleus, Graptolites: Phyllograptus, Tetragraptus, Didymograptus, Diplograptus, Monograptus.Plant fossils: Glossopteris, Gangamopteris, Ptillophyllum, Lepidodentron, Sigillaria and CalamitesMicroscopic identification and description of the fossils:-Micro Fossils: Lagena, Nodosaria, Textularia, Operculina, Elphidium, Ammonia. **6 hrs**

Unit:3. Megascopic identification of various Sedimentary rocks:-Clastic sedimentary rocks: breccia, conglomerate, sandstone, siltstone and shale; Chemical sedimentary rocks: rock salt, iron ore, chert, chalk, flint, dolomites and limestones; Organic sedimentary rocks: coal, shell limestone and dolomites; Microscopic study of Sedimentary Rocks:- Breccia, conglomerate, sandstone, siltstone, shale, limestone, arkose and shell limestone.

9 hrs

Unit:4. Grain size analysis of sediments, Graphic presentation of data, Statistical parameters of grain size. Variation of grain size with distance of transport and their environmental interpretation. Exercises in grains size: Sphericity, roundness calculation. **9 hrs**

Unit:5. Interpretation of Aerial Photographs for Sedimentary Rock mapping. Interpretation of Satellite Images for Sedimentary Rock mapping. **6 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Learning of fossils, sediment characteristics, bedding styles, etc. in the field with special reference to Cretaceous of Tiruchirappalli, Gondwana palnt fossils and wood fossils.

Course outcomes:

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

- The evolution of life from fossils
- The different types of sedimentary rocks
- The origin of sedimentary rocks
- The mapping of sedimentary rocks from aerial photographs and satellite data

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0407	Elective -I	3	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT 0408	Elective -II	3	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	MTIGT0409	TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS	4	25	75	100

OBJECTIVES:

1. To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes;
2. To introduce Fourier series analysis which is central to many applications in engineering
3. To develop the analytic solutions for partial differential equations used in engineering by Fourier series;
4. To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

Unit I – PARTIAL DIFFERENTIAL EQUATIONS

Formation Solutions of first order equations - Standard types and Equations reducible to standard types - Lagrange's Linear equation - Solution of linear equations of higher order with constant coefficients - Linear non-homogeneous partial differential equations.

Unit II - FOURIER SERIES

Dirichlet's conditions - General Fourier series - Odd and even functions - Half-range Sine and cosine series - Complex form of Fourier series- Parseval's identity - Harmonic Analysis.

Unit III – APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION

Classification of partial differential equations- Method of separation of variables - Solutions of one dimensional wave equation and one-dimensional heat equation - Steady state solution of two-dimensional heat equation - Fourier series solutions in cartesian coordinates – solution of PDE by Laplace transforms

Unit IV – FOURIER TRANSFORM

Fourier integral theorem - Fourier transform pair - Sine and cosine transforms - Properties - Transform of elementary functions - Convolution theorem - Parseval's identity.

Unit V - Z-TRANSFORM AND DIFFERENCE EQUATIONS

Z-transform Elementary properties - Inverse Z-transform - Convolution theorem - Initial and final value theorems - Formation of difference equation - Solution of difference equation using Z-transform.

Primary Books:

1. Erwin kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition, New Delhi, 2015.

2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

Reference:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7 Edition, New Delhi, 2009
2. Glyn James, "Advanced Modern Engineering Mathematics, Pearson Education, 4th Edition, New Delhi, 2011.
3. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
4. Ramana, B.V. "HigherEngineering Mathematics", Tata McGraw Hill, 11th Reprint, New Delhi, 2010.

OUTCOMES:

At the end of the course, students will be able to

- Solve partial differential equations which arise in application problems.
- Analyze the functions as an infinite series involving sine and cosine functions. Obtain the solutions of the partial differential equations using Fourier series.
- Obtain Fourier transforms for the functions which are needed for solving application problems.
- Manipulate discrete data sequences using Z transform techniques.

SEMESTER V

Sem	Code	CorecourseName	Credit	Marks		
				I	E	T
V	MTIGT0501	Geographic Information Systems	3	25	75	100

Objectives:

- To learn the basics and concepts of GIS
- To know the components and importance of GIS
- To study the capabilities of GIS in input, verification, analysis, modelling and outputgeneration
- To understand the importance of manipulation and their applications
- To learn the methods of spatial data analyses, simulation and modelling aspects.

Syllabus:

Unit:1. Basics of GIS: Definition - Usefulness of GIS - Components of GIS - Computer Hardware, Software Modules and Organizational Context of GIS. **6 hrs**

Unit:2. Data Structure: Data Structure in GIS - Types of Data (Points, Lines and Polygons)- Data Base Structures (Raster Data Structures and Vector data Structures) - Data Conversion, (Vector to Raster and Raster to Vector).

6 hrs

Unit:3. 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, etc. - Vector to Raster conversion - Raster to Vector conversion - Input devices) - Entry of non-spatial data - Linking of Spatial & Non- spatial data - Data Verification (Errors of different types) - Correction (Rubber Sheet Transformation, Bilinear interpolation, Cubic Convolution, use of topology) - GIS capabilities for Data correction - Data output (Types of Output, GIS Capabilities for output,Output devices). **12 hrs**

Unit:4. Methods of Spatial Interpolation and Digital Elevation Model: Spatial Interpolation: Basic Principles of Interpolation - Methods of Interpolation (Interpolation by Joining Boundaries, viz., Simple vector maps, Theisson polygons) - Global Methods of Interpolation, Local Interpolation (Trend Surface Analysis) - Local Interpolation (Splines) - Optimal Interpolation (Kriging). Digital Elevation Modeling: Need For Three Dimensional Models - Methods of DEM - Products of

DEM (Contour Maps, Shaded Relief Map, Maps Related To Slopes, Line of Sight Maps, Drainage Analysis, Volume Estimation, Fly-thru models, Anaglyph stereo images) – DSM – TIN - Usefulness and applications of DEM, DTM and DSM. **12 hrs**

Unit:5. **Data Analysis and Spatial Modeling:** Simple data retrieval - Data retrieval through Boolean Logic - Data Pre-processing – Spatial Buffer - Map Overlaying and Cartographic Modeling (Two layers, Multiple layers, Binary, Index, Regression, and Process Models) - Overlay analysis, Capabilities (Point Operations, Regional Operations, Neighborhood Operations) **–** Look-up Tables - Post-processing of analysed outputs - Network analysis. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam, only for Discussion): Recent advancements in GIS; Application of GIS in automation, decision making and querybuilding processes in Geological Technology; Modules and capabilities of QUGIS, GRAM++, IDRISI GIS software.

Text Books:

1. Burrough, P.A Principles of Geographical Information Systems for Land Resources Assessment, Clarandone Press, Oxford, 1986.
2. Kang - Tsung Chang, Introduction to Geographic Information System, MC Graw Hill, Boston. 2002.

References:

1. Campbell, J, Introductory Cartography, Printers Hall Englewood Cliffs, N.J, 1984.
2. Dent B.D, Principles of Thematic Map Design, Addition - Wesley, Reading, Mass. 1985.
3. Freeman, H and Pieroni, GG., Map Data Processing, Academic Press, New York. 1980.
4. Monmonier, M.A, Computer Assisted Cartography - Principles and Prospects, Prentice Hall,Englewood Cliffs, NJ, 1982.

Course outcomes:

After the successful completion of this course, the students are able to:

- Understand the basic concepts and virtues of this important tool providing various platformsto handle Geospatial data
- Gain basic ideas to generate, group, store Geospatial data in effective data structures
- Develop skills on manipulation, 3D visualization, Spatial Analysis and Spatial Modeling.
- Handle Geologic problems Geospatially in GIS platform independently.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0502	Practical: Geographic Information Systems	2	40	60	100

Objectives:

- To study the principles and concepts of GIS
- To learn the data input, editing in GIS
- To develop the spatial database on GIS
- To perform spatial analysis on GIS
- To learn the Map projection and area calculation
- To develop the geospatial model on GIS

Syllabus:

Unit:1. Scanning/Data input and Geo referencing of map **3 hrs**

Unit:2. Digitization, Data Editing, Labeling and geo database creation **12 hrs**

Unit:3. Projection and Transformation of map & area calculation **6 hrs**

Unit:4. Creation of non-spatial/attribute data base **6 hrs**

Unit:5. Linking of Spatial and Non Spatial data, Query based Retrieval and Spatial display of non-spatial data **6 hrs**

Unit:6. Data editing/ error removal for GIS analysis – Regrouping, Dissolving / Merging **6 hrs**

Unit:7. GIS spatial analyses (Buffering and Overlay) & Preparation of criteria table **6 hrs**

Unit:8. Map design and Map Layout creation **3 hrs**

Unit:9. 3D analysis/DEM/DTM creation **6 hrs**

Unit:10. Hands on exercise using various GIS packages (QGIS etc). **10 hrs**

Unit:11. Current Contours: (Not for Final Exam only for Discussion):

Geospatial model development- GIS Project: Planning and implementation

Course Outcomes:

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

- Digital map with geodatabase
- Spatial database with real world coordinate
- Geospatial models
- Spatial Information System/DSS.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0503	Stratigraphy and Indian Geology	3	25	75	100

Objectives:

- To study the principles of modern stratigraphy, nomenclature, classification and correlation.
- To study Thus as this branch of geology reveals the history of our planet, it is called as "Historical Geology.
- To understand the Achaean Era (The Oldest), Precambrian era, Primary era, Secondary era, - Tertiary era and Quaternary era (The last and the youngest).
- It is believed that the earth came into existence nearly 4500 million years ago. Therefore, its history is spreading over all this lengthy period.
- To study the relative comparison of ages of different sequence of rocks found in different places on the earth's surface, it is a proper framework of geological time to fulfill by the "Geological Time Scale", which is internationally accepted.

Syllabus:

Unit:1. Introduction: Nomenclature and the modern stratigraphic code. Radioisotopes and measuring geological time. Geological time-scale. Stratigraphic procedures of correlation of unfossiliferous rocks. Principles of Stratigraphy -Stratigraphic classification - Lithostratigraphic -Biostratigraphic - Chronostratigraphic and Geologic Time units - Correlation - Physical and Palaeontologic: Homotaxis, Imperfections in Geological Records. **16 hrs**

Unit:2. Precambrian -Carboniferous: Precambrian Structure and Tectonics of India- Cratonic Rocks (Dharwars, Singhbhum, Aravalli and Baster) -Stratigraphy, Structure and Tectonics and Economic Importance (Cuddapah, Vindhyan, Kaladgi, Bhima and their equivalents - and their Sedimentation, Depositional Environment, Primary, Sedimentary Structures, Fossils).

Cambrian to Lower Carboniferous systems: - their distributions, Geological Succession and Fossils - Age Discussion of the Saline Series. **12 hrs**

Unit:3. Upper Carboniferous -Cretaceous: Gondwana Group: Classification – Geological Succession -Distribution - Correlation - Structure - Sedimentation - Fossils – Palaeo geography and Economic importance - Triassic of Spiti - Jurassic of Kutch: Stratigraphy - Classification and Faunal characteristics - cretaceous of Trichinopoly and Pondicherry: Stratigraphy, Distribution and Faunal Characteristics, Palaeogeography of Cretaceous Period. **12 hrs**

Unit:4. Cretaceous -Tertiary: Deccan Traps: Distribution - Structural Features - Inter- Trappean and Infra- trappean beds, Lameta beds - Age and Economic importance. Tertiary group: Cretaceous-Tertiary transition in India- Rise of Himalayas, Facies and distribution - Eocene, Oligocene and Lower Miocene systems, their distribution, Stratigraphy and Fauna - Siwaliks- their distribution - Constitution, Sedimentation, climate, Fossils and correlation.

12 hrs

Unit:5. Quaternary Geology: Pleistocene-Holocene system - Division and distribution - Glacial and Interglacial periods - Igneous Epochs in India. Gondwana system and Gondwanaland. Rise of the Himalaya and evolution of Siwalik basin. Deccan Volcanics. Quaternary Stratigraphy. Rock record, palaeo climates and palaeo geography. **6 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Stratigraphic terms- Geological Time-Geological Systems. Correlation of formation in India-world. The International Commission on Stratigraphy is the largest and oldest constituent scientific body in the International Union of Geological Sciences (IUGS). International Stratigraphic Guide- Correlation of world stratigraphy.

Text Books:

1. Wadia D, Geology of India, Mc Graw Hill Book Co. 1973.
2. Krishnan, M.S., Geology of India and Burma. 6th Edition, CBS Publishers and distributors. 1982.
3. "Principles of Sedimentology and Stratigraphy" by Boggs S
4. "Stratigraphy and Sedimentation" by W C Krumbein and L L Sloss

References:

1. Ravindra Kumar, Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern Ltd, New Delhi, 1985.
2. Weller, J.M., Stratigraphic Principles and Practice, Harper & Bros. Publishers, New York - 1960.
3. Gignox, M. Grabau. A.W, Stratigraphic Geology, Principles of Stratigraphy, 1960.
4. Dunbar, C.S. & Rodgers .J, Principles of Stratigraphy,1957,
5. Read, H.H. and Waston, 1. 2 Vols, Earth's History, London, 1972.
6. Gupta, V.J, Indian Precambrian Stratigraphy.
7. Gupta, V.J, Indian Palaeozoic Stratigraphy.
8. Gupta, V.J, Indian Mesozoic Stratigraphy.
9. Gupta, V.J, Indian Cenozoic Stratigraphy.

10. Balasubramanian, M.N., Structure and Tectonics of India**.**

11. The Geology of Stratigraphic Sequence" by Miall A D
12. Stratigraphy: A Modern Synthesis" by Andrew D Miall

Course outcomes:

- Strata of the rock formations and the order of super positions.
- Precambrian to Carboniferous period and its depositional environments.
- Breaks up of Gondwana land and formation of coal and endanger species.
- Marine transgression and regression with fossil evidences.
- Formation of Deccan traps and orogenic movements also correlation of fossils.
- Quaternary sediments.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0504	Structural Geology	3	25	75	100

Objectives:

- To study the principles and scope of the structural geology
- To understand the fold style and classification
- To Understand the fault, lineament and classification
- To study about microstructures, shears and intrusive structures
- To learn about basics of plate tectonics

Unit-I

Basic Principles: Definition and Scope of Structural Geology – Primary and Secondary Structures- Geological Mapping (Along the strike and Across the strike), Different scales of mapping, Mapping using tape and compass – Stereographic projection: Application of stereographic projection.

6hrs

Unit-II

Folds: Anatomy of fold, Types of Folds; based on sense of curvature, based on Plunge of fold, on the basis of orientation of Axial Plane, on the basis of Youngling direction, on the basis of symmetry of fold, on the basis of nature of hinge line etc. Ramsay classification of fold - Superposed folds**:** Type 0, Type 1, Type 2 and Type 3 - Recognition of folds in field.

1**2hrs**

Unit-III

Faults: Anatomy of Fault – Stress and Strain – Analysis of stress and strain ellipsoid - Classifications of faults: on the Basis of orientation of Faults, on the Basis of Dip Amount of Beds, on the basis of Movement, on the basis of Slip of Faults, on the basis of mode of occurrences - Effect of fault on the outcrop – Evidences of Fault - Recognition of fault in field.

12hrs

Unit-IV

Microstructures and Structures of Sedimentation and Intrusion: Anatomy of Joints – Classification of Joints: Geometric and Genetic classification – Shear: Types of shear, evidences of shear, shear zone – Cleavage: foliation and lineation – Unconformity structures related to igneous intrusion, Diapirs, salt domes etc. **12hrs**

Unit-V

Mapping of geological structures through Remote Sensing and GIS techniques – Lineament mapping (Fault, Joint & Shear) – Lineament Density – contouring. Mapping of fold- mapping of trend line – interpretation of folded structures using trend line. Mapping of geological structures using geophysical data.

6hrs

Unit-VI: Current Contours: (Not for Final Exam only for Discussion):

Scope of Structural Geology: Mineral and Groundwater Exploration - Identification of F_1 and F_2 fold in field, Fold style mapping using structural trend line – Identification of structural porosity and permeability zones using lineament analysis.

Materials for Study and References

Text Books:

1. Billings, M. P. Structural Geology, Prentice-Hall, Inc, New Jersey, USA, 1972.
2. S.K. Ghosh. Structural Geology, Fundamentals and Modern SDevelopments
3. Hobbs, B. E., Means, W. D., & Williams, P. E. An Outline of Structural Geology, John Wiley & Sons, Inc, Australia 1976.
4. Gupta R.P, Remote Sensing Geology, Springer - Verlag - New York, London, 1991.

References:

1. Ramsay & Huber, Folds and Fractures (Volume II).
2. Lillisand, T.M. and P.W.Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 1986.
3. Sabins, F.F.Jr., Remote Sensing Principles and Interpretation, Freeman, Sanfrancisco. 1978.
4. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers,Jaipur
5. Rao. D.P, Remote Sensing for Earth Resources, Association of Exploration Geophysicists, 2nd Edition, Hyderabad.

Course Outcome:

- The study of structure help the students to identify the zone of weakness.
- Students will understand the important of structures in the mineral exploration
- Application of lineament mapping in groundwater exploration.
- Students will understand the importance of structure in construction of engineering structures like Dam, bridge, Ghat roads etc.
- Students will learn about structures and its important pertaining to natural hazards like earthquake, landslides etc
- Students will learn about the applications of satellite data in mapping of structures
- Students will also learn about the applications of Aerial Photos for mapping of structures.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0505	Practical: Geoinformatics in Structural Geology	2	40	60	100

Objectives:

- To study the topographical information
- To learn the use of brunton compass and clinometer
- To Understand the geological maps and cross sections
- To trainmathematical and graphical method for determination of true and apparent dip
- To learn the structural trend line mapping

Experiments:

1. Study of Topographical maps:
    a. Identification of land forms, major structures such as Fold, Fault, Joint, Unconformities and Intrusions.
2. Uses of Clinometer and Brunton Compass:
    a. Laboratory exercises in structural Geology maps, contours – Completion of outcrops.
3. Three point problems in structural mapping
4. Combination of any two structures:
5. Such as Fold and Fault, Fault and Unconformities.
6. Drawing of cross – sections across the geological maps to bring out the structure of the area.
7. Interpretation of structures, determining the Order of Superposition of beds.
8. An account of geological sequences that affected the area.
9. Exercise on structural geology problems/Graphical determination of Dip in gradient.
    a. Determination of True dip by simple calculation.
    b. Determination of Apparent dip by Graphical method.
    c. Determination of Thickness of bed by calculation, on a level ground.
10. Mapping of structural trendlines and folds using aerial photographs and satellite images.
11. Mapping and analysis oflineaments using aerial photographs and satellite images.
12. Structural analysis usingDEM wrapped FCC satellite data
13. Structural analysis usingSRTM shaded relief map
14. Plotting of plane, line, plunge data using stereogram projection.

Additional Experiments:

1. Mapping of attitudes on field using brunton compass
2. Making of 3D modelling for 3 point problems

Materials for Study and References

1. S.K. Ghosh. Structural Geology, Fundamentals and Modern Developments
2. Geological structures and maps, A practical guide, Richard J Lisle
3. Structural geology laboratory manual, by David T. Allison
4. A Manual of Problems in Structural Geology 1st Edition, N. W. Gokhale

Outcomes:

- Student will learn about the usage of toposheet in geological mapping
- Student will understand different structural problems
- Students will learn mapping and drawing cross section.
- They understand mathematical and graphical calculations for true and apparent dip determinations,
- Mapping of structural trend lines and lineament analysis
- Student will study the usefulness of clinometer and brunton compass in geological mapping
- Students also learn profile making and structural feature extraction.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0506	Geomorphology and Modern Geodynamics	3	25	75	100

Objectives:

- ➢ To study the principles of landform development
- ➢ To study the different types of landforms formed by the denudational and tectonic processes
- ➢ To understand the fluvial and coastal processes and related landscape
- ➢ To learn the Aeolian, volcanic and groundwater related landforms
- ➢ To study the application of geomorphology in resources, hazards and environmentalassessment

Syllabus:

Unit:1. Introduction to Geomorphology: History - Development in geomorphology - catastrophism, uniformitarianism - Basic Principles of Geomorphology, concept of geomorphic cycle and evolution of landforms, Davis, penck and King model of landform development, **- E**ndogenous and exogenous processes.

. **Denudational Geomorphology:** Need for studying the denudational geomorphology - Physical and chemical weathering Process and types of Mass wasting - Types of landforms: Summit Zone landforms, Slope Zone landforms, Foot hill zone landforms, plain zone landforms and their expressions in aerial photographs and satellite images.

12 hrs

Unit:2 Tectonic Geomorphology: Need for Studying the Tectonic Geomorphology - Types of Landforms: Structural Hills, Tors complexes, Horizontal Landforms, Landforms in marginally deformed rocks, landforms related to folding, landforms related to faulting **-** Their expressions in aerial photographs and satellite Images.

Fluvial Geomorphology: Need for studying the fluvial geomorphology - Drainages (Classification, Morphology and Types) - Life cycle of river systems - Constructional and Destructional Landforms (in youthful, mature and old stages of the river) **-** migratory behaviorof rivers - Deltas of Tamil Nadu – Mapping of fluvial landforms using aerial photographs and satellite images

12 hrs

Unit:3. Coastal Geomorphology: Need for studying coastal geomorphology - Coastal zone processes: waves, currents and tides –**Coastal zone -** Classification of Shorelines – Coastal landforms: Landform formed by the coastal erosion and landforms formed by the waves, currents and tides - Manifestations of coastal landforms in aerial photographs and satellite images.

Unit:4.

Aeolian Geomorphology: Need for studying aeolian geomorphology - Processes in arid region - landforms of wind erosion, landforms of wind deposition: different types of Sand dunes, Fluvio-desertic landforms - Manifestations of aeolian landforms in aerial photographs andsatellite images.

12 hrs

Unit:5

Volcanic Geomorphology: Need for studying volcanic geomorphology –Magma generation and plate tectonics – Classification of volcanoes - Different Volcanic Landforms: Shield volcanoes, Strato volcanoes, Cinder cones, Lava domes, volcanic craters and calderas, Plateau Basalts, etc. and their manifestations in aerial photographs and satellite images. **Glacial Geomorphology:** Need For its Study – Formation of glaciers, Glacier system – Movement of Glaciers and Crevasses, Types of glaciers - Landform Types: Erosional and depositional landforms. **Groundwater generated landforms:** Need for its Study – Karst topography, Karst Landforms: Types and causes of Sink holes, - Different types of Cave environments –

Cave Landforms - Speleothems. **Bio-genic Landforms:** Need For its Study - Effects of organisms on geomorphology

Application of Geomorphology: Application of geomorphology in mineral exploration, water resources - Role of Geomorphology in disaster mitigation and management.

12 hrs

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Landscape of Tamil Nadu; Landform development in east coast of Tamil Nadu; Landscape of Western Ghats and Eastern Ghats; Geomorphic processes and landforms of major deltas of India; Development of Himalayan landforms.

Text Books:

1. Thornbury, W.D., Principles of Geomorphology, John Wiley and Sons, 2nd Edition, NewYork. 1985.
2. Jha. V.C., Geomorphology and Remote Sensing, ACB Publications.
3. Verstappen, H. Remote Sensing in Geomorphology, Elsevier, Amsterdam. 1977.
4. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church,Virginia. 1983.
5. Drury, S.A A guide to Remote Sensing Interpreting Images of Earth, Oxford SciencePublications, Oxford. 1990.
6. Gupta R.P Remote Sensing Geology, Springer - Verlag - New York, London, 1991.
7. Gary L.Prost Remote Sensing For Geologists - A Guide to Image Interpretation, Gordon andBreach Science Publishers, The Netherlands. 1997.
8. Doehring, Geomorphology in Arid Regions, Allen and Unwin, London. 1980.
9. Verstappen, H. Applied Geomorphology, Elsevier, Amsterdam. 1983.
10. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers, Jaipur, 1996.
11. Rao. D.P, Remote Sensing for Earth Resources - Association of Exploration Geophysicists,2nd Edition, Hyderabad, 1999.
12. Surendra Singh, Geomorphology and Remote Sensing in Environmental Management,Scientific publishers, 1992.
13. Tripathi. N.K. Remote Sensing in Geosciences, Anmol Publications, 1998.
14. David Paine, Aerial Photography & Image Interpretation for Resource Management, JohnWiley & Sons, 1981.
15. Keller E.A., Environmental Geology, CBS Publishers, 1985.
16. Chouhan. T.S., Applied Remote Sensing and Photo Interpretation, Vigyan Prakashan, 1996.
17. Rice R.J, Fundamentals of Geomorphology, E.L.B.S, Longman, 1988.
18. Chouhan, T.S., Readings in Remote Sensing Applications, Scientific publishers, 1992.
19. Ramasamy, SM., Remote Sensing in Geology, Rawat Publishers
20. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, NewDelhi, 2005.

Course outcomes:

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

- ➢ Principles of landform formation and its significant
- ➢ Origin of Landforms related to weathering, river action, coastal processes, volcanic activity,wind movement, glacial processes, etc.
- ➢ Understand the recent geological processes by analyzing the landforms
- ➢ Evaluate the Landforms with reference to the resources like water, mineral and oil resources
- ➢ Evaluate the landforms with reference to the various disasters like earthquakes, landslides,volcanic eruption, glacial avalanches, tsunami, etc.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0507	Practical: Geoinformatics in Geomorphology	2	40	60	100

Objectives:

- To understand the various photo recognition elements for mapping of landforms
- To study the principles of mapping of landforms from aerial photographs
- To map the different types of landforms formed by the denudational and tectonic processes
- To understand the fluvial and coastal processes and mapping their landforms
- To visualization and mapping of various landforms under the 3D GIS environment

Syllabus:

Unit:1. Tectonic geomorphic mapping using aerial photographs and satellite images; Denudational geomorphic mapping using aerial photographs and satellite images. **12 hrs**

Unit:2. Fluvial geomorphic mapping using aerial photographs and satellite images;Coastal geomorphic mapping using aerial photographs and satellite images. **12 hrs**

Unit:3. Aeolian geomorphic mapping using aerial photographs and satellite images;Glacial geomorphic mapping using aerial photographs and satellite images. **12 hrs**

Unit:4. Volcanic geomorphic mapping using aerial photographs and satellite images; Karast geomorphic mapping using aerial photographs and satellite images. **14 hrs**

Unit:5. 3D GIS based visualization of tectonic, denudational, fluvial, coastal, Aeolian and volcanic landforms using SRTM and satellite FCC data; Mapping of landforms using topographic profiles; Mapping landforms SRTM based shaded relief images. **6 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Field verification of landforms, Himalayan landforms, landforms in major deltas of India, mapping of landforms in 3D GIS environment and topographic profiles of various types of landforms

Course outcomes:

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

- Recognize the various types of landforms
- Understand the landforms in the field as well as in aerial and satellite images
- Understand the landforms related to resources
- 3D GIS based mapping of landforms

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0508	Elective III	3	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	MTIGT 0509	Elective IV	3	25	75	100

SEMESTER VI

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0601	Economic Geology	4	25	75	100

Objectives:

- To study the different types of ore deposits
- To study the formation of ore deposits due to earth internal processes
- To learn the formation of ore deposits due to earth external processes
- To learn the Indian ore deposits
- To study the minerals used in industries

Syllabus:

Unit:1. Introduction-Ore and gangue minerals - Mineral resources and ore reserves -nature and morphology of the principal types of ore deposit- Textures and structures of ore and gangue minerals- Metallo genic epochs and provinces of India - Geologic Thermometry, Paragenitic Sequence and Zoning - concentration of elements in the crustal rocks - Classification of ore mineral deposits (Lindgren's, Bateman's and recent classifications). **12 hrs**

Unit:2. Internal Processes and environment of ore formation: Magmatic processes of mineralization, classification of magmatic deposits, early and late magmatic deposits - hydrothermal ore deposits, types, cavity filling and replacement deposits, Wall rock alteration -– Volcanogenic massive sulfide ore deposit deposits - Metamorphic processes and formation of mineral deposits.- **12 hrs**

Unit:3. External Processes and environment of ore formation: Introduction - Principles of chemical weathering - lateritic and Bauxite deposits- clay deposits - supergene enrichment of Copper and other metals in near surface deposits - placer deposits, different types of placers - chemical sedimentation - banded iron formations - phosphorites and evaporates. **12 hrs**

Unit:4. Metalliferous deposits in India: Occurrence and distribution of base metals (copper, lead and zinc), iron, manganese, aluminium, chromium, nickel, gold, silver, molybdenum. Indian deposits of non-metals - Diamond, mica, asbestos, barytes, gypsum, graphite, apatite and beryl. **12 hrs**

Unit:5. Industrial minerals: Gemstones-refractory minerals - abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries - Building stones- Placer deposits - rare earth minerals - Strategic, critical and essential minerals. National Mineral Policy. Mineral Concession Rules. Marine mineral resources and Laws of Sea.

12 hrs

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Formation of ore deposits with reference to India; Economic mineral deposits of Tamil Nadu; Indian mineral economy; status of renewable and nonrenewable resources of India; Role remote sensing in mineral deposits investigation.

Text Books:

1. Bateman, AM and Jonsen, M.L., Economic mineral Deposits, John Wiley
2. Gokhale & Roa, Ore Deposits of India, Thomson press, 1972,
3. Krishnaswamy, S., Indian Mineral Resources, Oxford IBH, 1980,

References:

1. Bateman, AM and Jonsen, M.L., Economic mineral Deposits, John Wiley
2. Gokhale & Roa, Ore Deposits of India, Thomson press, 1972,
3. Krishnaswamy, S., Indian Mineral Resources, Oxford IBH, 1980,
4. Alkinson, Ore Deposit Geology Chapman &Hall, 1985
5. Craig, 1985, Ore Petrology and Petrography, Wiley, 1981.
6. Desppande M.L., Gemstones and Semiprecious stones. Indian Minerals, Vol-32 No.1 Geol.Survey of India Pub. 1978.
7. Iyengar, N.K.N. Mineral wealth of Tamil Nadu, Madras Govt.
8. Karanth, K.V., Gems and Gem Industry in India, Geol. Soc., 2000.
9. Krishnan, M.S. Mineral Resources of Madras, Geology Society of India Pub.
10. Laford, S.J., Industrial minerals and Rocks, AIME Pub., 1975.
11. Lindgren, W, Mineral Deposits, McGraw Hill, 1942.
12. Nancy, & Ron Perry, Practical Gem Cutting, David & Charles, 1982.
13. Prasad, V., Economic Geology, CBS Pub., 1994.
14. Ram Dohr, P., Ore Deposits and their Relationship, Springer Verlaz, 1960.
15. Stanter, R.L. Ore Petrology, McGraw Hill, 1972.
16. Sinha RK & Sharma, N.L., Treatise on Industrial Minerals of India, Pub, 1967.
17. Subramanyan, K.S. Geology of Tamil Nadu and Pondicherry, Geol Soc. India, Pub., 2001.
18. GSI, Geology and Mineral Resources of Tamil Nadu, Geol. Survey of India Pub.

Course outcomes:

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

- ➢ Utility of various minerals
- ➢ Various types of mineral and ore forming processes
- ➢ Identification of various minerals and ores through various physical, chemical, optical andspectral properties
- ➢ What type of mineral deposits in which type of areas, rocks and environment
- ➢ Major mineral deposits of India
- ➢ Mapping of mineral deposits from remote sensing

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0602	Geoinformatics in Mineral Exploration	4	25	75	100

Objectives:

- To study the different controls of mineralisation
- To learn the geological technique and procedures for mineral exploration
- To Understand the applications of remote sensing technique in mineral exploration
- To study about visualization of geophysical and geochemical data
- To learn about geostatistical modeling for minerali exploration

Unit-I

Introduction to mineral exploration - Various stages of mineral exploration – History of mineralisation event – Origin of ore deposits - Various controls of mineralization (Lithological, structural, geomorphological and stratigraphical controls) –-Guides to ore deposits – **8 Hrs.**

Unit-II

Geological techniques and procedures for Mineral exploration-Geological aspect of site selection- Field Procedure for sampling - Types sampling - lab analysis of samples – trenching – pitting – exploratory drills – Geological logging of borehole samples - panning of soils and their interpretation – Cutoff grade and thickness-calculation of average grades and thickness – Ore Reserve Estimation; conventional and geostatistical approach - GIS and database management for mining exploration – documentation of exploration. **16Hrs.**

Unit-III

Mapping of Lithologically, Structurally and Geomorphologically Controlled Mineral Deposits Using FCC and Digitally Enhanced Data – Optimization of Spectral Bands and Enhancement Techniques for mineral targeting– Thermal and Microwave Remote Sensing for Mineral Exploration – Mineral mapping through Hyperspectral image -Mapping hydrothermal alteration for mineral exploration. **16Hrs.**

Unit-IV

GIS based visualisation of magnetic, gravity, resistivity and electro-magnetic data for mineral exploration. GIS based visuvalisation of geochemical data, airborne gamma ray spectrometer data, Airborne / Heliborne geophysical data for mineral exploration. **12Hrs.**

Unit-V

Introduction to Multidisciplinary approach for mineral exploration – Preparation of thematic layers - Integration of thematic layers for mineral exploration - Integration of inter-discipline for mineral exploration. **12Hrs.**

Unit-VI: Current Contours: (Not for Final Exam only for Discussion):

Multidisciplinary Approach: Mineral Exploration based on geological, geophysical, geochemical and remote sensing parameters. Interpretation and correction of Magnetic, Gravity and Radiometric data.

Materials for Study and References

References:

1. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church, Virginia. 1983.
2. Gary L.Prost Remote Sensing for Geologists - A Guide to Image interpretation, Gordon and Breach Science Publishers, The Netherlands. 1997.
3. Bateman, A. Economic Mineral Deposits, John Wiley.
4. Krishnasamy S., Indian's Mineral Resources, Oxford IBH, 1980.
5. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers,Jaipur
6. 8. Rao, D.P. Remote Sensing for Earth Resources, Second Edition, Association of Exploration Geophysicist, Hyderabad p.212, (CERS-236), 1999.
7. 12. Kearey P. and M. Brooks, An introduction to Geophysical Exploration, English Language Book Society / Blackwell Scientific Publications, p. 296 (CERS 51). 1989.

Outcomes:

- Students will learn the techniques for mineral exploration
- Students will learn about different approaches and methods of mineral exploration
- Students will understand geological, geophysical and geochemical usage in mineral exploration.
- Students will understand the usage of Remote Sensing and GIS role in mineral exploration
- Students will learn about geostatistical modeling for mineral exploration
- Students will learn about ore reserve estimation methods.
- Student will understand the different enhancement technique in mineral exploration

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0603	Practical: Economic Geology and Mineral Exploration	2	40	60	100

Objectives:

- To study physical, chemical and optical properties of various ore minerals
- To study physical, chemical and optical properties of various industrial minerals
- To map the ore deposits from satellite data
- To learn the role of resistivity data in mineral exploration
- To learn the important of gravity and magnetic data in mineral exploration
- To learn the 3D GIS visualization of geophysical dataset and mapping of mineral deposits

Syllabus:

Unit:1. Megascopic study of important ore minerals Megascopic study of important industrial minerals **12 hrs**

Unit:2. Study of optical properties and identification of important ore minerals under ore-microscope.

Preparation of maps showing distribution of important ore minerals in India. **9 hrs**

Unit:3. Mapping of ore mineral deposits from satellite images; Lithology controlled mineral deposits; structure controlled mineral deposits

Generation of various mineral indexes using ASTER and LANDSAT data

Spectral reflectance of important ore and industrial minerals **6 hrs**

Unit:4. Interpretation of resistivity data for mineral exploration.

Interpretation of gravity and air borne data for mineral exploration. **6 hrs**

Unit:5. 3D geophysics in mineral exploration

Geomatics in mineral exploration **7 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Role of GIS and DIP in mineral exploration, case studies in mineral explorations, familiarization of minerals found in extra-terrestrial environment.

Course outcomes:

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

- Identify various ores and minerals
- Map the ore deposits from satellite data
- Understand the role of geophysical dataset in mineral exploration
- Map the mineral deposits through GIS based 3Dvisulaization

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0604	Geoinformatics in Water Resources	4	25	75	100

Objectives:

- To know the potential sources, origin, occurrences of water resources
- To understand the concepts of water resources prospecting, water quality mapping andconservation
- To learn the capabilities of Geoinformatics and its applications for water resources targeting,quantification, budgeting and management
- To learn the Geological Technology and Geoinformatics in understanding the functions ofaquifers and groundwater movement
- To learn the basics and applications of hydrogeological models.

Syllabus:

Unit:1. **Surface Water Resources:** Hydrological Cycle - Global Distribution of Surface water Bodies -Drainage Morphometry -Sources of Surface water -Snow, Rainfall and groundwater table. Modeling assumptions - choice of equation - phenomena and model geometry - choice of variables and parameters - data and knowledge acquisition - model building -calibration and verification, results presentation. **12 hrs**

Unit:2. Geoinformatics in Surface Water Resources: Satellite data based Surface water budgetingand Quantification -Automated drainage Mapping Using DEM -Spectral Response Pattern of Water -Water quality mapping and monitoring using Remote Sensing -Infra Red data based Water Quantity Forecasting -Water quality Mapping and Monitoring using satellite data. **12 hrs**

Unit:3. Groundwater Resources: Groundwater Origin & Occurrence: Sources of Groundwater - Classification of Groundwater. Aquifer Types**:** Crystalline Aquifer, Sedimentary aquifer, Unconsolidated Sedimentary Aquifer, Geomorphic aquifer. Darcy's Law in homogeneous and heterogeneous media, Quantification of Groundwater, Groundwater quality, Application of H and O isotopes in groundwater studies; Targeting: General Investigations- Geological mapping- Geological Cross sections- Well inventory- Geophysical Methods- Drilling and Exploration - Pump tests - Groundwater Assessmentand Budgeting - Issues and conservation Strategies. **16 hrs**

Unit:4. **Geoinformatics in Groundwater Resources:** Geoinformatics and evaluation of lithologically controlled, Structurally controlled and Geomorphologically controlled aquifers -Concept of Hydro geomorphic mapping. Natural and Artificial recharge site selection - detection of site specific mechanisms -Quantification of allowable recharge.

12 hrs

Unit:5. **Hydrological Models:** Surface Water Hydrological Models: Snow melt Runoff modeling - GIS based Runoff modeling -Various hydrological models using Geoinformatics models for Inter watershed water transfer. Groundwater models: Stochastic -MOD Flow- Linear -Finite Element Modeling. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Hydrogeological Information System; Hydrological models in GIS, Use of Digital Image Processing methods for surface water prospecting; Use of high resolution DEM for surface water quantification; Use of tracers to understand the aquifer characters, recharge behaviors and contaminant transport through groundwater.

Text Books:

1. David Keith Todd, Groundwater Hydrology, Wiley Student Edition.
2. Raghunath H.M., Ground Water, New Age International (P) Limited Publishers, 1987.
3. Ramakrishnan. S. Groundwater, 1998.

References:

1. Chang, H.H. Fluvial processes in river engineering, John Wiley and Sons, New York. 1988.
2. Bedient, P.B, Hydrology and flood Plain analysis, Addision westery publishing company.1988.
3. Driscoll, F.S. Groundwater & Wells, 2nd Edition, Scientific Publishers, Joclpur, 1986.
4. Karanth K.R., Groundwater Assessment Development and Management, Tata McGraw Hill Publishing Company Limited, New Delhi, 1987.
5. Clorer. R.C., Groundwater Management.
6. Scalf M.R., Manual of SW Quality Sampling procedure
7. Mutreja, K.N Applied Hydrology, Tata McGraw Hill Publishing Company Limited, NewDelhi, 1986.
8. Thomann R.V, Principles of Surface Water Quality Modeling and Control, HIE, Harper &Row, Publishers, New York, 1987.

9. Mohammed Ali, George E Radosevich, Water Resource Policy for Asia, A. A. Balkema/Rotterdam/Boston, 1987.
10. Mcdonald AT, Water Resources: Issues and Strategies, Longman Scientific & Technical,1988.
11. Pillai, K.M., Water Management and Planning, Himalaya Publishing House, 1987.
12. Gower. A.M., Water Quality in Catchment Ecosystem, John Willey & Sons, 1980.
13. Ramesam. V. Trends in Groundwater Research, The Geological Society of India, Bangalore,1987.
14. Trivedi, R.N., Shatrunjay Kumar Sing, Water Resources and Quality Management, Commonwealth Publishers, New Delhi, 1990.
15. Fetter C.W. Applied Hydrology, CBS Publishers & Distributors, 1988.
16. Gautam Mahajan. Groundwater Surveys and investigations, Ashish Publishing House, New Delhi, 1995.
17. Chow V.T., maidment, D.R., and Mays, L.W. applied Hydrology, McGraw Hill, New York, pp.530 to 537. 1988.
18. Deman, MCJ. Smith G.S and H.T.Verstappen (eds), Remote Sensing for resources development and environmental management, A.A. Ballkema Publishers, Totterdam, Netherlands. 1986.

Course outcomes:

After the successful completion of this course, the students are able to:

- Understand the availability, sources and importance of the water resources prospect for both surface and groundwater resources using Geoinformatics technology
- Determine the types of aquifers, their characteristics and their recuperation ability
- Delineate suitable sites and mechanisms for natural and artificial recharge
- Understand the application of Geoinformatics technology for surface and groundwater resources exploration, targeting, quantification, budgeting, conservation and management
- Learn the application of Geological technology and Geoinformatics tools in developing various hydrological models.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0605	Practical: Geoinformatics in Water Resources Management	2	40	60	100

Objectives:

- To learn the method of mapping surface water resources, watershed delineation and their morphometric characters using remote sensing data and DEM
- To learn the water quality mapping methods
- To understand the hydrogeological mapping methods to know the functions of aquifers
- To learn the methodology of preparing groundwater targets
- To learn the Geological Technology and Geoinformatics in understanding the functions of aquifers for groundwater management
- To learn the application of statistical analysis for hydrogeology.

Syllabus:

Unit:1. Spectro Radiometric Survey of Water Bodies. **12 hrs**

Unit:2. Analysis of Aerial Photographs and Satellite Images for Drainage Morphometry and Watershed Demarcation. **12 hrs**

Unit:3. Surface Water Resources, Snow and water quality mapping using Aerial and Satellite Data. **6 hrs**

Unit:4. Mapping of Lithologically controlled Aquifers using Satellite and Aerial data. **6 hrs**

Unit:5. Mapping of Structurally controlled Aquifers using Satellite and Aerial data. **6 hrs**

Unit:6. Mapping of Geomorphologically controlled Aquifers using Satellite and Aerial data. **6 hrs**

Unit:7. GIS based Aquifer Function Modeling. **4 hrs**

Unit:8. Optical data analysis for Groundwater targeting & Recharge. **4 hrs**

Unit:9. Thermal & Microwave data analysis for Groundwater Prospects & Recharge. **4 hrs**

Unit:10. Statistical analysis for understanding Groundwater functions & Recharge. **4 hrs**

Unit:11. Current Contours: (Not for Final Exam only for Discussion): 3D visualization of aquifer characteristics, groundwater level, natural recharge and water quality for water resources budgeting and management.

Course outcomes:

After the successful completion of this course, the students are able to:

- Understand the availability, sources and importance of the water resources
- Prospect for both surface and groundwater resources using Geoinformatics technology
- Determine the types of aquifers, their characteristics and their recouperation ability
- Delineate suitable sites and mechanisms for natural and artificial recharge
- Understand the application of Geoinformatics technology for surface and groundwater resources exploration, targetting, quantification, budgetting, conservation and management
- Learn the application of geoinformatics in developing various hydrological models

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0606	Elective V	3	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	MTIGT 0607	Elective VI	3	25	75	100

SEMESTER VII

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0701	Petroleum Geology	3	25	75	100

Objectives:

- To understand the fundamentals of hydrocarbon and oil exploration
- To learn the principles of different methods used in hydrocarbon exploration.
- To acquire knowledge in the application of Remote sensing and GIS in oil exploration.
- **Syllabus:**

Unit:1. Basic Principles: Hydrocarbon - (Definition, chemical composition of petroleum - organic and inorganic theories of Hydrocarbon formation– Source rock - The maturation of organic matter in the source rock - Primary and secondary migration of hydrocarbon – Entrapment. **8 hrs**

Unit 2: Diversity in Occurrences - Traps (structural, stratigraphic and combination) - Basin Analysis and Basin History - Field Geological and Geophysical methods for of hydrocarbon Oil Exploration. Sedimentary basins of India - Important hydrocarbon provinces of the world - Worldwide Proven hydrocarbon reserves. **10 hrs**

Unit:3. Reservoir Engineering: Petrophysical properties of the reservoir rock. Porosity and permeability and its types - Reservoir fluid properties - Phase behavior of hydrocarbon system. Flow of fluids through porous media. Water and gas coning. Reservoir pressure measurements. Reserve estimation & techniques. **11 hrs**

Unit:4. Remote Sensing and GIS for hydrocarbon exploration: Remote Sensing for Oil Exploration in Terrestrial basins – detection of obscured Structures, buried structures and basement structures for Oil Exploration. Hyperspectral Remote Sensing & GIS for detecting hydrocarbon micro seeps and diagenetic modifications of the rocks – Analysis of deep seated Geological Structures and faults - Detection of soil tonal anomalies using hyperspectral data. **12 hrs**

Unit:5. Offshore Oil Exploration: Offshore Drilling Overview – Understanding and mapping offshore regions - Major offshore oil and gas fields of the world & India - Types of offshore drilling rigs –The Technology of Offshore Drilling - Subsea Production Systems – Effects on the marine environment. **10 hrs**

Unit 6: Current Contours: (Not for Final Exam only for Discussion): Latest trends in Petroleum exploration : Coal bed methane, shale gas, oil shale, gas hydrate and heavy oil.

Text books:

- Ahmed, T. (2010). Reservoir engineering handbook. Elsevier, 4ed.,
- Bhagwan Sahay, Petroleum Exploration and Exploitation Practices, Allied Publishers
- Laake, A. (2022). Remote Sensing for Hydrocarbon Exploration, Springer
- Levorsen A.I. (1985). Geology of Petroleum, CBS Publishers and distributors, 2nd ed.,
- Tissot, B.P. and Welte, D.H. (1984). Petroleum formation and occurrence. Springer-Verlag

Course Outcomes:

- To apply geological and remote sensing methods for oil exploration
- Skills in basin analysis, interpreting borehole data
- Acquire knowledge in offshore exploration for oil

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0702	Engineering geology	3	25	75	100

Objectives:

- To study the principles of Engineering Geology
- To study the role of Geology in Engineering Projects
- To understand the site selection for Dam, Tunnel and
- To understand the Site suitability analysis based on Geological consideration
- To learn the Foundation engineering
- To understand the Coastal engineering and Geotechnical Engineering

Unit I: Role of Geology in planning, designing and construction of engineering structures – Engineering properties of rocks and soft sediments - stresses in rocks - modulus of elasticity, deformation – Poisson's ratio and their measurement. Geotechnical Significance of soils: Glacial – alluvial - Aeolian deposits – organic deposits – residual soils. Soil mechanics - soil classification **12 Hrs.**

Unit II: Dams and reservoirs engineering (types of dams, dam foundation rock problems) - Geotechnical evaluation of tunnels (types of tunnels; methods of tunneling; classification of ground for tunneling purposes) - Aseismic design of building - influence of geological causes for failures of engineering structures **12 Hrs.**

Unit III: Geoinformatics in roads, bridges, culverts and ghat roads: Site suitability evaluation - (Lithological, structural, Geomorphologic considerations) Site specific recommendations. **12 Hrs**

Unit IV: Foundation Engineering: Penetration tests (SPT and SCPT) - Bore log report – Data interpretation - strength parameters and Liquefaction potential - Selection of foundation based on soil condition Earth pressure on retaining walls of simple configurations-Stability analysis of retaining walls. **6 Hrs.**

Unit V: Coastal Engineering and Offshore Engineering : Distribution of long shore currents and Sediment transport rates in Surf zone- Coastal erosion, Planning and methods of coast protection works - Design of shore defense structures- Case studies on coastal erosion and protection **6 Hrs.**

Unit VI: Geotechnical Engineering: Nature of Soil- Phase relationships- Classification for Engineering Purpose- Index properties of Soils- Shear strength (Pore pressure, parameters, cyclic mobility, liquefaction) Slope stability (slope failure mechanics, Infinite and Finite slope) - Stress analysis for Saturated Clay. **12 Hrs**

Course Outcome:

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

- To study the Geology to select the type of foundation required
- Apply the field geology type and structure for site suitability study
- Geotechnical study for selection of foundation
- Slope stability model based on soil property
- Coastal protection measures for planning and protection

References:

1. Maslov N.N., Basic Engineering Geology and Soil Mechanics, Mir Publishers Moscow, 1987.
2. Blyth, F.G.H. and De Freitas, M.H, A Geology for Engineers, Elsevier, 7th Edition.
3. Shiv N.Pandey, Principles and Applications of Photogeology, Wiley Eastern Limited, India, 1987.
4. Girija Bhushan Mahapatra, A Text Book of Geology, CBS Publishers & Distributors, New Delhi, 1987.
5. Ravi P. Gupta, Remote Sensing Geology, Springer (India) Private Limited, Akash Deep Building, Barakhamba Road, Second Edition, New Delhi, 2003.
6. Burrough, P.A Principles of Geographical Information Systems for Land Resources Assessment, Clarandone Press, Oxford, 1986.
7. Murthy.V.N.S, Soil Mechanics and Foundation Engineering, CBS Publishers distribution Ltd., New Delhi

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0703	Practical: Engineering Geology	2	40	60	100

Objectives:

- To acquire skills in the interpretation of bore hole logs
- To acquire knowledge in the correlation of bore hole data
- Skills in the usage of GIS for various engineering geological problems

Syllabus:

Unit:1. Stratigraphic correlation of the subsurface from bore hole data **10 hrs**

Unit:2. Delineating the reservoir and determining Oil-Water contact from borehole data **9 hrs**

Unit:3. Drawing isolines of the productive formation using bore hole data **9 hrs**

Unit:4. Interpretation of Remote Sensing Data for Geothermal Zones **6 hrs**

Unit:5. Mining Practical **6 hrs**

Unit:6. GIS based slope mapping **6 hrs**

Unit:7. Geoinformatics in alignment of tunnels **6 hrs**

Unit:8. Geoinformatics in site selection for dams and reservoir **4 hrs**

Unit:9. Geoinformatics in Ghat road alignment **4 hrs**

Unit:10. GIS based 3D analysis of subsurface for foundation engineering. **4 hrs**

Unit:11. Current Contours: (Not for Final Exam only for Discussion):

Groundwater quality – determining water quality from geochemistry

Course Outcomes:

- Understanding the utility of bore hole data for various petroleum geological problems
- Estimating the reservoir
- Capacity to use the GIS for engineering geological problems

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0704	Geoinformatics in Disaster Management	3	25	75	100

Objectives:

- To study the Earthquake, Plate Tectonics, Neo-Active Seismo tectonics
- To study the Landslides and Slope Stability
- To learn the various types of coastal disaster management and mitigation
- To learn the causes and remedial measures for flood
- To understand the volcanic, glacial and environmental disasters

Syllabus:

Unit:1. Earthquake Plate Tectonics, Neo-Active Seismo tectonics: Introduction to geohazards, classification of natural disasters- Earthquake and its causes, Elastic rebound theory, plate tectonics and earthquakes, earthquake belts of the world, fault associated earthquakes - types and nature of seismic waves - intensity and magnitude of earthquake - Warning and prediction of earthquake, Remote Sensing techniques in warning and prediction of earthquakes - Neo-Active Seismotectonics, mapping of Lineament anomalies – Geomorphic anomalies (Tectonic, Denudational, Fluvial, and Coastal) -Geophysical anomalies -Groundwater anomalies - historic seismic data analysis. **12hrs**

Unit:2.LandslidesandSlopeStability: Mass wasting, morphology and classification of Landslides – Causes and triggering factors of landslide: geomorphological, geological, hydro-meteorological parameters - Remote Sensing and GIS based Landslide Hazards Zonation Mapping: Integrated Land system Analysis, Information Value, Weight of Evidence, Index Overlay and Bureau of Indian Standard (BIS) Methods - Mitigation Strategies.

12 hrs

Unit:3. Coastal disasters: Tsunami: Causes of Tsunami - Characteristics of Tsunami wave, velocity and speed of Tsunami – Tsunami generation belts of world- Causes of 26th December 2004 Indian Ocean Tsunami - Tsunami propagation and inundation models: Method of Splitting Tsunami (MOST) Model - tsunami inundation and run up mapping - offshore configuration vs tsunami run up - coastal geomorphology vs tsunami inundation - Mitigation strategies. **Other Coastal Hazards**: Coastal Erosion - Saltwater intrusion- Global warming and Sea level rise - Remote Sensing and GIS based coastal vulnerability mapping.

12hrs

Unit:4. Flood: Definition, types and causes of flood - controlling factors of flood - Remote Sensing and GIS in flood mapping, prediction, warning, monitoring, flood preparedness, relief and rescue action, flood mitigation -Run-off Estimation: Soil Conservation Service (SCS) method - Flood scenario of India and Tamil Nadu – Remedial strategies.

Drought: Causes and types, Meteorological drought, Hydrological drought, Agricultural drought, Socio-economic drought, drought indices and drought detection- Remote and GIS in prediction, warning, mapping and management of drought.

12hrs

Unit:5. Other Geohazards. Volcanic hazards: Nature of volcanic hazards, Factors determine violence of volcanic eruption - volcano exclusivity index - role of remote sensing in prediction and fore warning of volcanic eruption. Glacial: Types of glacial hazards - Remote Sensing and GIS in glacial hazards mapping and mitigation- Formation and types of Cyclones – forewarning of cyclone – Geoinformatics in cylone prediction and management studies

-12 hrs

Unit:6.CurrentContours: Major disasters of India; Major disasters of Tamil Nadu; Disasters of Western Ghats, central plains and coastal region of Tamil Nadu; Principles and development of disaster management support system.

References:

1. Chouhan.T.S., Joshi,K.N., Applied Remote Sensing and Photo Interpretation, Vigyan Prakashan,1996.
2. Chouhan,T.S., Joshi,K.N., Readings in Remote Sensing Applications, Scientific publishers,1992.
3. Ramasamy,SM., Remote Sensing in Geology, Rawat Publishers
4. Ramasamy,SM., RemoteSensing in Geomorphology, New India Publishing Agency, New Delhi, 2005.
5. Ramasamy, SM., C.J. Kumanan. The Indian Context -Allied Publishers, Chennai.
6. Ramasamy, SM., C.J.Kumanan, Sivakumar, Bhoop Singh, Geomatics in Tsunami, New India, Publishing Agency, New Delhi.
7. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, NewDelhi, 2007.

Course Outcomes

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

- Nature of various natural disasters
- Role of Geoinformatics in disaster management and mitigation.
- Where the earthquake, landslide, tsunami, volcanic eruption, etc. occur.
- Preparation of disaster management plans.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0705	Spatial analysis and applications / Spatial data modelling	3	25	75	100

Objective:

- This course aims to provide students with the knowledge and skills necessary to investigate the spatial patterns which result from social and physical processes operating on or near the Earth's surface.
- spatial autocorrelation, network connectivity, interpolation and geostatistics, and the suitability of GIS as a framework for spatial analysis are examined.
- The focus is on understanding the theories and context of spatial analysis and modeling so that you are equipped to find and apply the best analytical tool for your problem and to correctly and appropriately interpret and present your results.

UNIT I- INTRODUCTION TO SPATIAL DATA ANALYSIS: Introduction to Spatial data representation – discrete Euclidean plane/ geometric domain/ discretization of arcs – spatial object domain: vector data models: spaghetti, arc – node , DCEL – field based model: tasseled representation, triangulation, Voronoi, Delaunay triangulation – geometric algorithms, topological and set based algorithms – network analysis, traveling salesperson algorithm.

UNIT II- SPATIAL DATA MODELLING: spatial analysis: interpolation methods, deterministic, stochastic, enstatites, spatial autocorrelation, semi-variogram, kriging, types of kriging – uncertainty and its assessment.

UNIT III- SPATIAL DATA ANALYSIS: Basic concepts of machine learning, inductive learning, decision tree learning, clustering, artificial neural networks, deep learning, Convolution neural network – accuracy assessment.

UNIT IV- SPATIAL PATTERN ANALYSIS: Kernel Methods: Introduction to metric space, vector space, normed space, inner product space – Learning theory – SVM for classification & regression; implementation techniques of SVM – kernel ridge regression; kernel density estimation; kernel PCA; kernel online learning - Random forest.

UNIT V- SPATIAL PATTERN RECOGNITION: Spectral Clustering – model based clustering, Expectation Maximization, Independent Component Analysis, Hidden Markhov models – Factor Analysis; introduction to Graphical models & Sampling Methods**.**

Text books:

1. Machine Learning for Spatial Environmental Data: Theory, Applications, and Software (Environmental Sciences: Environmental Engineering) 1st Edition Mikhail Kanevski,VadimTimonin,Alexi Pozdnukhov
2. Deep learning by Ian Goodfellow, Yoshua Bengio,Aaron Courville, MIT Press, 2016. 3 Neural Networks and Learning Machines (3rd Ed) by Simon Haykin, McMaster University, Canada,2008.

References:

1. Pattern Recogonition and Machine learning Christopher M Bishop 2006
2. Machine Learning, Tom Mitchell, McGraw Hill, 1997
3. GIS : A computing perspectives, Second edition by MichealWorboys and Matt Duckham CRC Press 2004
4. Geospatial analysis, 5th Edition – de Smith, Goodchild, Longley http://www.spatial analysisonline.com/html
5. Geostatistics for Environmental Scientists, Second Edition by Richard Webster and MargaratA . Oliver, John Wiley and Sons Ltd.

Learning Outcomes:

- On completion of this course, students should be able to: Plan, design and implement a spatial analysis and/or modeling investigation demonstrating the ability to select, apply and critically interpret appropriate methods for the analysis and/or modeling of geographical information.
- Explain how point patterns, including clustering, can be identified and understood as realizations of spatial processes.
- Discuss how linear feature concepts of length, direction and connection are represented and analyzed in networks.
- Outline the central role that spatial automation plays in spatial analysis and explain how it helps and hinders the use of current tools.
- Demonstrate how different concepts about nearness and neighborhoods result in a variety of interpolation and Machine learning methods that produce different results.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0706	Elective -VII	3	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0707	Elective -VIII	3	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	MTIGT 0708	Mini project in Geological Technology and Geoinformatics	3	25	75	100

SEMESTER VIII

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VIII	MTIGT 0801	Major Project in Geological Technology and Geoinformatics	13	25	75	100

Objectives:

- To learn the different application of Remote sensing and GIS in different industries.
- To understand the usage of different thematic maps in different field.

Course Outcomes:

Skill development for the students to prepare theme 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 modeling / GIS analysis / field survey / lab analysis etc.

SEMESTER IX

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0901	Hyperspectral Remote Sensing	4	25	75	100

Objectives:

- To study the principles of hyperspectral remote sensing
- To study the character and limitation of hyperspectral data
- To learn the preprocessing of hyperspectral data
- To learn the various classification techniques of hyperspectral data
- To understand the application of hyperspectral data in various fields.

Syllabus:

Unit:1. 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 Hyperspectral 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.

12 hrs

Unit:2. Hyperspectral data and Imaging sensors: Principles of operation, specifications of various sensors: Airborne (CASI, AVIRIS, HYDICE, DAIS, etc.) - 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 bandwidth, spectral 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. **12 hrs**

Unit:3. 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.

16 hrs

Unit:4. 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.

12 hrs

Unit:5. 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:6. 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 hyperspectral remote sensing.

References:

1. American Society of Photogrammetry, Manual of Remote Sensing (2nd Edition), ASP FallsChurch, Virginia, 1983.
2. Lillisand, T.M. and Kiefer, P.W, Remote Sensing and Image interpretation, John Wiley &Sons, New York.1986
3. Hord R. Michel, Remote Sensing Methods and Application, John Wiley and Sons.1986.
4. Alexay Bunkin & Konstantin Volia. K, - Laser Remote Sensing of the Ocean Methods &Publications. John Wiley & Sons, New York, 2001.

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

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0902	Thermal and Microwave Remote Sensing	4	25	75	100

Objectives:

- To study the principles thermal remote sensing
- To learn the interpretations and applications of thermal band
- To study the principles of microwave remote sensing
- To study about space borne radar remote sensing and the sensors
- To learn about the applications of microwave remote sensing

Syllabus:

Unit:6.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. **16 hrs**

Unit:2. 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. **12 hrs**

Unit:3. Microwave Remote Sensing: Basic principles - RADAR systems - SLAR operations - Antennas (receivers), Spatial resolution - geometric characters of SLAR imagery (Slant Range and distortion, relief displacement, parallax) - influence of earth surface features over Radar energy (geometry, electrical property, soils, vegetation, water, etc.) - interpretation of Radar imagery. **12 hrs**

Unit:4. Space borne Radar Sensing- Seasat - SIR - ERS-I - Radarsat - JERS - Elements of passive microwave remote sensing (sensors) - applications of LIDAR and ALTM. **12 hrs**

Unit:5. Applications of Microwave Remote Sensing: Applications of Microwave remote sensing in Earthquake study; Din-SAR, Sentinel, Surface and subsurface Lithological Mapping - Palaeo channel mapping. Seismotectonic, Landslip / Lanslide and Land subsidence studies; SAR Interferometry and its Geological applications. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Change Detection Analysis: Urban Heat Island, Sea surface Temperature Mapping, Land Surface Temperature Mapping- Mapping of hard rock fracture system. Microwave Remote Sensing: Mapping of subsurface lithology.

References:

1. American Society of Photogrammetry, Manual of Remote Sensing (2nd Edition), ASP Falls Church, Virginia, 1983.
2. Curran, P. Principles of Remote Sensing, Longman, London.1985.
3. Barrett, E.C. and L.R. Curits, introduction To Environmental Remote Sensing, Halstged Press, Wiley, New York.1976.
4. Lillisand, T.M. and Kiefer, P.W, Remote Sensing and Image interpretation, John Wiley&Sons, New York.1986.
5. Lintz, J. and Simonett L.S. (Eds.), Remote Sensing of Environment, Addition-Wesley, Readings, Mass.1976.
6. Lo. C.P. Applied Remote Sensing, Longman, London.1986.
7. Richadson, B.F.Jr.(Ed), Introduction To Remote Sensing of The Environment, Kendall / Hunt, Dubuque, Iowa.1978.
8. Sabins, F.F.Jr., Remote Sensing Principles and interpretation, Freeman, Sanfrancisco.1978.
9. Schanda,E. (Ed), Remote Sensing for Environmental Science, Springerverlag.1976.
10. Burney, S.S Application of Thermal Imaging, Adam Hilger Publications.1988.
11. Hord R.Michel, Remote Sensing Methods and Application, John Wiley and Sons.1986.
12. Drury S.A, A Guide to Remote Sensing - interpreting Images of Earth, Oxford Science Publications, Oxford.1990.
13. Floyd M. Henderson; Principles & Applications of Imaging Radar, John Wiley & Sons, New York, 1998.
14. Alexay Bunkin& Konstantin Volia. K, - Laser Remote Sensing of the Ocean Methods & Publications. John & Wiley & Sons, NewYork, 2001.

Course Outcomes:

- Students will learn about the difference among reflection, scattering and emission from earth materials.
- Students will understand the principles of thermal and microwave remote sensing.
- Students will come to know the applications of thermal and microwave remote sensing.
- Students will learn about application of microwave remote sensing in earthquake field.
- Students will understand the LIDAR and ALTM applications
- Students will also learn about application of microwave data in subsurface lithological mapping.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0903	Practical: Hyperspectral, Thermal and Microwave Remote Sensing	2	40	60	100

Objectives:

- Understand character and limitation of hyperspectral, thermal and microwave data
- Hands on exercise on preprocessing of hyperspectral data
- Classification techniques in hyperspectral data
- Application of hyperspectral, thermal and microwave data

Syllabus:

Unit:1. Atmospheric correction of hyperspectral Data.

Pre-processing of hyperspectral data, MNF, PPI, n-Dimensional Visualizer and end members collection **9 hrs**

Unit:2. Classification of Hyperspectral images: Spectral Angle Mapper - Support Vector Machine - Spectral Feature Fitting Spectro radiometric measurements of important minerals in hyper spectral ranges **9 hrs**

Unit:3. Spectro radiometric measurements of soil, water, plants/leave stock in hyperspectral ranges Interpretation of thermal imagery for geological mapping Interpretation of day and night thermal imagery Interpretation of heat loss from day time thermal data **9 hrs**

Unit:4. Interpretation of microwave imagery in geology Interpretation of ERS, Radarsat and SIR data **6 hrs**

Unit:5. Generation and interpretation of SAR Interferograms Interpretation of LASER Remote sensing data **4 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Case studies in hyperspectral remote sensing, thermal and microwave remote sensing

Course Outcomes:

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

- 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
- Understand the significance of thermal and microwave in various fields

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0904	Geoinformatics in Urban Planning	4	25	75	100

Objectives:

- To introduce the relevance of Geoinformatics to Urban Planning and Management
- To expose recent developments in Geoinformatics for Urban Planning and Management
- To sensitize the importance of Inclusive urban planning towards sustainable development

Syllabus:

Unit:1. 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. **9 hrs**

Unit:2. 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.**9 hrs**

Unit:3. 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 Modeling – Urban Landuse and Land cover Classification – Change Detection – Urban Heat Island Urban Air quality mapping - Noise pollution modeling - 3D City Modeling – Flood Modeling in Urban Areas - Geoinformatics for Smart Cities. **9 hrs**

Unit:4. 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. **9 hrs**

Unit:5. 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. **9 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Smart Cities Concepts: challenges facing urban environments - frames and attributes of a smart city.

Text book

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

Reference

1. Jean- Paul Donnay, Michael John Barnsley, Remote sensing and urban analysis, 1st Edition, Taylor & Francis e-Library, 2005
2. Qihao Weng, Dale A. Quattrochi (Eds), Urban Remote Sensing, 1st edition, CRC Press, 2006

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 land use scenarios

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0905	Geoinformatics in Coastal Dynamics and Coastal Management	4	25	75	100

Objectives:

- **To get familiarized in the basic coastal zone processes and coastal dynamics**
- **Understand the various environmental problems affecting the coast / offshore areas**
- **To acquire knowledge in the applications of remote sensing in Coastal zone management.**
- **To acquire skills as efficient Coastal Zone Managers and apply knowledge in the sustainable development of the coast.**

Syllabus:

Unit:1. Coastal morphodynamics and geomorphology: coastal morphodynamics and coastal engineering problems – Quaternary coastal evolution – tectonic controls of the coast – Sea level fluctuations and coastal evolution – Sediment deposits along the coast – Sediment variation – gravely, sandy, muddy coast – coastal morphodynamic processes – Fluvial, wave, tidal processes and delta development. Constructional and destructional landforms (in emerging, submerging, neutral and compound coasts) - Manifestations of coastal landforms (in the field, aerial photographs and satellite images). **12 hrs**

Unit:2. Environmental Concerns: Environmental Concerns - Characteristics of Pollution – Suspended Sediments - Oil pollution and Industrial wastes - Sewage discharges - Toxic algal blooms - Eutrophication - Thermal discharge - Human Impact. **12 hrs**

Unit:3. Remote Sensing Applications for Coastal management : Remote sensing in Coastal zone management - Mapping Coral Reefs, Mangroves – Shoreline changes - Coastal geomorphology – Coastal land use and Land cover. **12 hrs**

Unit:4. Principles of Integrated Coastal Zone Management: Basic principle, major issues/problems Database management, Socio-economic and Legal aspects of Coastal Zone Management: Stake holder identification, Protocols in management of Ocean, Coastal seas and Lands, Legal controls which affect use of National coastal zones, Laws on coastal regulation zone. **16 hrs**

Unit:5. Integrated Coastal Zone Management Applications: The ICZM development process: Demonstration, Consolidation, Extension, Coastal Bio-diversity, Coastal environmental impact assessment, Resource allocation conflict, Sustainable development, case studies **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Indian legislations for coastal environmental protection - environmental policy – Rio conventions –Jakarta Mandate – wetlands - Ramsar convention – Future of ICZM.

Text books :

1. Bosboom, J. and Stive, M.J.F. (2021). Coastal Dynamics, Delft University of Technology

2. Barman, N.K, Chatterjee, S. and Paul, A.K. (2016). Coastal Morphodynamics: Integrated Spatial Modeling on the Deltaic Balasore Coast, India, Springer

3. Thornbury, W.D (1985). Principles of Geomorphology (2nd Edition) John Wiley and Sons, New York

4. 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.

5. 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.UNESCO, Paris. 2000.

6. Lundin CG, (1996). Guidelines for integrated coastal zone management. World bank environmentally sustainable development series

Course Outcomes:

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

- Apply knowledge in solving various issues affecting the coastal environment
- Ability to mitigate and solve any coastal zone management issues in an integrated manner.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0906	Elective -IX	4	25	75	100

sem	Code	Course Name	Credit	Marks		
				I	E	T
IX	MTIGT 0907	Elective -X	4	25	75	100

SEMESTER X

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	MTIGT 1001	Satellite Meteorology	4	25	75	100

OBJECTIVE:

To impart knowledge in Concepts in Meteorology, Radio and Satellite Meteorology and its Applications

UNIT I

Introduction to Meteorology: Weather and Climate- composition of atmosphere- weather elements and characteristics - Global temperature, pressure and wind belts - scales of atmospheric processes, Land/Ocean Coupling, Vegetation types and climate, climatic classification, energy in the atmosphere - Indian monsoons - weather systems and seasons, Indian Climatology – atmospheric particles and radiations - Mechanism of cloud formation- Types of Clouds- Precipitation processes-weather stations, data, maps and symbols.

UNIT II

Radar Meteorology: Principles and classifications of Radar- Meteorological Applications of radar – atmospheric sounding - Wind estimation through Radar - Doppler techniques for precipitation estimation – Precipitation Radar (PR) - Global Precipitation Measurement (GPM), Ozone soundings – principle and satellite measurements of ozone – Aerosol soundings Tracking of weather Thunderstorms, Tropical cyclones, Tornadoes through Radar – Hydro meteorological Applications of Radar - Applications to aviation meteorology – TIROS Operational and Vertical sounder – Retrieval methods and algorithms.

UNIT III

Satellite Meteorology Missions: Brief History of Satellite Meteorology, Orbital dynamics of satellite – Polar and Geostationary weather satellites - Active and passive sensors (Radar / Lidar / Radiometery, scatterometer and altimeter) - Absorption bands of atmospheric gases - Design and characteristic of different types of sounders and imagers used in Meteorological satellites – Viewing geometry - INSAT Meteorology - Data Processing System (IMDPS), IRS series – APT – AVHRR - Need for Remote Sensing techniques in weather forecasting and Numerical Weather Prediction (NWP) - imaging and non-imaging techniques in Meteorology.

UNIT IV

Meteorological Applications : Precipitation – soil moisture - estimation and their Applications – Normalised Difference Vegetation Index – Ocean Colour monitoring – Coastal zone mapping - Satellite communication systems in operational meteorological Applications (Cyclone Warning Dissemination system / Automatic Weather stations – Meteorological data dissemination) - Estimation of snow and ice cover – Water body boundary mapping – aerosols – Dust storms and Volcanic ash clouds and fires – maritime, dwelt, floods and agriculture.

Unit V

Global and sub global metrological events – tracking of large weather system – Cloud motion vector – wind direction and speed, Cylone Intensity estimation - storm surge estimation - Satellite soundings, Detecting Trace Gases in the Atmosphere, Biomass Burning and Global Climate Change, Global Warming – Sea level changes and Consequences.

Outcome:

- Impacts the knowledge about basis of Meteorology
- Acquire knowledge about radar techniques in Meteorology
- Understand the knowledge about platforms and sensors used in Meteorology
- Develops knowledge about the remote sensing for Meteorology
- Gives solutions to manage critical meteorological events.

REFERENCES:

1. Kidder and Vonder Harr, "Satellite Meteorology: An introduction", Academic Press, San Diego, CA, 2008
2. Arthur P. Cracknell, "The Advanced Very High Resolution Radiometer (AVHRR)", 1997, CRC Press, ISBN: 9780748402090.
3. Asnani, G.C "Tropical Meteorology", Vol. I and II, 3rd Edition, 2016.
4. Richard J. Doviak, Dusan S. Zrnic, "Doppler Radar and Weather observations", Dover Publications;2014, ISBN: 978-0486450605
5. Ellingson, "Satellite Data Applications: Weather and Climate", Proc.of AO I Symp., COSPAR,
6. Birmingham, UK, Elsevier, MD, USA. Pergamon Pr; 1st Edition 1997
7. Sauvageot, 1992, "Radar Meteorology", Artech House Publishers, Norwood, MA. 1992
8. Hartwig Dobesch, Pierre Dumolard, Izabela Dyras, "Spatial Interpolation for Climate Data: The Use of GIS in Climatology and Meteorology", Wiley Publication, (2007 – Print), 2010 – Online)
9. Raghavan S. , "Radar Meteorology", Springer, 2003, ISBN: 9781402016042
10. Kelkar R.R. Satellite Meteorology, B S Publications, Hyderabad,2007
11. Satellite Meteorology: R.R. Kelkar, BS publication. Satellite Meteorology – An Introduction: S.Q. Kidder and Thomas H. V. Harr, Academic press.
12. Bringi, V. N. and V. Chandrasekar, 2001: Polarimetric Doppler Weather Radar: Principles and Applications, Cambridge University Press.
13. Doviak, Richard J. and Dušan S. Zrnić, 1993: Doppler Radar and Weather Observations, 2nd Ed, Academic Press.
14. Meischner, Peter (Ed.), 2004: Weather Radar: Principles and Advanced Applications, Springer-Verlag.

Sem	Code	Course Name	Credit	Marks		
X	MTIGT1002	Computer Programming in Geological Technology	4	I	E	T
				25	75	100

OBJECTIVES :

- To know the fundamentals of computer programming.
- To facilitate the student to develop Object Oriented Programming
- The open source options are for research and development.It helps the candidate to think creatively and independently in Geoinformatics project implementation. It also gives complete freedom to modify the software to suit the needs. The course exposes to major avenues of opensource opportunities.

Unit 1: R Programming basics

Introduction, Data types, Variables, Vectors, Scalars, Conclusion, Data Frames, Lists, Matrices, Arrays, Classes, Arithmetic and Boolean Operators and values, Structures, Control Statements, Loops, Recursion, Scoping Rules, Loop functions, Array and Matrices, Spatial programming- R environment and R spatial-standards in GIS documents. **12 hrs**

UNIT 2: Python for GIS: Goeprocessing with Python, Importing -, use of built-in tools, setting environments, tool messages, working with vectors and its geometries, raster data handling, batch processing, Map automations, Working with toolbox, model builders and development of graphical user interfaces (GUI), development of Python addins. **14 hrs**

Unit3: Concepts of Object Oriented Programming

Object Oriented Methodology: Introduction, Advantages and Disadvantages of Procedure Oriented Languages, what is Object Oriented? What is Object Oriented Development? Object Oriented Themes, Benefits and Application of OOPS. **Principles of OOPS:** OOPS Paradigm, Basic Concepts of OOPS: Objects, Classes, Data Abstraction and Data Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Passing- Object Oriented GIS-Object Oriented Analysis-Object Oriented Design–Examples. **12 hrs**

Unit4:Python OOPs Concept

Python : Classes and Objects, Methods, Constructors – Inheritance, Polymorphism, Data Abstraction , Encapsulation – Database Access – Error Handling –Examples. **12 hrs**

Unit5: Open Source Software and Services

Introduction : OS Remote Sensing software - Desktop Systems - MapServers and Web Services (GeoServer and MapServer)- Embedded scripts for GIS services - Geo Statistical operations and Open Statistical tools **14 hrs**

Unit:6.CurrentContours:(NotforFinalExamonlyforDiscussion): ObjectOriented programming in the field of geotechnology- Apply the Open source programming for analysis of spatial and non- spatial data and for visualization

REFERENCES:

1. Timothy Budd, Introduction to Object Oriented Programming, Addison-Wesley, 2001.
2. Mike O.Docherty, Object oriented analysis and design, John Wiley and sons, 2005.
3. Mapserver - Opensource GIS Development - BilKropla - Apress - 159069-490-8 - 2005.
4. The GeoSpatial Desktop Open source GIS and Mapping - Gary Sherman
5. Gary E Sherman, Desktop GIS: Mapping the Planet with Open Source Tools, Pragmatic Bookshelf publication 1 edition,2008, ISBN-10: 1934356069
6. DavidI. Schneider, Introduction to Programming Using Python,1st Edition, Pearson, ISBN:9780134058221, 2016
7. 4. LawheadJoel, QGIS Python Programming Cookbook,2ndRevised Edition,Packet Publishing, ISBN:9781783984985,2017.
8. Chaowei Yang, Introduction to GIS Programming and Fundamentals with Python and ArcGIS, 1stEdition, CRC Press, ISBN:9781466510081

OUTCOMES:

- Fundamental of Computer Programming
- Acquire skills in Object Oriented Programming and Problem Solving
- Understand the important of Open source technology in GIS and various options available in its implementation.
- Acquire skills in using open source software along with the principles of handling licenses and source code modification.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	MTIGT 1003	GIS Based 3D Visualization in Geological Technology	4	25	75	100

Objectives:

- To learn the fundamentals of 3D visualization in GIS
- To study the possible methods of visualizing various Geological data
- To understand the ways and means of representing topographic relief in a 3 dimensional pattern
- To learn the methods of generating 3D images and interpretation of important geological structures using Geophysical data
- To learn the application of Geoinformatics in natural disaster mitigation.

Syllabus:

Unit:1. Principles of 3D Visualization: Data Input (x, y, z) – Monoscopic and Stereoscopic 3D visualization; TIN - Vertical Exaggeration - DEM based visualization - Concepts of Shaded Relief mapping. **12 hrs**

Unit:2. 3D Visualisation of Topographic Data: Generation of x, y, z data -3D visualisation of topography - DEM based topographic analysis - Shaded Relief Map - applications. **12 hrs**

Unit:3. 3D Visualisation of Geophysical Data: X, Y, Z data from different sources - Generation of DEM, Different processed outputs of DEM, Shaded relief maps of Gravity, Magnetic and Resistivity data - Its applications. **16 hrs**

Unit:4. 3D Visualisation of Subsurface Lithology: Collection of borehole data - working out lithology and lithotop of various horizons -DEM of shaded relief of thickness of various formations, Depth of various formations and litho top of various formation -their interpretations. **12 hrs**

Unit:5. 3D Visualisation of Groundwater: Collection of water level and other aquifer variables (Transmissivity, Permeability, Storage co-efficient, etc.) -Generation of x, y, z -Generation of DEM and shaded relief of groundwater systems and interpretation. **12 hrs**

Unit:6. **Current Contours: (Not for Final Exam only for Discussion):** Step-by-step procedures for generation of high resolution DEM using CARTOSAT Stereo data; Derivation DEM products like Anaglyph and 3D Fence Diagram. Use of DEM for automated mapping of Geological Structures in GIS.

References:

1. Burrough, PA., Principles of Geographical Information Systems, Oxford University Press,1997.
2. DeMers, Michael N, Fundamentals of Geographic Information Systems, John Wiley andSons, 1999.
3. David J., Bringing Geographical Information Systems into Business, Second EditionGrimshaw, John Wiley and Sons, 1999.
4. Christian, Serving Maps on the Internet: Geographic Information on the World Wide WebHarder, ESRI Press, 1998.
5. Graeme F. Bonham-Carter, Geographic Information Systems for Geoscientists: Modellingwith GIS, Pergamon Publications, 1994.
6. Sabins, F.F.Jr., Remote Sensing Principles and Interpretation, Freeman, Sanfrancisco. 1978.
7. Lillisand, T.M. and P.W. Kiefer, Remote Sensing and Image Interpretation, John Wiley &Sons, New York, 1986.

Course Outcomes:

After the successful completion of this course, the students are able to:

- Understand the concepts, develop GIS database and generate 3D visualization of Geologicaland other terrain features
- Know the fundamentals pertaining to volume estimation, drainage mapping, watersheddelineation, slope classification using 3D visualization techniques
- Learn the method of 3D visualization of topographic data
- Understand the method of visualization of Geophysical data and their application
- Learn the method 3D visualization of subsurface lithology and its applications
- Understand the method of 3D visualization of groundwater and its applications.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	MTIGT 1004	Remote Sensing Application in Planetary Studies	3	25	75	100

Objectives:

- To understand the origin of universe, solar system, planets, etc.
- To learn remote sensing application in planetary studies
- To study the geology of planets
- To learn the landscape, rock types and surfacial processes of moon
- To study the past, present and future planetary exploration mission

Syllabus:

Unit-1. 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. **9hrs**

Unit-2. 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. **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-3. **Planetary interiors:** Interior of terrestrial planets, Mercury, Venus, Earth and Mars - Interior of the jovian (Gas) Planets, Jupiter, Saturn, Uranus, Neptune – 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. **12 hrs**

Unit-4 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. **9hrs**

Unit-5 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. **9hrs**

References

1. Taylor, Stuart Ross. Planetary science: a lunar perspective. Vol. 3303. Houston: Lunar and Planetary Institute, 1982.
2. Faure, Gunter, and Teresa M. Mensing. Introduction to planetary science: the geological perspective. Springer Science & Business Media, 2007.
3. Saunders, R. Stephen, Robert G. Strom, and Don E. Wilhelms. The Geology of the Terrestrial Planets. No. NASA SP-469. National Aeronautics and Space Administration, 1984.
4. Greeley, Ronald. Introduction to planetary geomorphology. Cambridge University Press, 2013.
5. Lindsay, John F. "Lunar stratigraphy and sedimentology." Amsterdam, Elsevier Scientific Publishing Co.(Developments in Solar System-and Space Science, No. 3), 1976. 315 p. 3 (1976).
6. Wilhelms, Don E. "To a rocky moon-A geologist's history of lunar exploration." To a rocky moon-A geologist's history of lunar exploration University of Arizona Press, 497 p. (1993).
7. Schombert, J., Astronomy 121: The Formation and Evolution of the Solar System; 2006.
8. Heiken, Grant, David Vaniman, and Bevan M. French, eds. Lunar sourcebook: A user's guide to the Moon. CUP Archive, 1991.
9. Mendell, Wendell W. "Lunar bases and space activities of the 21st century." (1985).
10. French, Bevan M. "Traces of catastrophe: A handbook of shock-metamorphic effects in terrestrial meteorite impact structures." Technical Report, LPI-Contrib-954 (1998).
11. Planetary Landscapes, Allen and Unwin, Inc., Winchester, MA, 275 pp. Greeley, R., 1987.
12. Meteorites and the Early Solar System, Univ. Arizona Press, Tucson AZ, 1269 pp. Kerridge, J.F. and M.S. Matthews, editors, 1988.

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 mission

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	MTIGT 1005	Practical: Research methodology in GIS	2	40	60	100

Objectives:

- To understand the basic philosophy of science.
- To explain and develop relevant research methodology to solve a scientific problem.
- To bring a research work to the scientific community under stranded framework.
- To evaluate different tools for literature search discuss different presentation tools.

Unit-1: Research Types and Research Framework

Research and its types, which method—scientific, technological, or artistic, which Method—qualitative, quantitative or mixed, geoinformatics research method, scientific and critical thinking, research objective, review of literature, empiricism, rationalism, scepticism.

Unit-2: Research framework

Research framework, ontology, epistemology, research paradigm, methodology (inductive, deductive, technological) - Collection of data, factors influencing the selection of geoinformatics data, analysis of data, multi-concept of data collection and analysis, level of detail.

Unit-3: Sampling

Sampling and Population, Techniques sampling solution, Characteristics of good sample, Sampling error and method to reduce, Reliability and validity of various tools and techniques.

Unit-4: Research Design

Functions and features of research design, sampling design, observational design, analytical design, operational design -Hypothesis, Individual and Institutional - Research proposal: Format of Research Proposal and Research Question - Power/politics/ethics in research, corruptions of expert knowledge, personal and professional ethics

Unit-5: Documentation and Research

Research paper – Dissertation - Thesis - Referencing style, guidelines on writing and presentation Review and submit a research paper in Remote Sensing & GIS Field

Course Outcomes:

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

- Knowledge and understanding account for basic philosophy of science.
- explain and develop relevant research methodology (e.g. testing of hypothesis) to solve a scientific problem.
- evaluate different tools for literature search discuss different presentation tools.
- use tools for literature search plan a scientific work based on applicable theories.
- use chosen presentation tools for conveyance of scientific information.

Reference books

1. Kothari C.R. (2019), Research Methodology : Methods And Techniques, New Age International Publishers

2. Ahuja Ram (2001), Research Methods, Rawat Pubns

3. Bryman Alan (2018), Social Research Methods 5e Xe, Oxford University Press

4. Kumar (2005), Research Methodology: A Step by Step Guide for Beginners, 2e, Pearson Education

5. Napolean D. (2014), Research Methodology: A Theoretical Approach, Laxmi Publications

6. Chitnis K.N. (2006), Research Methodology in History, Atlantic

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	MTIGT 1006	Elective -XI	4	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	MTIGT 1007	Elective -XII	4	25	75	100

GEOINFORMATICS IN CLIMATE CHANGE STUDIES

Course Code: MTIGT1007 **Credits: 4**

Objectives:

- To demonstrate the understanding of the climate system.
- To evaluate the various factors that shape climate.
- To describe how past climates contribute to our current understanding of climate change.
- Explain the consequences, risks, and uncertainties of climate change.
- Understand the different modeling approaches, their scope and limitations and wide range of applications of modeling in climate scenario

1. **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 – driver's of climate change – Impacts of Climate change. **16 Hrs**
2. **Green house effect and Global Warming:** Global carbon budget – Soil carbon – Carbon cycle – Biophysical and Human component carbon cycle – High arctic carbon sink – Green house effect (Green house gas emissions) Effects of global warming (an Terrestrial and agnatic Ecosystems, Biogeochemical cycling, C02 concentrations, Nitrogen deposition, Ecological impacts, global dimming, Disease incidence, over water and lake productivity). **16 Hrs**
3. Multitemporal data analysis of Coastal, Riverine, Glacier and Mountain System. **12 Hrs**
4. **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. **12 Hrs**
5. **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. **8 Hrs**
6. **Climate change scenarios:** 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 uncertainty, and the different levels of risk associated with different consequences. **8 Hrs**

Course Outcome:

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

1. Understand some of the potentially serious consequences of climate change.
2. Explore the uncertainties associated with these and other consequences.
3. Examine the concept of risk and the interplay of probability and severity of impact in determining risk.
4. Consider the work of a climate scientist advocating for action to combat the effects of climate change.
5. Development of models based on the Paleoclimate
6. Prediction of the impact on the extreme events
7. Predict and generate future conditions under various climate scenarios or management/preventive action alternatives

References:

1. Andrew M. Carleton, Satellite Remote Sensing in Climatology, CBS publishers & Distributors Pvt. Ltd., New Delhi, 1992.
2. Kumarasamy, K. Dr., Kamaraj, E.C. Dr., Anand, P.H. Dr. Samuvel Selvaraj, R Dr, and Kumar, V., Kalanilaiyal, Grace Publications, Kumbakonam, 2001.
3. Howard H.Chang, Fluvial Processes in River Engineering, John Wiley & Sons, New York, 1988.
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

SEMESTER XI

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1101	Sedimentary basins of India	4	25	75	100

Objectives:

- To understand the origin and evolution of of different types of basins, etc.
- To understand the geological significance of basins
- To study basin tectonics
- To learn the different sedimentary basins of India

Syllabus:

UNIT I Basins Classification and Depositional Environments: Tectonic Basin Classification, Tectonics and Basin Filling, Basin Morphology and Depositional Environments.

Basin Evolution and Sediments: Rift basins, Continental Margin and Slope Basins, Intra continental Sag Basins. Deep-Sea Trenches, Foreland, Back arc and Retro arc Basins, Remnant and Foreland Basins, Collision -Related Basins, Pull-Apart Basins, Basin- Type Transitions (Polyphase Basins). **16 hrs**

UNIT II Basin mapping methods: Structure and isopach contouring, Litho facies maps, Geophysical techniques, Clastic petrographic data, Computer mapping methods, Stratigraphic cross sections, Palaeo current analysis, Remote sensing.

Depositional systems and sequence stratigraphy: Stratigraphic architecture, Non marine depositional systems, Coastal depositional system. Clastic shelves and associated depositional systems, Carbonate and evaporate depositional systems, Clastic depositional systems of the continental slope, rise and basin plain, Sequence stratigraphy. **12 hrs**

UNIT III Sedimentary basins of India-I Stratigraphy, Structure and Tectonics of Onshore and Offshore Sedimentary basins of East Coast of India with special reference to- Bengal Basin -Mahanadi - Krishna - Godavari and Cauvery Basins. **10 hrs**

UNIT IV Sedimentary basins of India-II Stratigraphy, Structure and Tectonics of Onshore and 0ffshore Sedimentary basins of West Coast of India with special reference to Kutch - Saurastra - Narmada - Cambay Bombay high, Kerala - Konkan Offshore Basins. **16hrs**

Unit:5. Stratigraphy, Structure and Tectonics of other Sedimentary basins of India with special reference to Cuddapah - Vindhyan -Rajasthan - Assam shelf -and Himalayan foot hill Basins. **10 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Major sedimentary basins of world; Basins tectonics; resources and hazards potential of various sedimentary basins of India.

Text books:

1. Einsele G 1992 Sedimentary Basins. Springer Verlag.
2. Miall A 2000 Principles of Sedimentary Basin analysis.
3. Sengupta S 1997. Introduction to Sedimentology oxford -IBH.
4. Petrol ferrous Basins of India, ONGC, Petroleum Asia Journal.

Course Outcomes:

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

- The evolution of sedimentary basins over the geological period
- The geology of the basins
- The role of remote sensing in basin analysis
- The significance of Indian sedimentary basins

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1102	**WEB GIS & Mobile mapping**	4	25	75	100

Objectives:

- Provide students with a comprehensive and up-to-date overview of Web GIS, including the basic concepts, principles, related fields (e.g. mobile GIS) and frontiers
- Inspire students with the broad and real-world applications of Web GIS,
- Provide students with the state-of-art technical skills to build Web GIS applications and the knowledge needed to choose from various WEB GIS development options

Syllabus:

UNIT I **WebGIS** - Introduction to Internet and GIS – Web GIS architecture and Components –Mobile GIS- Distributed WebGIS - Real time Applications. **9 hrs**

UNIT II **Scripting Language Programming for Web-I** - Introduction to Scripting Languages – Comparison of scripts - Java Script -Constructs -Usage of scripting constructs in web designing- C# - Constructs - Usage of scripting constructs in web designing- Type Scripts – Constructs - Usage of scripting constructs in web designing. **18 hrs**

UNIT III **Programming Language for Web Applications**: Revolutionary new approach to dynamic web programming through ASP.NET -Server-side controls - Validation controls -Database connectivity to websites through data control. **18 hrs**

UNIT IV **Distributed WEB GIS and GeoServer**: Distributed WEB GIS concepts – Internet Mapping – Fundamental concepts of Mobile GIS –ODK- GeoServer – Introduction – GeoServer loading and working with data and directory – security – case studies on GeoServer. **9 hrs**

UNIT V **ArcGIS Server ArcSDE** - ArcGIS Server and Architecture- Web Application Functionality-GIS Web Service - ArcSDE: Introduction, SDE Connection, Configuration Options. SDE for Developers Data Storage: SDE Geodatabase - ArcSDE Architecture. Utility GIS: Ericson network engineering software, Arc FM, APDRP, Enterprise GIS, ArcGIS online - GIS Server: GIS Client -Server Architecture - Web Application Functionality-GIS Web Service. Introduction to spatial database connection, Blogs, Images and Geometrics for data storage, Enterprise GIS, Online GIS. **9 hrs**

UNIT VI **Current Contours**: (Not for Final Exam only for Discussion): Create A web application supporting spatial analysis.

References:

1. Thomas A. Powell, Web Design -The Complete Reference, Tata Mc Graw Hill, 2000.
2. Peng Z.R. and Tsou M.H, Internet GIS -Distributed Geographic Information Services for the Internet & Wireless Network. John Wiley & Sons. Inc. New York. 2003
1. 1. Roland Billen, Elsa Joao, David Forrest (2006): Dynamic and Mobile GIS: Investigating Changes in
2. Space and Time, CRC Press
3. 2. Zhong-Ren Peng, Ming-Hsiang Tsou, Peng (2003): Internet GIS: Distributed Geographic Information
4. Services for the Internet and Wireless Networks, John Wiley & Sons
5. 3. Jonathan Raper (2008): Mobile GIS: The Arcpad Way, Esri Pr; Illustrated edition

Course Outcomes:

After completing this course, students will be able to:

- Explain what Internet mapping is, how it works, and what it can do,
- Understand and apply the basic principles of web page development,
- Work with simple Google and ESRI products to share spatial data and maps,
- Understand how to use and work with Arc GIS Server to create map services,
- Understand and explain the difference between Scripting languages
- Design, build and deploy a web-mapping application in your field of study - and document the process,
- Critically assess and critique web-mapping and geoserver applications in their field of study

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1103	Database Management Systems	4	25	75	100

Objectives:

- Knowledge of DBMS and SDBMS, both in terms of use and implementation/design
- Experience with SQL
- Experience with analysis and design of (DB)software

Syllabus:

Unit:1 Introduction - Data -Information – Database - File system Vs Database Management Systems (DBMS)- Advantage and Disadvantages of DBMS- Database Architecture: Classification of DBMS- Spatial Data- Points, Lines and Polygons – Non- Spatial Database concept– Data types – operations on spatial objects. **12hrs**

Unit:2. Spatial DBMS and Data models - Definition of Spatial Database Management systems (SDBMS)- GIS and SDBMS– Spatial Database design – Data Models – Types of Data models -Keys- Applications of Data models with spatial Concepts. 12**hrs**

Unit:3 Database Security and Recovery: Security and Integrity – Authorization – Granting Privileges - Recovery System: Failure Classification–Storage Structure–Advanced Recovery techniques.

10**hrs**

Unit:4 Concepts in SQL: Introduction to SQL **–** Types of SQL commands **–**Constraints –SQL Functions – Relational Operators (Union, Intersect, Joins)-Simple Queries & Nested Queries.

18hrs

Unit:5 Google Earth Engine: Introduction – Setting up the environment- Earth engine basics- Spatial data downloading. **12hrs**

Unit:6 Current Contours: (Not for Final Exam only for Discussion):

Data Warehousing and Mining- Classification-Association rules -Clustering- Information Retrieval-Relevance ranking -Crawling and Indexing the Web-Object Oriented Databases-XML Databases.

References:

1. Bipin C Desai, An Introduction to Database Systems, First Edition, Galgotia Publications Pvt.Ltd,1998.
2. Henry F korth&Abraham Silberschetz, Database system concepts, Mc Graw HillPublications.
3. Henry F Korth & Abraham Silberschetz, Database System Concepts.
4. Majumdarand bhattacharya, Database management system, Fourth Reprint, Tata McGraw hill Publishing, 1999.
5. Database Management Systems-Shubhi Lall, University Book House (P)Ltd.,79,Chaura Rasta, Jaipur-3,India,2001.
6. Kevin Loney, Rachel Carmicel: Oracle SQL & PL/SQL AnnotatedArchives,Tata McGraw hill.

CourseOutcomes:

- The ability to apply the concepts of engineering i.e collecting data, organize the data in the systematic form; arrange the data in a computational way and this the way in applying mathematics and geological applications.
- Able to design the database system due to inferring the knowledge
- Skills are developed while working for the project during academic calendar.

Sem	Code	Course Name	Credit	Marks		
XI	MTIGT1104	Query Based Information systems and Spatial Decision Support systems	4	I	E	T
				25	75	100

Objectives:

- To learn the concepts, components and importance of QUBIS & SDSS
- To know the methods of database generation and pre-processing of data for SDSS
- To study the methods of providing linkage with spatial and non-spatial data for SDSS
- To learn designing methods of main menu and related modules
- To learn the interface and programme development.

Syllabus:

Unit:1. Introduction to QUBIS and SDSS: Definition - Concepts – Multi criterion Approach - Customization of GIS tasks, Automation of Data Pre-processing, Manipulation, Analysis, Modeling and Post-processing - Usefulness. **6 hrs**

Unit:2. Designing and linking of Spatial and Non-spatial Database: Identification of Geographic features - Defining the storage parameters - co-ordinate registration - map projection - Transformation; Classification and Manipulations. Checking for errors and accuracy. Creation of database table file to hold the attributes - Adding up of description attribute values to table – Classification and Manipulations. Checking for errors and accuracy. **14hrs**

Unit:3 Linking of Spatial Database & with Non spatial Database: Verification of common item, availability and joining of attribute - table with existing spatial records - spatial display of non-spatial data. **8 hrs**

Unit:4. Programming Language: C # – Introduction to C# - Basics of C# - .Net Object and Architecture – Development and configuration of C# in QUBIS – Creating Database Connection **18 hrs**

Unit:5. Designing & Coding of QUBIS and SDSS: Planning for the user requirement - preparation of spatial & non-spatial relational databases - QUBIS and SDSS Designing - QUBIS and SDSS Coding (Testing, Error handling, Monitoring, User interface Development). **18 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Cloud data processing and handling images; Generation of high-resolution DEM using automation method. Operation modalities of Google Earth, BHUVAN and FEMA, Google Earth Engine.

REFERENCES:

1. Jeremiah Lindemann, Lisa Markham, Robert Burke, Janis Davis, Thad Tilton, Introduction to Programming Arc Objects with VBA, ESRI , USA. 2004.
2. Kang-Tsung Chang, Programming Arc Objects with VBA, A Task Oriented Approach, CRC Press.
3. Arc Objects Developer's Guide -Arc Info 8, ESRI INC., California, 1999.
4. Jonathan S. Harbour, Microsoft Visual Basic .NET Programming for the Absolute Beginner, Prima Tech; Pap/Cdr edition, 2002
5. Kang-tsung chang, Introduction to Geographic Information Systems, McGraw Hill, 2002.

COURSE OUTCOMES:

After the successful completion of this course, the students are able to:

- Understand the ideas, concepts and programming methods for developing QUBIS and SDSS in GIS platform
- Learn the method of designing Menus for QUBIS and SDSS
- Generate processed spatial and non-spatial database for QUBIS and SDSS
- Develop models for QUBIS and SDSS
- Learn the method of providing link between spatial and non-spatial database for QUBIS
- Get thorough knowledge of C# Programming Languages .NET
- Learn the methods of testing, handling, monitoring and user interface development for QUBIS and SDSS.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1105	Lidar and Unmanned Aerial System	4	25	75	100

Objectives:

- To understand the space borne laser technology and its application
- To understand the air borne laser technology and its application
- To study LiDAR data processing
- To learn the Terrestrial and bathymetric laser scanner
- To learn the principles and application of Unmanned Aircraft Systems

Syllabus:

Unit:1. LASER AND SPACE BORNE 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). **8 hrs**

Unit:2. AIR BORNE 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 - Synchronisation of Laser Scanner and PoS- LASER Scanners Specification and Salient Features - Concept of Multi return - 3D Cloud Points - Reflectivity of Ground features - Range CorrectionFactor. **8 hrs**

Unit:3. 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.

10 hrs

Unit:4. 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.

10 hrs

Unit:5. UNMANNED AIRCRAFT SYSTEMS: UAS History - UAS Platform Types and Characteristics, Characteristics and Examples of UAS Categories - UAS sensors, UAS cameras and software - Image acquisition process – Photo grammetric process, Imagery Geo- location, Ground Control Requirement, Aerial Triangulation, DEM Production, DOM Production - Application of UAS. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Recent scientific and technological development, advancement, Industrial application, job opportunities, etc.

References:

1. Jie Shan and Charles K., Topographic laser ranging and scanning : principles and processing, CRC Press, Taylor & Francis Group, 2008
2. Mathias Lemmens, Laser Altimetry: Principles and Applications, CRC Press 2006.
3. Roger Read and Ron Graham, Manual of Aerial Survey: Primary Data Acquisition, Whittles Publishing, 2002.
4. Zhilin Li Qing Zhu, Chris Gold, Christopher Gold, Digital Terrain Modeling: Principles and Methodology, CRC Press, 2004.
5. Zhilin Li, Jun Chen, Emmanuel Baltsavias, Advances in Photogrammetry, Remote Sensing and Spatial Information Sciences, CRC Press; 1 edition, 2008
6. Watts, A.C.; Perry, J.H.; Smith, S.E.; Burgess, M.A.; Wilkinson, B.E.; Szantoi, Z.; Ifju, P.G.;
7. Percival, H.F. Small unmanned aircraft systems for low-altitude aerial surveys. J.Wildl.Manage. **2010**, *7*, 1614-1619.
8. Watts, A.C.; Kobziar, L.N.; Percival, H.F. Unmanned Aircraft Systems for Wildland Fire Monitoring and Research. In *Proceedings of the 24th Tall Timbers Fire Ecology Conference:*

The Future of Fire: Public Awareness, Health, and Safety, Tallahassee, FL, USA, 11-15 January 2009; pp. 86-90.

9. Hannavy, J., Ed. Encyclopedia of Nineteenth-Century Photography; Routledge, Taylor & Francis Group: 2007; Volume 1, pp. 14-15.

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

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1106	Elective - XIII Current Trends in GIS	4	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1107	Mini Project in Geological Technology and Geoinformatics	2	25	75	100

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	MTIGT 1108	Industrial cum Geological field visit	2	25	75	100

SEMESTER XII

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XII	**MTIGT 1201**	**Major Project in Geological Technology and Geoinformatics**	**10**	**25**	**75**	**100**

OPTIONAL ELECTIVES SEMESTER - IV

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	Optional Elective - 1	Geostatistical and Geomathematical concepts	3	25	75	100

Objectives:

- To understand the concept of confidence intervals and hypothesis tests.
- To understand the concept of frequency distribution for sample data.
- To understand the concept of sample preparation error within a geo-statistical sampling context.
- To explore the uses and pitfalls of statistical techniques in Geo-statistical analysis
- To use statistical tools for providing solutions to common problems like presenting data and mapping parameters.

Syllabus:

***U*nit:**1. Matrices - Characteristic equation - Eigen values and Eigen vectors of a real matrix- Cayley-Hamilton theorem - Reduction of a real symmetric matrix to diagonal form and reduction of quadratic form to canonical form by orthogonal transformation. **6 hrs**

Unit:2. Analytical Geometry (3 dimensions): Distance Division formulae - Direction Cosines and direction ratios, planes - straight line - angle between planes / straight line - shortest distance. **9 hrs**

Unit:3. Differential Calculus: Determination of nth derivatives of standard functions - Leibnitz's theorem (without proof) and applications. **10 hrs**

Unit:4. Partial differentiation - Euler's theorem - Total differentiation, differentiation of composite and implicit functions - Jacobians errors and approximations. Vector differentiation: Velocity, acceleration of a vector point function - Gradient, Curl, Solenoidal, Irrotational fields and their properties. **9 hrs**

Unit:5. Applied statistics: review of frequency distribution, Measures of location. Dispersion Skewness, Kurtosis, Regression on analysis. **8 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Spatial Sampling Procedures- Use of existing software with emphasis on analysis of real data from the environmental, geological and agricultural sciences.

Text Books:

1. Higher Engineering Mathematics by Grewal, B.S., Khanna Publishers, 1993.
2. Engineering Mathematics by Sastry, S.S., Vol. I and II, Prentice-Hall of India, Second edition, 1994.
3. Elementary differential equations by Rainville, E.D. and Bedient, P.E., 6th edition.
4. Higher Engineering Mathematics by Grewel, B.S., 33rd edition.
5. Differential Calculus by Shanthi Narayan, 13th edition.
6. Introductory Probability and Statistical Applications by Paul L. Meyer, Addison Wesley.
7. Engineering Statistics by Bowker and Libermann, Prentice-Hall.
8. Probability statistics and decision for Civil Engineering by Benjamin and Corel, McGraw Hill.
9. Introduction to Mathematical Statistics by G.R.V. and Craig, A.T., Macmillan.
10. Statistical models in Engineering by Hahn and Sapiro, John Wiley and Sons.

Course outcomes:

After the completion of the course the students will able to

- Make statistical comparisons of means (paired and unpaired samples), proportions and variances.
- Understand correlation and regression, and be able to make predictions and understand their limitations.
- Able to summarize the distribution by diagrams and statistics.
- Create, devise, restructure and relate various data components such as maps, tables, digital documents, air photos, drawings, geological and geographic data etc. to produce mapping results of the combined GIS and geostatistical analyses.
- Quantify spatially distributed data in terms of spatial statistics (e.g. correlation length, trends), estimate and model the Variogram / covariance.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	Optional Elective - 2	Mining Geology	3	25	75	100

Objectives:

- To learn the need of drilling and mining methods ensuring suitability, economic, safety for natural resources exploitation
- To know the concepts of surface and subsurface mining methods
- To understand the methods of mining metals, petroleum, coal.
- To learn the problems encountered during different mining methods
- To study the groundwater mining methods and well development.

Syllabus:

Unit: 1. Definitions of mining terms : Ore, Protore, Gangue, Shaft, Hanging wall, Adit, Roof, Drive, Cross cut, Tunnel, Raise, Winze, Stope, Assay value, Grade, Cutoff grade and Tenor. Drilling: Types of Drilling methods - Percussion Drills - Rotary Drills - Other Drilling Methods, Drill Sampling - Accuracy of bore Hole Sampling **12 hrs**

Unit: 2. Surface Mining: Basic Concepts of Alluvial mining, Strip Mining, Open cast Mining or Quarrying, Open pit mining - Break even stripping Ratio - Determination of Pit limits for Different cutoffs – Ore reserve estimation- background threshold - Ore assaying - Determination of ultimate depth. Benches, working slope. Mining equipments – Dragline and Power showels **9 hrs**

Unit: 3. Underground Mining: Open stopes: Methods of Open stopes - Supports for stoping - Square set method. Filled stopes: Methods of Filled stopes, Shrinkage stopes, Mitchell slicing systems - Caving methods - Advantages and disadvantages of different underground mining methods. **9 hrs**

Unit: 4. Mining Methods for Mineral and Oil: Metal mining methods -Coal mining methods - (surface mining) Strip mining and Augering. Underground mining: Room and pillar method – Longwall method- hydraulicking. Mining methods of Hydrocarbon -Problems in various mining. Bore Hole Problems (bore hole deviation, core recovery, bore hole instability) - Bore Hole Logging, Preservation andSampling of cores. **9 hrs**

Unit: 5. Mining Methods for Groundwater: Test holes and well logs -Well design –

Well development - Methods for constructing shallow wells & deep wells -Well completion - Water wells and types of water wells – Pumping from wells and cone of depression, Well Hydrographs - Pumping equipment -Protection of wells -Well rehabilitation -Horizontal wells - Groundwater Extraction methods. **9 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Environmental problems need to be tackled; Reclamation and Restoration of mined areas and areas of mine dumps; Sustainable and safer methods of exploration and mining of natural resources.

Textbooks:

1. Arogyasamy, R.N.P. Courses in Mining Geology, 4TH Edition, Oxford & IBH Publishing Co.,Pvt. Ltd., New Delhi.
2. Deshmuk D.J. Elements of Mining Technology, Dhanbad, Vidyaprakashan, 1998.

References:

1. Mc Kinstry, H.E. Mining Geology, New York, Prentice-Hall Inc., 1970.
2. Bruce, A.K., Surface Mining, Colorado, Society for Mining, Metallurgy and Exploration Inc.,1990.
3. Hustrulid H.V. and Mark Kuchta, Open Pit Mine Planning and Design Fundamentals,Brookfield, USA: A.A Balkema, 1995.
4. Hartman, Howard, L. Introduction to Mining Engineering, New York,: John Wiley & Sons,1987.
5. Driscoll, F.S., Groundwater & Wells, 2nd edition, Scientific Publishers, Jodhpur, 1986.
6. Karanth K.R. Groundwater Assessment, Development and Management. TATA McGraw-Hill Publishing Company Ltd., Delhi. 1987.
7. Davind Keith Todd, Groundwater Hydrology, Second Edition, John Willey & Sons, Singapore, 1980.
8. Ramakrishnan. S. Groundwater, 1998.

Course outcomes:

After the successful completion of this course, the students are able to:

- Understand the type and method of drilling and mining for exploration and exploitation of economic deposits
- Evaluate the terrain condition and able to suggest suitable methods and plans for mining operations
- Determine the problems in drilling and mining sites as well as methods and suggest remedial plans to solve, overcome and further proceed

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	Optional Elective - 3	Micro Palaeontology	3	25	75	100

Objectives:

- To study the micro fossils and their mode of preservation
- To understand vertebrate and Invertebrate fossils

Syllabus:

Unit:1. Introduction: Introduction to microfossils and micro palaeontology, Historical development of micro palaeontological studies world-wide in general and India in particular, Applications of microfossils viz, bio stratigraphical, palaeo ecological, palaeo bio geographical and economical (hydrocarbon and coal) uses. Divisions of the marine environment and their characteristic fauna and flora. **9 hrs**

Unit:2. Field Sampling and Lab Studies: Surface and sub-surface sampling methods, processing of samples, preparation of thin sections of larger foraminifera. Sampling techniques for ecological studies living microforms. Scanning Electron Microscope photographic techniques. **6 hrs**

Unit:3. Test morphology: Wall structure, dimorphism, classification, evolution and ecology/ paleoecology of Foraminifera, Biometrics of important larger foraminifera, Stratigraphy of foraminifera with emphasis on Indian stratigraphic horizons. **9 hrs**

Unit:4. Carapace morphology: Ecdysis, Scatter diagrams (Ontogenic studies), classification, evolution and ecology / palaeoecology of Ostracoda. Applications of functional morphological characteristics in environmental studies, Carapace/valve ratio, adult/juvenile rati o, predation and pyritisation of carapace to interpret palaeoecology and hydrocarbon potential. Morphology, mineralogy and geological distribution of nanofossils. **12 hrs**

Unit:5. Skeletal morphology: Wall structure, classification, palaeoecology and palaeo-oceanography of Radiolaria -Morphology and classification of Conodonts, Bryozoa, Diatoms and Pteropods. Palynological techniques, Morphology, distinguishing characteristics of spores and pollen and their uses in oil industry. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Micro fossils: Use of microfossils in study about evolution and resource studies. Importance of microfossils in stratigraphical studies.

Text Books:

1. Gérard Bignot : Elements of micropalaeontology: microfossils, their geological and palaeobiological applications, Edition: illustrated, reprint, Published by Springer, 1985
2. D. Graham Jenkins : Applied Micropaleontology, Edition: illustrated, Published by Springer, 1993, ISBN 0792322649, 9780792322641.

References:

1. Brian McGowran: Biostratigraphy: Microfossils and Geological Time, Edition: illustrated, Published by Cambridge University Press, 2005, ISBN 0521837502, 9780521837507
2. Howard Armstrong, M. D. Brasier: Microfossils, Edition: 2, illustrated, Published by Wiley-Blackwell, 2005, ISBN 0632052791, 9780632052790
3. Simon K. Haslett : Quaternary Environmental Micro palaeontology, Edited Vol., Published by Arnold, 2002, ISBN 0340761989, 9780340761984
4. Robert Wynn Jones: Applied palaeontology, Edition: illustrated, Published by Cambridge University Press, 2006, ISBN 0521841992, 9780521841993
5. Ronald E. Martin : Environmental micropaleontology: the application of microfossils to environmental geology, Edition: illustrated, Published by Springer, 2000, ISBN 030646232X, 9780306462320.

Course outcomes:

After the successful completion of this course, the students are able to:

- Students will understand mode of micro fossil preservation.
- Students will understand the importance of micro fossils in geological application.
- Students will understand the stratigraphic and geographical distribution of fossils.
- The students will learn about fossils fuel and energy resources.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IV	Optional Elective - 4	Geospatial statistics	3	25	75	100

Objectives:

- ✓ To educate the learners on statistical tools that could support data analysis pertaining to geological studies.
- ✓ To support analysis of dependent and independent variables and their relationship.

Syllabus:

Unit:1. Basic Statistics : Frequency Distributions, Cumulative Frequency Distributions and Frequency Curves, Measures of Central Tendencies – (Mean, Median and Mode) - Measures of Dispersion – (Range, Variance and Standard Deviation). **9 hrs**

Unit:2. Sampling: Theory of Sampling - Population and Sample - Sampling Survey Methods - Estimation of Mean and Proportion in Simple Random Sampling. **6 hrs**

Unit:3. Statistical inference: Testing of Hypothesis and Tests of Significance for Mean, Proportion and Variance. **12 hrs**.

Unit:4. Factor and Regression Analyses: Factor and Factor Varimax analysis (Factor loadings, Delineation of relevant data/Samples: Variables and parameters) - Linear Correlation Coefficient - Linear Regression - Non- Linear Regression - Multiple Correlation and Multiple Regression. **12 hrs**

Unit:5. Concept of Modeling: Fundamentals of Modeling - Types of Modeling – (Binary, Index, Process and Regression model: Predictive types and Illustrations- spatial regression model output expressing quantitative and qualitative relationship). **9 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Recent concepts – Technological and Scientific developments – Real world cases/examples – Policy/Practice updates – Contradictions – World/Indian Scenario.

Text Books:

1. Freund, J.E., Modern Elementary Statistics, Prentice Hall of India, 1981.
2. Saroj K.Pal : Statistics for Geoscientists Techniques and Applications, Concept Publishing company, New Delhi, 1998

References:

1. Urray R. Spiegel, Theory And Problems Of Statistics, Schaum's Outline Series - Mcgraw Hill Book Company, 1972.
2. Sizeh, B, Use And Abuse Of Statistical Methods In The Earth Science, Oxford University Press, Oxford, 1987.
3. Margaret Armstrong: Basic Linear Geostatistics, Springer, 1998.
4. Taxali, PC Software Made Simple, Tata Mc Graw hill Publications, 1987.

Course outcomes:

After the successful completion of this course, the students are able to:

- Ability to analyse and interpret gathered data in a research process
- Ability to design and test hypotheses.

OPTIONAL ELECTIVES SEMESTER - V

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	Optional Elective - 5	Geophysics	3	25	75	100

Objectives:

- To study the physical properties and measurements of density, susceptibility and natural remnant of magnetization in the earth.
- To understand the electrical and electromagnetic methods in geophysical exploration for minerals.
- To understand the gravity and magnetic methods in geophysical exploration for minerals.
- To understand the reflection and refraction methods in geophysical exploration for hydrocarbon.
- To understand the Aerial survey methods for the exploration for radioactive mineral

1. **Introduction:** Definition of Geophysics – Physical properties of Earth – Classification of Geophysical Methods: Active and Passive methods – Historical development. **6 Hrs**

2. **Electrical and Electro Magnetic Methods:** Electrical properties of the Earth – Self Potential method – Resistivity Method (Principles, Instruments, Field procedure, Interpretation and application) – Selp-potential – Induced Polarisation Method – 2D and 3D Tomography, Principles – Instruments – Methods of exploration (Lateral & Vertical Exploration) – Interpretation of E.M. data – Effective depth of E.M. Surveys – Application of E. M. methods. **9 Hrs**

3. **Gravity and Magnetic Methods:** Gravity Methods: Introduction – Gravitational field of the Earth – Density of rocks and Minerals – Instruments – Field procedure for data collection – Reduction of gravity data – Gravity Anomaly mapping – Interpretation and application. Magnetic Methods: Introduction – Earth Magnetism – Magnetism of Rocks and Minerals – Instruments – procedure for data collection – Reduction of data – Magnetic Anomaly maps – Magnetometer for marine surveys, Interpretation and application. **12 Hrs**

4. **Seismic Methods:** General principles – Seismic prospecting – Elastic properties of Rocks – Refraction and Reflection of Seismic waves. Refraction method of Survey (principles – Instruments – Data collecting Methods – Data Interpretation and application). Reflection method (principles – Instruments – Data collecting Methods – Data Interpretation and application). **9 Hrs**

5. **Airborne Geophysical Surveys and other Surveys:** Air borne Geophysical Survey: Introduction – Advantages and Limitations – Aerial Survey procedure – Data Interpretation. Radioactivity Methods: Introduction –

Radioactive decay - Radio activity of Rocks and Minerals – Instruments – Data collecting procedure – Data Interpretation and application. Well logging: Introduction – Different Well logging Methods – Interpretation and application. **12 Hrs**

Text Books:

1. Kearey P. & M. Brooks, An introduction to Geophysical Exploration English Language Book Society / Blackwell Scientific Publications, p. 296. 1989.
2. Parasmis D.S. Principles of Applied Geophysics, Chawpman & Hall, New York, Fourth Edition, p. 402, 1986. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church, Virginia. 1983.

References:

1. Gary L.Prost Remote Sensing for Geologists - A Guide to Image interpretation, Gordon and Breach Science Publishers, The Netherlands. 1997.
2. Bateman, A. Economic Mineral Deposits.
3. Krishnasamy S., Indian's Mineral Resources.
4. Sinha R.K., A Treaties on industrial Minerals of India - Allied Publishers.
5. Ramasamy, SM. Trends in Geological Remote Sensing, Rawat Publishers, Jaipur, 1996.
6. Alexey F. Bunkin and Konstantin I- Voliak, Laser Remote Sensing of the Ocean- Methods and Applications, Wiley Series, John Wiley & Sons. inc. New York, pp.244., 2001
7. Lavorsen, A.I. Geology of Petroleum, CBS Publishers & Distributors, Second Edition, New Delhi, p.724. 1985.
8. Rao, D.P. Remote Sensing for Earth Resources, Association of Exploration Geophysicist, Second Edition, Hyderabad p.212, (CERS-236) 1999.
9. Amurskii G.I., G.A. Abramenok, M.S., Bondarieva & N.N. Solov'ev, Remote Sensing Methods in Studying Tectonic Fractures in Oil and Gas bearing formations, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, p. 138. 1991.
10. Alistarir R. Brown, interpretation of Three Dimensional Seismic Data, American Association of Petroleum Geologists, USA, p. 194. 1986.

Course outcomes:

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

- Physical properties of earth and various types of geophysical methods.
- Electrical and electromagnetic methods in geophysical exploration for various minerals.
- Gravity and magnetic survey methods in geophysical exploration for different types of minerals.
- Seismic methods in geophysical exploration for hydrocarbon.
- Aerial survey methods for the exploration for radioactive mineral and well logging for interpretation.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	Optional Elective - 6	Geochemistry	3	25	75	100

Objectives:

- To study the principles and concepts of Geochemistry
- To study the pattern of dispersion
- To understand the methods of Geochemical surveying
- To understand the concepts of sampling and analysis
- To learn the techniques and geochemical analytical processes
- To understand the environmental geochemistry

1. **Introduction:** General principles – Geochemical environment- Major elements, trace elements – Geochemical dispersion – Geochemical mobility (trace elements in stable minerals, hypo gene mobility – super gene mobility – association of elements **6 Hrs**

2. **Pattern of dispersion:** Primary halos and leakage halos – secondary halos and dispersion trains – statistical distribution of background values – Interpretation of geochemical anomalies – Key and path finder elements – sampling techniques – chemical analyses (AAS, ICPMS, TOC analyzer, XRF (**X-ray fluorescence**) is a non-destructive analytical technique, XRD, Flame photometer/Spectra photometer, HPLC and Gas Chromatography). **12 Hrs**

3. **Geochemical surveys – I:** Reconnaissance surveys and detailed surveys – litho geochemical surveys (sampling, analysis, contours of equal elemental values, interpretation) - Pedogeochemical surveys (soil zones, collection of soil sample, heavy mineral separation and interpretation). **12 Hrs**

4. **Geochemical surveys – II:** Hydrogeochemical analysis (anomalies in natural water, anomalies in drainage sediments, collection of water samples and sediments, on spot and lab analysis, interpretation) – Biogeochemical analysis (collection of plant material samples, chemical analysis, interpretation) – Geobotanical survey (indicator plants, interpretation of anomalies). **12 Hrs**

5. **Spectral signature based geochemical mapping:** Chemical properties of minerals and rocks and spectral reflection – spectral signature/ Hyper spectral based geochemical mapping and rock discrimination. **6 Hrs**

6. **Environmental geochemistry:** Radioactivity in the environment, radioactive elements in rocks, radio-elements in soils and water, environmental aspects of radionuclides. Environmental pollution on global nature, acid rain, greenhouse effect, ozone layer, Microbiological methods, microbial activity, methane – oxidizing bacteria, Iron, sulfide consuming bacteria, Air pollution mapping, sampling and analysis-High resolution air quality sensors. **12 hrs**

Course Outcomes:

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

- Conduct geochemical survey and sampling survey
- Handling of equipments and carry out Geochemical analysis
- Apply principles of theory of major and trace elements measurements
- compilation of element isohydal map from analyzed data
- Various soil, water and rock sampling and analysis
- Geobotanical indicator plants and path finding elements
- Spectral based Geo chemical analysis method
- Environmental pollution Assessment

***Text books*:**

1. Govett. GJ.S (Ed.). Hand book of Exploration Geochemistry, Elsevier. 1983.
2. Kans Kopt, K.B. Introduction to Geochemistry. 1967.
3. Mason, B and Moore, C.B. Introduction to Geochemistry, Wiley Eastern. 1991.

References

1. Faure, G. Principles of Isotope geology. John Willey. 1986Livinson. A.A., Int. to Exploration Geochemistry. 1976,
2. Marshal, C.P and Fairbridge, R.W., Encycopaedia of Geochemistry, Kluwer Academy. 1999.
3. Solovov, A.P., Geochemical Prospecting, Mir Publishers, Moscow, 1987.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	Optional Elective - 7	Industrial Geology	3	25	75	100

Objectives:

- Understand the importance and nature of geologist work in mining industries.
- To understand the environmental problem due to mining

Syllabus:

Unit:1. Geology in Mining Industry: Role of geologist in mine/mineral based industry, specific aspects of coal and mineral deposits, mining geological aspects of Indian ore occurrences- Bauxite. Iron ore, Limestone, Granites for dimension stone. Elementary principles on mine surveying. **12 hrs**

Unit:2. Mineral Economics and Finance: Sources of Mine Finance, factors governing profitability value, types of ore reserves/resource base, concepts of DCF, Depreciation, Present Value, Fixed/Operating costs, conservation, utilization of low grade mineral wealth, Bulk sampling for pilot plant studies, pricing, Demand analysis, Balance sheet, P&L Account. **12 hrs**

Unit:3. Project Evaluation: Project Evaluation methods- NPV, IRR, ERR, DCF, Evaluation of prospects of operating mines, feasibility studies, preparation of mine plan under MCR 1960. **9 hrs**

Unit:4. Numerical Problems: Calculation of dip strike, pitch from Borehole data, fault data interpretation, ore reserve calculations, surface and underground Deposits, preparing slice plans from Borehole data. **9 hrs**

Unit:5. Mining Policy: National Mineral Policy, Prospecting License, Mining Lease, Important mines/ minerals related Acts and Rules -MMRD, MCDR, Environment Protection and Forest Acts. **6 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Recent status of mining activities in India-

References:

1. Kennedy, Bruce, Surface mining. A., 2nd Ed. Society for mining, metallurgy and Exploration Inc, Colorado, 1990.
2. Gentry D. W & J. a Neill, Mine Investment Analyses. Society of Mining Engineers of American Inst. Of mining, Metallurgical and Petroleum Engg. Onc. New York 1984.
3. Kaulir K C, Introduction to Mineral Economics. Wiley Eastern Ltd. 1993. SME Mining Engg. Volume1, 1992.

Course Outcomes:

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

- Students acquire knowledge about the role of Mining activities for development of economic importance of public

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
V	Optional Elective - 8	Sequence Stratigraphy	3	25	75	100

Objectives:

- To understand the role of stratigraphic succession in the field of Oil and Gas exploration.

Syllabus:

Unit:1. Introduction: Introduction to sequence stratigraphy, scope, applications in exploration of hydrocarbons, stratigraphic terminology, problems and research trends, stratigraphic architecture, facies and sea level cycles. **9 hrs**

Unit:2. Methods for studying sequence stratigraphy: Construction of sequence framework, importance of unconformities, assessing regional and global changes in sea level, areas and volumes of stratigraphic units, hypsometric curves, back stripping, integrated tectonic stratigraphic analysis. **9 hrs**

Unit:3. Sequence Depositional model: Depositional systems and systems tracts, sequence boundaries, litho-log analysis, sedimentary facies, fossil assemblages, counts and their controls, paleoecology & Milankovitch processes. **9 hrs**

Unit:4. Stratigraphic cycles: Types of stratigraphic cycles, tectno-stratigraphic model, Eustasy, epiorogeny, global cycle chart, tectonic mechanisms. **9 hrs**

Unit:5. Sequence biostratigraphy, chrono stratigraphy and correlation: Determination of the biostratigraphic framework, diachroneity of the biostratigraphic record, dating and correlation of stratigraphic events, time in sequence stratigraphy. Applications of sequence bio stratigraphy. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Sequence stratigraphic succession in India.

Text Books:

1. Andrew D. M. Geology of stratigraphic sequences Springer publ. Newyork. 1997.
2. Emery, D., and Myers, K, Sequence Stratigraphy, Blackwell Science, Publ. 1996.

References:

1. Weimer and Posmentier, Sequence Stratigraphy, sedimentary Geology, 1993.
2. Seismic stratigraphy -Applications to hydrocarbon exploration, AAPG Memoir No. 26. 1977.
3. Van Wagonar., P. R. Vail an ovelView of the fundamentals of sequence stratigraphy and key definitions. Sea level changes -an integrated approach. SEPM Publ. No. 42, 1988.

Course Outcomes:

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

- Students gain knowledge about the application of sequence stratigraphy in the field of Geological studies.

OPTIONAL ELECTIVES SEMESTER - VI

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	Optional Elective - 9	Computer Applications in Geotechnology	3	25	75	100

Objectives:

- To know about the basic and fundamental computer applications.
- Practice as computing professionals (appropriate to the description of the Computer Science program described above), conducting research and/or leading, designing, developing, or maintaining projects in various technical areas;
- Apply the ethical and social aspects of modern computing technology to the design, development, and usage of computing artifacts;
- To enhance their skills and embrace new computing technologies through self-directed professional development and post-graduate training or education.

Syllabus:

Unit:1. **Basics of Computers (Hardware):** An introduction to computers, development of computers, Hardware and Software - Fundamentals of Computers - Input devices, output devices & storage devices-Primary, secondary - Central processing unit.

Basics of Computers (Software): Introduction-Types of Software's- Operating systems- Types of OS, Functions and maintenance of OS – Application software's – Compliers and translators – Computer threats and Security **9 hrs**

Unit:2. **Data communication and network:** Introduction to networks, Types of networks, Topologies, Protocols, Server-client Technology, hubs, nodes, modes, Wireless Networking **6 hrs**

Unit:3. **Information Super Highway:** Internet**:** Introduction to Internet - Scope of Internet - Equipment required for an Internet Connection - Electronic Mail - Concepts of Information Storehouse - Suring the Net - Browsing the WWW - Search Engines- Cloud computing. Application of internet to Geoinformatics. **9 hrs**

Unit 4: Programming Fundamentals

Fundamentals in Programming Languages - (Data types, Constants Variables, Operators and Expressions) - Programming Statements -(Branching and Looping) - Arrays, Functions and Procedures - Modules, File Access, List, Dictionaries. **9 hrs**

Unit:5. **Web design:** HTML: HTML Elements, formatting and Fonts – Backgrounds- Images – Hyperlins – Lists-Tables- Frames-HTML forms – GML – DHTML: Introduction – Cascading Style Sheets (CSS) - GDAL.

15 hrs

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Microprocessor- Registers – Computer formatting – Assembling- Software installation - Network Hacking – Neural Networks

References:

1. Fundamentals of computers -V. Rajaraman, PHI publication.
2. Sanjay Saxena, A First Course in Computers 2003 Edition, Vikas publishing house Pvt Ltd., New Delhi, 2006.
3. Mc Namer, Local Area Networks, BPB Publications
4. Toom Savole using HTML (Second Edition).
5. Andrew S. Tanenbaum, Computer Networks, Pearson Prentice Hall, Fourth Edition, 2003.

Course outcomes:

- An ability to apply knowledge of computing and mathematics appropriate to the discipline.
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solutions.
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
- An ability to analyze the local and global impact of computing on individuals, organizations, and society.
- An ability to use current techniques, skills, and tools necessary for computing practice.
- An ability to apply design and development principles in the construction of software systems of varying complexity.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	Optional Elective - 10	Marine Geology and Geoinformatics In Sea Bed Exploration	3	25	75	100

Objectives:

- To study the principles of oceanography
- To study the physical, chemical and biological oceanography
- To learn the techniques of satellite oceanography
- To understand sea bed exploration methods
- To understand the Ocean resources
- To understand the advantage of Remote sensing for ocean resource management

Syllabus:

Unit:1. Basic Principles: Origin of seas and oceans – Ocean Morphology– Continental and Oceanic crust and Ocean margin — Continental Margin, Shelf, Slope, Sub marine canyons – Sea bottom topography – Abyssal hills, plains – Mid oceanic ridges – Continental drift and sea floor spreading - Application of ETOPO and satellites remote sensing for in sea bed morphology. **12 hrs**

Unit:2. Physical Phenomena and Features of the Ocean: Ocean circulation – thermohaline and wind driven circulations – down welling and upwelling - Ocean currents – el nino and la nina and its impact on the global weather conditions - Remote sensing for monitoring ocean circulation - Waves, currents, tides, turbidity, submarine sedimentation processes- Marine sediments – Tectonic history of the oceans. **9 hrs**

Unit:3. Ocean Resources: Classification of marine mineral deposits – Origin and depositional system of marine resources – Beach placers, Shelf deposits, Deep ocean phosphatic and polymetallic nodules, sulphate deposits, hydrocarbon deposits – Sea water properties. **9 hrs**

Unit:4. Physical & Chemical Oceanography: Concepts of sea level changes – Physical & Chemical properties of sea water – Marine Pollution – Pathways, Residence time, Pollutants in marine environment – Impact of climate over Oceanography - Remote Sensing and GIS applications in marine pollution, **9 hrs**

Unit:5. Geoinformatics in Ocean Studies and sea bed exploration: Mapping of sea surface roughness & temperature (SST) using satellite data – Ocean colour mapping – Turbidity mapping – Suspended Sediments Concentration (SSC) - Potential Fishing Zone (PFZ) mapping – Marine mineral exploration**.** **9 hrs**

Unit:6. Marine Meteorology: Meteorological data in oceans- interpreting the data and metadata and its utility in study of oceans and the overall earth climate, various aspects of meteorology for devising various models in climate prediction, Anthropogenic activities for better – practical analysis of the data – metadata generated in meteorological studies of oceans.

Textbooks:

1. Kennet, J.P. (1982) Marine geology. Printice Hall Inc., New Jersey, 813p
2. Kerth. S (1996). Ocean Science, John Wiley and Sons. Inc. New York.
3. Stewart, R.H. (2004). Introduction to Physical Oceanography, 351p

References :

1. Bhatt, J.J. (1994). Oceanography - Exploring the Planet Ocean. D.Van. Nostrand Company, New York,
2. Seibold, E. and Berger, W.H. (1982). The sea floor. Springer-Verlag, Berlin
3. Valavanis, V.D. (2002). Geographic information systems in oceanography and fisheries, Taylor and Francis. 209 p.
4. Weisberg, J. and Parish, H. (1974). Introductory Oceanography. Mc Graw Hill
5. Shepard, F. P. Submarine Geology, Harper and Row Publ. New york, 1994.
7. Eric. C. Bird Coasts, an introduction to coastal geomorphology, III ed. Basil Black well Publ. 1984.

Course outcomes:

After the successful completion of this course, the students are able to:

- Conduct bathymetric survey
- Handling of equipments and carry out wave tide data collection
- Apply principles of ocean resource evaluation
- Compilation of map from surveyed data and satellite data
- GPS, Eco sound based Hydrographic survey
- Ocean colour study for SSC and SST mapping
- Physical oceanographic modeling
- Utilize ocean meteorological data for Climate model development.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	Optional Elective - 11	Mineral Processing Technology	3	25	75	100

Objectives:

- To study the principles mineral beneficiation
- To understand steps involved mineral processing
- To learn about laboratory and screening technique
- To study the processes involved in ore beneficiation

Syllabus:

Unit:1. Introduction Need for mineral beneficiation – importance, scope, advantage and limitations of mineral beneficiation – Major unit operations involved – material balancing. **6 hrs**

Unit:2. Mineral Dressing I: Objectives, liberation – importance and determination of liberation mesh size, crushing – fundamentals of breakage, construction and operational features of primary and secondary crushers (HJaw and Gyratory crushers, cone and roll crushers) – Grinding – theory, ball and rod mills – construction and operation, circulating load problems. **12 hrs**

Unit:3. Mineral Dressing II: Laboratory sizing and industrial screening – movement of solids and liquids – free, hindered and equal settling – rake, spiral and hydrocyclone classifiers. **9 hrs**

Unit:4. Ore Beneficiation I: Classification: types of classifiers. Gravity concentration: principles. Types of Gravity separators; Heavy Medium Separation - Separating Vessels. Magnetic Separation : Types of Magnetic Separators - Low intensity and high intensity Machines: High Tension Separation. **9 hrs**

Unit:5. Ore Beneficiation –II: Froth Flotation technique of Separation of Complex Sulfide over: Reagents : Collectors, Frothers and Regulators - Activators & Depressants. Disposal of Tailings. **9 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Ore beneficiation- different types of crushers-Gravity separator-Magnetic Separator- method of tailing disposal.

References:

1. Gaudin : Principles of mineral dressing - -Tata Mc. Graw Hill Publishing co., Ltd
2. Richards and Looke: Text books of ore dressing - Mc. Graw Hill Pub.Co. Inc.
3. Roberts: Elements of ore dressing
4. Pryor : Mineral processing -
5. Taggart : Handbook of Mineral dressing -
6. Taggarat : Elements of dressing

Course outcomes:

After the successful completion of this course, the students are able to:

- Students will learn the advantage and limitations of ore beneficiation.
- They understand the usefulness of ore be beneficiation.
- Students will understand different steps involved in the processes of ore beneficiation.
- Students will learn about laboratory technique involved in ore beneficiation.
- Students will learn about different instrument used for separation of ore

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VI	Optional Elective - 12	Applied Hydro geochemistry	3	25	75	100

Objectives:

- To study the Ground water chemistry
- To understand steps involved collection of water samples
- To learn about Hydrochemical sequences.
- To study the regional hydrogeochemical studies

Syllabus:

Unit:1. Ground water chemistry: Equilibrium and redox reaction -activity coefficients -solution - precipitation - saturation indices with respect to common minerals adsorption -ion exchange processes in ground water. **9 hrs**

Unit:2. Sample collection and parameters: Chemical parameters -Sampling and influence of well conditions -Sampling for environmental isotopes -pore water sampling -Calculation of parameters - representation of results -hydrochemical sections -Statistical diagrams and techniques. **12 hrs**

Unit:3. Ground water chemical evolution: Hydrochemical sequences- major -ion evolution - groundwater in carbonate terrain -crystalline rocks -sedimentary deposit -interpretation of isotope data. **9 hrs**

Unit:4. Flow and transport: Transport processes -advection -dispersion -diffusion- hydrochemical processes during flow -influence of saline waters. **9 hrs**

Unit:5. Hydrogeochemical studies: Chemical processes in relation to hydrogeology -regional hydrogeochemical studies -mixing of waters -hydrogeochemical models -case studies. **9 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): saturation indices- hydrochemical sections -Statistical diagrams and techniques- advection -dispersion – diffusion- hydrogeochemical models

References:

1. Lloyd, J. W. and Heathcote, J.A., National inorganic hydrochemistry in relation to groundwater, Oxford university press, 1985.
2. Freeze, R.A and Cherry, J.A. Groundwater, Printice Hall, 1979.
3. Stumm, W. and Morgan, J.J., Aquatic chemistry, An introduction emphasizing chemical equilibria in natural waters. Wiley Interscience, New York, 1981.
4. Garrels, R.M and Christ, C.L, Solutions, minerals and Equibria, Harper and Row, New York, - 1965

Course outcomes:

After the successful completion of this course, the students are able to:

- Students will learn the groundwater chemistry
- They understand the water quality parameters
- Students will understand water geochemical evolution
- Students will learn Chemical processes in relation to hydrogeology

OPTIONAL ELECTIVES SEMESTER - VII

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	Optional Elective - 13	Geoinformatics in Environmental Impact Assessment	3	25	75	100

Objectives:

- To study the principles of EIA
- To understand steps involved in EIA
- To learn about forest taxonomy and mapping using remote sensing
- To study the water quality and its related EIA
- To learn about applications of remote sensing in EIA in various field like dam construction, ghat road, etc.

Unit-I

Introduction: Definitions of Environmental Assessment, General Principles, Overview of Environmental Assessment,Principles of Ecology, Environment & Environmental Management, Policies and Legal Aspect of Environmental Management. **6 Hrs**

Unit-II

Steps in the Environmental Assessment Process: Scoping, Screening, Alternatives to the Proposal, Collection and Analysis of Information, Public Involvement, Reporting the Findings of the Study, Post Project Analysis. Study design: Baseline Studies, Predicting Impacts, Mitigation Measures. **12Hrs**

Unit-III

Forest Environment & Ecology: Introduction – Forest Taxonomy – Forest density and type mapping using Remote Sensing techniques – Timber Volume Estimation.Forest cover type mapping, density assessment and quantitative measurements, deforestation / afforestation / encroachment mapping. Factors for degradation of forests- Damage assessment. Environment laws & legislation in India. **12Hrs**

Unit-IV

Water Quality: Surface and subsurface water quality monitoring, Analysis and Reporting, Hydrogeology, Groundwater Pollution and Distribution of Pollutants in Groundwater. Role of GIS in water quality mapping and EIA. Mapping of water body encroachment and EIA using satellite data. **12Hrs**

Unit-V

Application of Remote Sensing in Environmental Impact Assessment for Construction of New Dams, Nuclear Power Plants, Nuclear waste disposal, Bridges, Ghats Roads, Chemical factories and industries, solid waste disposal etc. **6 Hrs**

Unit-VI: Current Contours: (Not for Final Exam only for Discussion):

Policies and Legal Aspect:EIA, Forest, Environment laws and legislation in India and USA - Follow-up process in EIA and it important, Water body encroachment and flooding and related EIA

Materials for Study and References

1. Anji Reddy Mareddy., Environmental Impact Assessment 1st Edition Theory and Practice.eBookISBN:9780128112380,https://www.elsevier.com/books/environmental-pactassessment/mareddy/978-0-12-811139-0
2. John Glasson, RikiTherivel., Introduction To Environmental Impact Assessment (Natural and Built Environment Series)4th Edition by
3. Betty Bowers Marriott., Environmental Impact Assessment: A Practical Guide1st Edition
4. James R. Craig,David J. Vaughan, Brian J. Skinner., Earth Resources and the Environment, 4th Edition
5. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers,Jaipur, 1996
6. Charles H. Eccleston,Environmental Impact Assessment: A Guide to Best Professional Practices1st Edition
7. Charles Eccleston and J. Peyton Doub., Preparing NEPA Environmental Assessments: A User's Guide to Best Professional Practices1st Edition

Outcomes:

- Environmental Impact Assessment creates awareness among the students.
- Students will learn the Policies and Legal Aspect of Environment.
- They understand the usefulness of remote sensing for EIA.
- Students will understand different steps involved in the EIA processes
- Students will learn about follow up process even after completion of the EIA report
- Students will learn about water quality, degradation of water quality and remedial measures.
- Student will understand the applications of remote sensing in EIA
- They will understand the procedure of EIA before any constructions like dam, bridges, ghat roads etc.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	Optional Elective - 14	Geoinformatics in Soil Science	3	25	75	100

Objectives:

- To learn the importance, characters and types of soil and its relation with biotic systems
- To study the significance of soil nutrients and micronutrients
- To understand relevant aspects like soil organic matter, water holding property and landscape
- To learn the application of Geological Technology and Geoinformatics in soil resources mapping and management
- To learn the application of Geoinformatics in mitigating soil erosion and reservoir siltation.

Syllabus:

Unit:1. Introduction to Soil Science: Nature and importance of Soil, soil formation, soil survey, physical, chemical and biological characters of soil, Relationship between Soil, plants and animal. **9 hrs**

Unit:2. Soil Types: Soil types and classification, soil genesis, Soil mineralogy and geochemistry of soil types: Laterites, Bauxites, Aridisols, Vertisols, Camborthids. Application of soil micromorphology and landscape evolution. Radiometric age determination of soils. **12 hrs**

Unit:3. Soil Nutrients and Crop Production: Elements essential for plants and animals, soil nutrients - nitrogen, phosphorous, potassium, calcium, magnesium and sulphur in soil and its significance in plant growth, micronutrients. **9 hrs**

Unit:4. Soil Quality and Landscape: Soil and water relation, organic matter in soil, functions of organic matter, organic matter and soil structure, organic matter and essential elements, tillage, cropping systems and fertility and case studies.. **12 hrs**

Unit:5. Soil Management and Conservation: Introduction, irrigation, drainage soil management for field crops, gardens, lawns, pastures, rangelands and forests. Problem Soils - Soil surface crusting; Salinity; Soil Erosion & Siltation – types, RUSLE, vegetative and structural control measures; Soil Contamination. Soil conservation factors and methods. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Environmentally safe and sustainable methods of mitigating soil erosion and reservoir siltation using Geological Technology and Geoinformatics; Development of suitable and pragmatic methods to protect soil from fertility loss, soil pollution and degradation.

References:

1. Nyle, C. Brady, Ray R. Weil, The Nature and Properties of Soils (13th Edition) Prentice Hall, 2002.
2. Donald, L. Sparks, Environmental Soil Chemistry, 2002.
3. Raymond B. Daniels, Richard D. Hammer., Soil Geomorphology, John Wiley & Sons, 2000.
4. M.E. Sumner, Hand book of soil Science, 1992.
5. Donald Sparks, Donald L. Sparks D, Environmental Geochemistry, Academic Press, 2002.

Course Outcomes:

After the successful completion of this course, the students are able to:

- Understand the importance and the physical, chemical and biological properties of soils
- Know the different types of soils and classification
- Reflectance properties of different soils and mapping them using satellite data
- Understand the problems to soils using Remote Sensing, field surveys in GIS platform through modeling.
- Suggest pragmatic soil management and conservation practices using Remote Sensing, field surveys in GIS platform through modeling.
- Understand the importance of soil nutrients, quality and relation with landscape.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	Optional Elective - 15	Geoinformatics in Earth quakes	4	25	75	100

Objectives:

- To understand the fundamental concept of Seismotectonics.
- To acquire knowledge in seismic hazard analysis and its Mitigation.

Syllabus:

Unit:1. Fundamentals of Neo – Seismotectonics: Strain Accumulation – Elastic Rebound and Faulting – Energy Release and Seismic waves – Physical parameters of Earthquake source – Magnitude –Seismic moment and Fault plane solution - Geological and Seismological input for Seismic evaluation on magnitude – Frequency relations. **12 hrs**

Unit:2. Remote Sensing Inputs in Neo-Seismotectonics: Anomaly Mapping using raw and Digitally Enhanced Aerial & Satellite Remote Sensing data, Shaded Relief Maps and FCC wrapped DEM – Lineament Anomalies - Disharmonies in Structural Trend Lines and Fold Styles - Geomorphic anomalies (Tectonic, Denudational, Fluvial, Coastal & Aeolian) **9 hrs**

Unit:3. Geophysical Inputs in Neo-Seismotectonics Identification of Resistivity, Seismic, Gravity & Geomagnetic anomalies – Three Dimensional Modelling of Subsurface Geological Structures using GIS - Ground water anomalies – Historic seismic data analysis – Generation of GIS Database. **9 hrs**

Unit:4. Seismic Hazard Mapping and Risk Assessment through seismic data analysis: Intensity and earthquake strong motion – seismic hazard analysis and estimation of design ground motions – seismic hazard mapping – seismic zonation and response – design codes – protective and reducing measures for infrastructures and structures – regulation of landuse **9 hrs**

Unit:5. Geoinformatics in Seismic hazard mapping and risk assessment : GIS Integration of Remote sensing derived inputs, Geophysical Inputs, Groundwater Anomalies and Historic data and Vulnerability analysis (Hazard Zonation Mapping) and Risk Assessment. Case Studies.**6 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Alpine Himalayan orogenic belt- Seismic cordious of India- Seismic Micro zonation

References:

1. Bell, F.G. Geological Hazards: Their Assessment, Avoidance and Mitigation. E and FN SPON, Routledge, London, 1999.
2. David Alxander, National Disasters. UCL Press, London. Research Press, New Delhi, 1993.
3. Moores, E.M. and Twiss, R.J., Tectonics. W.H.Freeman and Company, New York, 1995.
4. Nick Carter, W. Disaster Management – A Disaster Manager's Handbook. Asian Development Bank, Philippines, 1991.
5. Penelis, G. G and Kappos, A.J. Earthquake-resistant Concrete Structures, E and FN SPON, London, 1997.
6. Ramasamy, SM. Trends in Geological Remote Sensing - Rawat Publishers, Jaipur
7. Avasthy R.K., Bhoop Singh, Sivakumar R. Landslides: A Perception and Initiatives of DST. Indian Society of Engineering Geology. 2006.
8. Gupta P.N, Roy, A.K. Mountain Resource Management and Remote Sensing. Surya Publications, Dehradun. 1991.
9. Ramasamy, SM., Remote Sensing in Geomorphology, New India Publishing Agency, New Delhi, 2005.

Course Outcomes:

After the successful completion of this course, the students are able to:

- Basic skill in the earth quake classification
- Skills in Earth Quake disaster mitigation and management using geospatial techniques.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
VII	Optional Elective - 16	Geoinformatics in Quaternary Geology	3	25	75	100

Objectives:

- To understand the characteristics quaternary landforms
- To understand the quaternary climate change
- To acquire skills and the knowledge of different techniques of age dating

Syllabus:

Unit:1. Introduction: Introduction to Quaternary period and types of Quaternary deposits. End of the tertiary period and prologue to the Quaternary period, tectonic movements, magnetic polarity reversal, colluvium, alluvium, aeolian deposits, glacial, action of the sea and littoral sedimentation, salars, tufa and travertines, soil types, shallow water reserves and sediments used in human activities. **12 hrs**

Unit:2. Quaternary study techniques: Relative chronologies and correlation, use of flora and fauna, nonradioactive techniques, radioactive techniques. Dating methods- radiocarbon, U/ Th Pb-Pb with case studies and dendrochronology **9 hrs**

Unit:3. Characteristics of the Quaternary Period: Causes of Quaternary climate change, manifestation of Quaternary climate change and current issues in climate change, Human and Quaternary climate change, fauna at the Pliocene-Quaternary transition, emergence of hominids and evolution of Man. **9 hrs**

Unit:4. Quaternary Climate Change: The climate between 2.5 Myr and 130,000 yr, ice ages, glaciations, last glaciations and the last glacial maximum, the deglaciation and the Holocene, Ocean and deep sea environments, terrestrial environments, lake and desert environments, soils. Humid tropical environments, subtropical arid zones and warm deserts, fluctuation in the polar region and Mediterranean environments. **9 hrs**

Unit:5. Deformation during the Quaternary Period: Recent crustal movements and young magamatism, post glacial crustal uplift, Analysis of Quaternary sediments from borehole data, climate modeling and prediction of climate change. **9 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Introduction about Neotectonic – quaternary sea level change and its impact of near shore environment.

References:

1. Bradley, R.S. Quaternary paleoclimatology, methods of paleoclimatic reconstruction, Allen and Unwin, US 1985.
2. Riser, J.A.M., Quaternary Geology and the Environment, Springer, Praxis Publishing, Chichister, UK. 2001.

Course Outcomes:

After the successful completion of this course, the students are able to:

- To obtain thorough knowledge for studying about quaternary landforms
- Idea about the various age dating and interpretation of climate change impact

OPTIONAL ELECTIVES SEMESTER - IX

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	Optional Elective - 17	Himalayan Geology and Geotectonics	3	25	75	100

Objectives:

- To study palaeo geography and closure of the Tethys sea. Metamorphism and Igneous intrusions.
- To study plate tectonics and formation of Tethys and evolution of the Himalayas and its classification.
- To understand seismotectonics and the earthquakes in Himalayas, landslides and river blockades; structure and uplift of Himalaya.
- To study Igneous activities and metamorphism in Himalayas and its mineral wealth of Himalayas.
- To study plate tectonics and Sea-floor spreading of the evidences.
- To understand Concepts of Isostasy and Horst- Graben structures.

Unit 1: Introduction and classification of Himalayas. The stratigraphy, structure and tectonics of Sub Himalaya, Lesser Himalaya, Higher Himalaya and the Tethys succession and the Indus Suture Zone. Plate tectonics and formation and evolution of the Himalayas. Formation of Tethyes Geosyncline. Phases of upheaval of Himalayas. Geological and Geographical sub-divisions of Himalayas Stratigraphical and lithological units of Himalayas and their correlation.

Unit 2: Geosynclines, their evolution and classification Plate tectonics, theories and plate movement Sea-floor spreading theories and evidences.

Unit: 3. Concepts of Isostacy Horst-Grabens and Rift valleys Neo-tectonic movements and its indicators

Unit 4: Structures of the Himalayas Sedimentation, Igneous activity and metamorphism in Himalayas. Mineral wealth of Himalayas Detailed study of important rocks type of Himalayas both in hand specimen and under microscope.

Unit 5: The metallogeny and plate tectonics of the Himalayas, its mineral deposits. Environmental aspects, Seismotectonics and the earthquakes in Himalayas, landslides and river blockades; structure and orogenic cycles, uplift, dating of Himalayan rocks, paleaotectonics, palaeogeography and closure of the Tethys Sea. Metamorphism and Igneous intrusions; relationship with Indian Peninsular shield elements.

Unit:6. Current Contours: (Not for Final Exam only for Discussion):

Continental drift- Pangaea - Panthalassa-Tethys sea- Gondwana and Laurasia -Mountain Building-Volcanic activities- Earthquakes-Marine fossil horizons-building stones-economic minerals-Mass wasting movements- Isotasy

References:

1. Ragan, D.M. – 1973 – Structural Geology, Wiley
2. Ramsay, J.G. 1967 – Folding and fracturing of Rocks. McGraw Hill
3. Philips, F.C.1954 – The use of Stereographic projection in Structural Geology, Arnold Publishers
4. Compton, R.R. – 1962 – Manual of field geology, Wiley
5. Allan Cox 1973 - Plate tectonics, Freeman &co.
6. A.L. Bloom (2004) General Geology V.V.P. Press.
7. Gregory , J.W. and Barret B.H (1931)- General stratigraphy Mathuen

Course Outcomes:

- Formation of Tethys and evolution of the Himalayas.
- Closure of the Tethys Sea and various igneous and volcanic activities.
- Plate tectonic theories, continental drift and evolution of Himalya.
- Zones of earthquake and other hazards in this Himalayan area.
- Fine balance of Isostasy is a fundamental concept in the Geology

Sem	Code	Course Name	Credit	Marks		
IX	Optional Elective–18	Object Oriented Programming in GIS & Open source GIS	4	I	E	T
				25	75	100

OBJECTIVES :

- To know the fundamentals of computer programming.
- To facilitate the student to develop Object Oriented Programming
- The open source options are for research and development. It helps the candidate to think creatively and independently in Geoinformatics project implementation. It also gives complete freedom to modify the software to suit the needs. The course exposes to major avenues of open source opportunities.

Unit 1 : Concepts of Object Oriented Programming

Object Oriented Methodology: Introduction, Advantages and Disadvantages of Procedure Oriented Languages, what is Object Oriented? What is Object Oriented Development? Object Oriented Themes, Benefits and Application of OOPS. **Principles of OOPS:** OOPS Paradigm, Basic Concepts of OOPS: Objects, Classes, Data Abstraction and Data Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Passing - Object Oriented GIS - Object Oriented Analysis - Object Oriented Design –Examples. **8 hrs**

Unit 2: OPEN SOURCE SOFTWARE AND SERVICES

Introduction : OS Remote Sensing software (Eg: ILWIS, OSSIM, ORFEO, OpenEV) - Desktop systems (Grass, gvSIG, QGIS and SAGA) - Map Servers and Web Services (GeoServer and Map Server) - Embedded scripts for GIS services (HTML with PHP and Python) - Geo Statistical operations and Open Statistical tools - R environment and R spatial - standards in GIS documents – ArcGIS Online. **6 hrs**

UNIT 3: Python for GIS: Goeprocessing with Python, Importing ArcPy, use of built-in tools, setting environments, tool messages, working with vectors and its geometries, raster data handling, batch processing, Map automations, Working with toolbox, model builders and development of graphical user interfaces (GUI), development of Python addins for ArcMap. **14 hrs**

Unit 4 : Python OOPs Concept

Python : Classes and Objects, Methods, Constructors – Inheritance, Polymorphism, Data Abstraction, Encapsulation – Database Access – Error Handling –Examples. **12 hrs**

Unit 5: R Programming basics

Introduction, Data types, Variables, Vectors, Scalars, Conclusion, Data Frames, Lists, Matrices, Arrays, Classes, Arithmetic and Boolean Operators and values, Structures, Control Statements, Loops, Recursion, Scoping Rules, Loop functions, Array and Matrices, Spatial programming **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Object Oriented programming in the field of geotechnology- Apply the Open source programming for analysis of spatial and non- spatial data and for visualisation

REFERENCES:

1. Timothy Budd, Introduction to Object Oriented Programming, Addison-Wesley, 2001.
2. Mike O.Docherty, Object oriented analysis and design, John Wiley and sons, 2005.
3. Mapserver - Opensource GIS Development - Bil Kropla - Apress - 159069-490-8 - 2005.
4. The GeoSpatial Desktop Open source GIS and Mapping - Gary Sherman
5. Gary E Sherman, Desktop GIS: Mapping the Planet with Open Source Tools, Pragmatic Bookshelf publication 1 edition,2008, ISBN-10: 1934356069
6. David I. Schneider, Introduction to Programming Using Python, 1st Edition, Pearson, ISBN: 9780134058221, 2016
7. 4. Lawhead Joel, QGIS Python Programming Cookbook,2nd Revised Edition, Packet Publishing, ISBN: 9781783984985, 2017.
8. 5. Chaowei Yang, Introduction to GIS Programming and Fundamentals with Python and ArcGIS, 1st Edition, CRC Press, ISBN: 9781466510081

OUTCOMES:

- Fundamental of Computer Programming
- Acquire skills in Object Oriented Programming and Problem Solving
- Understand the important of Open source technology in GIS and various options available in its implementation.
- Acquire skills in using open source software along with the principles of handling licenses and source code modification.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	Optional Elective - 19	Nuclear and Isotope Geology	3	25	75	100

Objectives:

- Understand the structure of atomic nuclei and how this affects nuclear stability Be able to explain the processes by which the chemical elements have been synthesized over the history of the cosmos.
- Understand and be able to use the various techniques of radiometric dating to determine the age of geologic materials and events.
- Understand and be able to explain the evidence for the existence of extinct radioisotopes in the early solar system and the Earth and how these provide a detailed chronology of early solar system history.
- Be able to explain how radiogenic isotopes are used as tracers of geologic and oceanographic processes, including evolution of the continental crust and mantle, and ocean circulation.
- Be able to explain how slight differences in mass lead to slight differences in chemical behavior of isotopes of an element.

Syllabus:

Unit:1. Introduction: Introduction to isotope chemistry and geochronology. Fundamentals of dating methods Experimental work. Application of different dating methods and interpretation of data. . **12 hrs**

Unit:2. Isotope geochemistry: Stable isotope Geochemistry of rocks and minerals. Geochronology of the crystalline rocks. Archaean Geochronology. Isotope and trace element geochemistry of the Earth's mantle. **8 hrs**

Unit:3. Dating techniques: Fission track dating and geologic annealing of fission tracks. U/ Th - Pb dating of minerals. 40Ar / 39Ar dating principles, techniques and application in orogenic terrains. Geochronology of ophiolites. **8 hrs**

Unit:4. Dating of Rocks: Recent trends to Rb-Sr dating of sedimentary and metamorphic rocks. Geochemical studies of sedimentary and metamorphic rocks. Geochemistry of lead. Archaeometry dating. Theory of cooling Ages. **8 hrs**

Unit:5. Isotope geology: Carbon isotope in petroleum geochemistry. Sulfur Isotopes. Stable hydrogen and Oxygen Isotopes in water cycle. Diffusion experiments in Isotope geology with case studies. **8 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Stable Isotope Theory - Isotope fractionation in the Biosphere - Applications to Archeology and Paleontology – Palaeo climatology - Carbon Cycle and Climate.

Text books:

1. Fraure, G, Principles of Isotope Geology, John Wiley, Ed., 1986.

References:

1. Bradely, R. S., Quaternary palaeo climatology Methods of palaeo climatic reconstruction, Allen & Unwin Inc., US, 1985 Jager. E. and Hunzirer .
2. J. C. Lectures in Isotope Geology. Springer and Verlag Berlin, Heildelbero. 1979.
3. Jager. E. and Hunzier. J.C. Lectures in Isotope Geology. Springer and Verlag Berlin, Heildelberg.1979.
4. Stokes, .A. An introduction to tree ring dating, University of Chicago Press, Chicago. 1968.
5. Dickin, A.P. Radiogenic Isotope Geology Cambridge University Press. Cambridge. 1997.

Course Outcomes:

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

- Able to understand different techniques of radiometric dating to determine the age of geologic materials and events.
- Able to understand the importance of isotope studies in palaeo climate studies.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
IX	Optional Elective - 20	Geoinformatics in Desert Geotechnology	4	25	75	100

Objectives:

- To acquire the knowledge in various geomorphic processes of the formation of desert landforms
- Idea about desert landforms and its evolution
- Exposure in land and water resource development in the desert

Syllabus:

1. Evolution of Deserts

Definition and distribution of deserts – causes of aridity – Global distribution of deserts – Genesis and evolution of deserts – Topographic survey of desert surfaces: basin and range, shield topography - weathering processes and forms of arid region.

16 Hrs

2. Aeolian processes and landforms in Desert

Definition – sources of sand – actions of wind – wind erosion and landforms (wind carved rocks, bowels and caves, Desert parameters deflation basins blow out etc.,) Landforms of wind transport – Land forms of wind deposition (different types of dunes Loess deposits) – Palaeo Aeolian deposits.

12 Hrs

3. Mountain – Plain Systems

Mountain – Plain evolution: slope form – slope elements - Model classification of slope form: 4 unit model and 9 unit model – Evolution of slope: Slope decline, slope replacement and slope parallel retreat - slope hypothesis: parallel retreat, down wearing retreat, drainage basin, mantle controlled plantation, etc. – Formation and distribution of Cold deserts.

12Hrs

4. Fluvial Systems in Arid Region

Precipitation – Run off – Stream flow generation - Stream erosion landforms – debris covered slopes – Debris fans, Wash Controlled slopes – Ephemeral Streams – Channel geometrics in desert – Perennial rivers – Hydrograph - Palaeo fluvial landforms and buried rivers – Alluvial fans – Mudflows – origin, distribution and applications of Playa lakes **12 Hrs**

5.Land and water resources development in Arid Region

Mechanisms of Soil Conservation and management – Dune stabilization – Water conservation and management. Modern method of rainwater harvesting – Artificial recharge site selection – Waste water utilisation

12 Hrs

References:

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

Course outcomes:

After the successful completion of this course, the students are able to:

- Proficient in the desert landforms and its evolution and management
- Skill in the sustainable development of the desert ecosystem

OPTIONAL ELECTIVES SEMESTER - X

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	Optional Elective - 21	Sustainable Development	4	25	75	100

Objectives:

- To understand the role and the importance of various natural resources, critically relate to and analyze the history and development of the concept of Sustainable development
- To impart skills in the Analysis and planning for Sustainable development sustainable development of soil, forest, ecology
- To understand the need for resources management.

Syllabus:

Unit:1. Principles of Sustainable Development: Definition – Brundtland commission report - Classification of natural resources - Natural Resources Management (NRM) - Inventory of natural resources (Mineral, energy resources, water, oil, forest and biomass) - Evaluation of Status of exploitation of natural resources - Evaluation of availability versus depletion - Possible environmental issues - Resources versus societal needs -Sustainable development strategies – Millennium Development Goals (SDGs). 16 Hrs

Unit:2. Thematic data bases: Thematic data and SDGs - Lithology - Geomorphology - Slope - Drainage and Watershed - Slope - Land use / Land Cover - Climate /Rain fall transport and settlement. 12 hrs

Unit:3. Resources Management I : Mineral resources exploration and management. Water resources exploration, harvesting and management - Traditional water harvesting structures and environmental protection. 12 hrs

Unit:4. Resources Management II: Agriculture and Command area management-Animal husbandry and Fisheries management - Health and sanitation - Poverty and disease - Designing and Financing a Primary Health System in Low-Income Settings. 12 hrs

Unit:5. Socio-Economics: Social Properties-Demographic profile - Economic growth and progress - Continuing poverty - Environmental threats hitting the rich and poor countries - Sustainable development and society. 12 hrs

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Sustainable Food Supply and the End of Hunger – Malnutrition - ecology, and food security- How environmental change threatens the food system – How the food system threatens the environment - sustainable global food supply.

References:

1. Kumari, A.K. (2007). Understanding Sustainable Development, Hyderabad : ICFAI University.
2. Pierre, A., Shukla, P.R. and Prederic, G. (2000). India's Energy: Essays on Sustainable Development, New Delhi: Manohar Publications.
3. Rattan, V. (1997). Women and Child Development: Sustainable Human Development. New Delhi: S.Chand and Co.
4. Rogers, P.P, Jalal, K.F. and Boyd, J.A. (2007). An Introduction to Sustainable Development. (1st ed.). Routledge.
5. Soubbotina, T.P. (2004). Beyond Economic Growth: An Introduction to Sustainable Development, Washington DC: World Bank.

Course Outcomes:

- To provide general skills and wholistic understanding of the sustainable development concept
- To acquire skills needed for preserving the environment and mitigate the ecological and environmental problems.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	Optional Elective - 22	Geoinformatics in Climate Change Studies	4	25	75	100

Objectives:

- To demonstrate the understanding of the climate system.
- To evaluate the various factors that shape climate.
- To describe how past climates contribute to our current understanding of climate change.
- Explain the consequences, risks, and uncertainties of climate change.
- Understand the different modeling approaches, their scope and limitations and wide range of applications of modeling in climate scenario

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. **16 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 (Greenh ouse 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 Multitemporal data analysis of Coastal, Riverine, Glacier and Mountain System.

12 Hrs

UNIT IV 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

12 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

8 Hrs

UNIT VI Climate change scenarios: 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.

8 Hrs

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

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:

1. Andrew M. Carleton, Satellite Remote Sensing in Climatology, CBS publishers & Distributors Pvt. Ltd., New Delhi, 1992.
2. Kumarasamy, K. Dr., Kamaraj, E.C. Dr., Anand, P.H. Dr. Samuvel Selvaraj, R Dr, and Kumar, V., Kalanilaiyal, Grace Publications, Kumbakonam, 2001.
3. Howard H.Chang, Fluvial Processes in River Engineering, John Wiley & Sons, New York, 1988.
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

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	Optional Elective - 23	Geodesy	3	25	75	100

Objectives:

- To acquire knowledge on different types of Geodesy
- Geodesy application for precise and leveling

Syllabus:

Unit:1. Geometric Geodesy: Astro-geodetic determination of the reference spheroid – Transformation of Geodetic data between reference datum – The Bursa-Wolf transformation model, Horizontal and Vertical Geodetic datum – Three dimensional geodesy. **12 hrs.**

Unit:2. Gravimetric Geodesy: Gravimeters and Gravity networks – Moving base Gravimetry, Base station Networks; Potsdam Network, IGSN 71, IAGBN. Gravity reduction techniques – Gravimetric and Astro-geodetic methods of determination of Geoid and Deflection of vertical. Anomalous potential and gravity; Stoke's Integral, use of spherical harmonics. Deviation of generalized stoke's equation; Disturbing potential and Geoid undulation, Zero order undulation, Deflection of the vertical theory – Veining – Meinez Formulae. **16 hrs.**

Unit:3. Physical Geodesy: Potential theory – Solution of Laplace equation of spherical harmonics, concept of Ellipsoidal harmonics. Earth's gravitational field and Reference fields – Gravity and its potential of the earth in terms of spherical harmonics, Gravity field of the level ellipsoid; Equations for gravity and potential, Gravity on the ellipsoid. **12 hrs**

Unit:4. Satellite Geodesy: Perturbed orbits; Equation of motion, the disturbing function, osculating ellipse, lagrange and Gaussian planetary equations, Gravitational perturbations, Atmospheric drag. Luni-Solar perturbations, Solar-Radiation pressure. Engineering geodesy – crustal movements, Earth tides. **12 hrs**

Unit:5. Miscellaneous: Gyrotheodolites, Hydrostatic leveling, precise leveling – Procedures and computations. Lunar and planetary Geodesy. **12 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Recent trend in satellite geodesy- IRNSS.

References:

1. G.Bomford, Geodesy, Clarendon Press, Oxford, 1980.
2. Wolfgang Torge, Geodesy, Walter de Gruyter, Berlin, 1991.
3. Gunter Seeber, Stellite Geodesy, Walter de Gruyter, Berlin, 1993.
4. Ivan I, Mueller and Karl H TAmsayer, Introduction to Surveying, Frederick Ungar Publishing Co., New York
5. Teunissen P.J.D., GPS for Geodesy, Springer, 2nd Edition, 1998.

Course outcomes:

After the successful completion of this course, the students are able to:

- The students acquire the holistic knowledge on various geodesy application for earth related studies and mapping.

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
X	Optional Elective - 24	Geoinformatics in Glacial Geotechnology	3	25	75	100

Objectives:

- To know about the glacial formation
- To identify the different types of glacial landforms
- Sustainable management of glacial landforms

Syllabus:

Unit:1. Evolution of Glaciers: Definition, distribution of Glaciers – Causes of Glaciation – Global distribution of glaciers– Genesis and evolution of glaciers - Survey of Glaciated terrain – Types of Glaciers –Forms and Weathering processes. **12hrs**

Unit:2. Glacial Processes and Landforms: Definition – Actions of Glaciers –Nivation, Ablation, Calving, Seerace, Glacier Erosion - destructional landforms (Cirques, Aretes, U-Valleys, Striations, Roches-Moutannees, Crag and tail, etc. - Constructional / depositional features – Moraines-Types of moraines, Drumlins, Basket of egg topography, Tills, etc. Rock formations - Tillites, Breccia. **16hrs**

Unit:3. Glacio-Fluvial, Glacio-lacustrine Processes and associated Landforms : Glacio-fluvial transportation, erosional and depositional processes and related landforms,– outwash plain – Kame Terraces, Eskers, Kettles, logging-stone, Stratified drift, Varves. Glacio-lacustrine processes and related landforms - Fiords, Icebergs. **12hrs**

Unit:4. Glacial Landsystems: Definition – Ice-Marginal Terrestrial Landsystems – Supraglacial Landsystems – Surging Glacier Landsystems – Glaciated Valley Landsystems – Plateau Icefield Landsystems – Paraglacial Landsystems – Subaquatic Landsystems – Palaeo-Ice Stream Landsystems. **12hrs**

Unit:5. Land and Water Resources Development: Mass balance of the Glaciers – Meltwater Streams and Channels – Glacial and Proglacial Lakes, Tarns, Kettle lakes - Glacial aquifers – Conservation and Management.

12hrs

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Polar and continental ice sheet- climate change and its impact of glacial.

References:

1. Manmohan Nath Kaul, Glacial and Fluvial Geomorphology of Western Himalaya. Concept Publishing Company, New Delhi. 1990.
2. David J.A. Evans, Glacial Landsystems, Published by Hodder Arnold, London, 2005.
3. Thornbury, W.D., Principles of Geomorphology, John Wiley and Sons, 2nd Edition, New York. 1985.
4. Jha. V.C., Geomorphology and Remote Sensing, ACB Publications.
5. Verstappen, H. Remote Sensing in Geomorphology, Elsevier, Amsterdam. 1977.

Course outcomes:

After the successful completion of this course, the students are able to:

- Students gain the knowledge about different types of glacial landforms and its importance

OPTIONAL ELECTIVES SEMESTER - XI

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	Optional Elective - 25	Current trends in GIS	3	25	75	100

Objectives:

- Provide the latest state of art in GIS technology.
- Provide an opportunity to understand the application potentials of GIS in various fields
- Understand the applications of GIS in various utility sectors
- Understand the concepts of Neural network and Fuzzy logic.

Syllabus:

Unit:1. Automated Mapping (AM) and Facilities Management (FM): AM/FM -Definition - Applications in AM -FM studies in Water, Waste Water, Electric Utilities -Telecom applications, Radio coverage Prediction, Signal Strength Mapping - Case Studies. **12 hrs**

Unit:2. Demographic and Business Applications: Definition - Crime Analysis, Electoral Redistributing, Marketing and Retailing -Case Studies. **12 hrs**

Unit:3. Network Applications: Vehicle Routing -Scheduling, Vehicle Tracking and Navigation: Integration of GPS and GIS data -Case Studies. **12 hrs**

Unit:4. Open-Source GIS: Serving Spatial and Non-Spatial data on the Internet -Principles and Issues -Server and Client-Side Configuration -Web based GIS Applications -Software Modules -Case Studies. **12 hrs**

Unit:5. Miscellaneous Topics: Fuzzy logic and Neural Network applications using GIS, 3D GIS Case Studies. **16 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Web mapping: Static and interactive web mapping, Web Mapping Services, Open Layers, Google maps, Microsoft map services, internet in GIS, Mobile GIS.

References:

1. Burrough, PA., Principles of Geographical Information Systems, Oxford University Press, 1997.
2. De Mers, Michael. N, Fundamentals of Geographic Information Systems, John Wiley and Sons, 1999.
3. David. J., Bringing Geographical Information Systems into Business, Second Edition Grimshaw, John Wiley and Sons, 1999.
4. Christian, Serving Maps on the Internet: Geographic Information on the World Wide Web Harder, ESRI Press, 1998.

Course Outcomes:

- Clear understating the methodology and applicability of GIS in utility sector
- Capability to execute any task in business GIS applications
- Capability to carry out network-based analysis using GIS
- Understand the potentials of WEB GIS

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	**Optional Elective - 26**	**Geoinformatics in Operations Research**	**3**	**25**	**75**	**100**

Objectives:

- To gain knowledge about operational research
- To understand the different types of simulation techniques

Syllabus:

Unit: 1. Introduction to Operations Research: Nature and significance- Models and Modelling- Methodology- Applications and Scope; basic operations research models -Computer Software. **12 hrs**

Unit:2. Linear Programming (L.P.): Problem formulation -structure and assumptions- standard form- Graphical solution - solution by simplex method- Sensitivity Analysis -Formulations of Dual Linear problem - Advantages of Duality -Use of L. P. Packages. **12 hrs**

Unit:3. Dynamic Programming (D.P.): Bellman's optimality criteria -problem formulation and solution -Forward and Backward recursive approaches -Use of D.P. Packages. **12 hrs**

Unit:4. Project Management: PERT and CPM: Basic differences between PERT and CPM -steps involved -Network components and precedence Relationships -critical path analysis -Resource allocation -Use of computer packages. **12 hrs**

Unit:5. Simulation: Steps -Advantages and Disadvantages -Deterministic and Stochastic simulation - simulation of Inventory problems -Queing problems -Investment -maintenance problem -PERT problem -Role of computers in simulation. **16 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Recent trends in operational research

References:

1. Hiller, P. S. and G. I. Lieberman, Operations Research, Holder- day Inc., 1974. Sharma, J. K.,
2. Operations Research Theory and Applications, Mac Mil/an India Limited, 1998.
3. Frank S. Budnick, Dennis Mcleavey and Richard Mojena, Principles of Operations Research for Management, All India Traveler Delhi, 1988.

Course outcomes:

After the successful completion of this course, the students are able to:

- Students will gain the practical experience in different modeling techniques
- Acquire the skill in performance in modeling techniques

Sem	Code	Core course Name	Credit	Marks		
				I	E	T
XI	Optional Elective - 27	Object Oriented Information System	3	25	75	100

Objectives:

- Practical exposure in different types of Object-Oriented programme
- Introduction to embedded system

Syllabus:

Unit: 1. Principles of Object Orientation

Motivations for OOP, objects and classes, abstraction and encapsulation, messages in- heritance, overriding, multiple inheritance, dynamic binding, virtual methods, inclusion polymorphism abstract classes, virtual classes dynamic binding mechanisms in Smalltalk and C^{++} OO notations. **12 hrs**

Unit:2. Comparative Study of Object Programming Language

CRC method for designing classes, interclass relationships - A Comparative Study of some typical Object-Oriented Programming Languages such as C^{++}, JAVA, Eiffel and Smalltalk. Purity in Object orientation: the Smalltalk paradigm. **16 hrs**

Unit:3. Object Oriented Analysis and Design: Introduction to object-oriented software engineering, use case analysis, object diagrams Dynamic Models, object interaction diagrams and state diagrams functional model from analysis to design relevant topics from various methodologies such as Jacobson, Rumbaugh, Booch, and Unified Methodology Elements of Design Reuse, Object oriented design patterns. **16 hrs**

Unit:4. Object Oriented Systems: Object oriented Concurrent and Distributed Systems, Active Objects, Charm++, subcontracting, object-oriented concurrency mechanisms, CORBA standard. Advanced concepts such as inheritance anomaly, reflection in object-oriented systems, multiple interfaces, filter objects, compositional filters, business objects and meta, objects. **16 hrs**

Unit:5. Object Oriented Modeling: Object Orientation: Modeling and Design Paradigms, OOM of hardware for embedded systems, object orientation and structural design, integrated system design with an object-oriented methodology. **8 hrs**

Unit:6. Current Contours: (Not for Final Exam only for Discussion): Object Oriented programme in the field of geotechnology.

Text books:

1. Timothy Budd, Introduction to Object Oriented Programming, Addison, Wesley, 1991.
2. James Rumbaugh et al., Object,Oriented Modeling and Design, Prentice Hall, 1991.
3. Laylor, D., Object Oriented Information System Planning & Implementation, John Wiley & IMS, New York, 1992.
4. Jean-Michel Berge, Oz Levia and Jacques Rouillard, Object Oriented Modeling and Design, Vol 7, Springer, Kluwer Academic Publishers, 1996.

References:

1. A Goldberg, Smalltalk -80: The Language and its Implementation, Addison, Wesley, 1983.
2. M. Ellis, B. Stroustrup, Annotated C++ reference manual, Addison, Wesley, 1990.
3. James Gosling et al., The JAVA Language Specification.
4. Bertrand Meyer, Object Oriented Software Construction, Prentice Hall, 1988.
5. Ivar Jacobson, Object Oriented Software Engineering: A Use Case Driven Approach, Addison, Wesley, 1992.
6. Grady Booch, Object Oriented Analysis and Design, 2nd ed., Benjalnin/Cummings, 1994.
7. Eric Gaillma et al., DesifJn Patterns, Aclrlison, Wesley, 1995.
8. Gul Agha et al., Research Directions in Concurrent Object-Oriented Programming, MIT Press, 1993.

Course outcomes:

After the successful completion of this course, the students are able to:

- Students gain to understand the holistic about Object Oriented programme
- Acquire skill to independently carry out in the field of Object-Oriented programme