Structure and Detailed Syllabus

Undergraduate Course (B.Sc.) in Geology
Learning Outcome based Curriculum
(Under CBCS)

For Affiliated Colleges

Manonmaniam Sundaranar University

Common Course Structure for B.Sc., GEOLOGY – 2023-2024

Manonmaniam Sundaranar University

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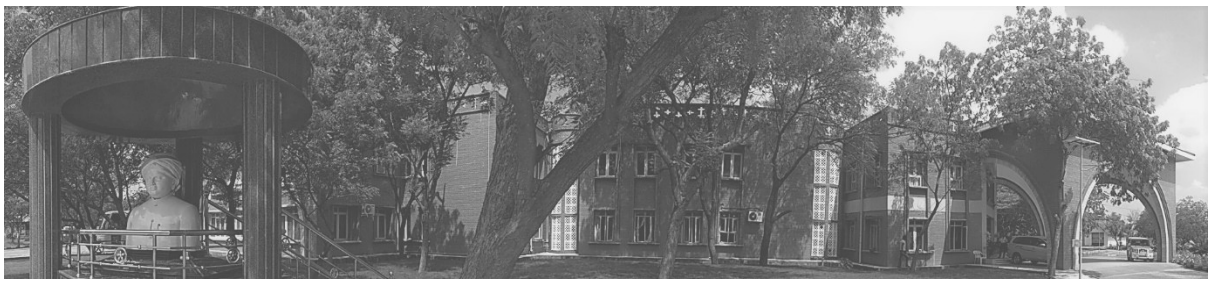

2023

Contents

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc. GEOLOGY**
Programme Code:	1514
Duration:	**3 Years (UG)**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesizing and articulating; Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team. **PO8: Scientific reasoning:** Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking:** Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

	PO10 Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning:** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities**: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning**: Ability to acquire knowledge and skills, including „learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes:	On successful completion of Bachelor of Geology programme, the student should be able to: **PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to physics and computer science. Also, exhibit proficiency in performing experiments in the laboratory. **PSO2: Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively **PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities. **PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models. **PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate

	research findings and collaborate in research projects. **PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.

PO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	✓					
PO2		✓				
PO3			✓			
PO4				✓		
PO5					✓	
PO6						✓

2. Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application-oriented content wherever required.
- The core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The general studies and statistics-based problem-solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the industry-Academia interface and provide more job opportunities for the students.
- The statistical quality control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The mapping camp during the second year will help the students gain valuable field experience that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest Remote sensing and GIS, Geophysics and Geochemistry.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome/ Benefits
I	Foundation Course To ease the transition of learning from higher secondary to higher education, providing an over view of the pedagogy of learning. Literature and analyzing the world through the literary lens give rise to an perspective.	➢ Instill confidence among students ➢ Create interest for the subject
I, II, III, IV	Skill Enhancement papers (Discipline centric /Generic/ Entrepreneurial)	➢ Industry ready graduates ➢ Skilled human resource ➢ Students are equipped with essential skills to make them employable
		➢ Training on language and communication skills enable the students gain knowledge and exposure in the competitive world.
		➢ Discipline centric skill will improve the Technical knowhow of solving real life problems.
III, IV, V & VI	Elective papers	➢ Strengthening the domain knowledge ➢ Introducing the stake holders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and interdisciplinary nature ➢ Emerging topics in higher education/industry/communicationnetwork/healthsectoretc.areintroducedwith hands-on-training.

IV	Elective Papers	➢ Exposure to industry moulds students into solution providers ➢ Generates Industry ready graduates ➢ Employment opportunities enhanced
V	Elective Papers	➢ Self-learning is enhanced ➢ Application of the concept to real situation is conceived resulting in tangible outcome
VI	Elective Papers	➢ Enriches the study beyond the course. ➢ Develop in the research framework and presenting their independent and intellectual ideas effectively.
Extra Credits: **For Advanced Learners/Honors degree**		➢ To cater to the needs of peer learners/research aspirants
Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

CREDIT DISTRIBUTION FOR U.G.

3 – Year UG Programme Credits Distribution			
		No. of Papers	**Credits**
Part I	Tamil (3 Credits)	4	12
Part II	English (3 Credits)	4	12
Part III	Core Courses (4 Credits) + Elective Courses (3 Credits)	6	92
Part IV	Foundation Course	1	2
	Skill Enhancement Courses	7	13
	EVS	2	2
	Value Education	1	2
	Internship/Industrial Visit/ Field Visit	1	2
	Extension Activity (NSS / NCC / Physical Education)	1	1
Part V	Professional Competency Skill		2
	Total Credits for the UG Programme		**140**

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	11	11	11	11	22	18	84
Part IV	6	6	6	7	3	3	31
Part V	-	-	-	-	-	1	1
Total	23	23	23	24	25	22	140

*Part I, II, and III components will be separately taken into account for CGPA calculation and classification for the under graduate programme. The other components Part IV, V has to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions.	
Understand/Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or Overview.	
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain.	
Analyze(K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge.	
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons.	
Create (K6)	Check knowledge in specific or offbeat situations, discussion, debating or Presentations.	

MANDATORY REQUIREMENTS OF B.Sc GEOLOGY PROGRAMME

- Students should have to complete two days short field trips, as per the decision by Professor in- charge during I, IInd and IIIrd year B.Sc. Geology. Report of this two days short field trip should be submitted by individuals at the end of the IIIrd year practical examination and there will be a viva-voce on it. Geological specimens collected during their field trips to be displaced during VIVA VOCE.

- Geological mapping of nearby area chosen by professor-in-charge should be held during II year, not more than one week. The reports of the geological mapping will be submitted at the end of IIIrd year course during viva-voce.

- A Geological long field trip, not more than two weeks, in IIIrd years will be conducted. The geological field report and specimen collected during field trip to be submitted during VIth semester practical examination and their will a viva-voce on it.

Credit Distribution for all UG courses with LAB Hours

B.Sc., GEOLOGY

First Year: Semester-I

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core: General Geology	5	5
	Core: General Geology Practical	3	3
	Allied Chemistry -I	3	4
	Allied Chemistry Practical	2	2
Part-4	Skill Enhancement Course SEC-1 *Field Techniques in Geology*	2	2
	Foundation Course for Geology	2	2
		23	**30**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core: Mineralogy and Crystallography	5	5
	Core: Mineralogy and Crystallography Practical	3	3
	Allied Chemistry -II	3	4
	Allied Chemistry - II Practical	2	2
Part-4	Skill Enhancement Course -SEC-2 *Natural Hazards and Mitigation*	2	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific) *Remote sensing and GIS*	2	2
		23	**30**

First year: Semester-I

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	General Geology	Core	Y	-	-	-	5	5	25	75	100
Course Objectives											
CO1	The main objective of this course is to enumerate the origin of Earth, its interior and its age.										
CO2	To describe the concepts of rock weathering and wind										
CO3	To explain Geological agent: Glacier and sea										
CO4	To explain Geological agents: River and Groundwater										
CO5	To describe all the dynamic activities of Earth										

Unit	Details	No. of Hours	Course Objectives
I	A brief account of various theories regarding the origin of earth. Interior of the Earth: an outline of the composition and constitution of the interior of earth. Age of the earth: relative dating and absolute dating – radiometric dating: Potassium – Argon, Rubidium – Strontium, Uranium – Lead, Lead –Lead, Fission track dating and Carbon dating method.	15	CO1
II	Rock weathering: Geology and weathering-agents of weathering, processes of weathering-mechanical weathering: Frost wedging, frost heaving, saltaction and sheeting, chemical weathering: solution, hydration, hydrolysis, oxidation/reduction, carbonation and chelation. Biotic weathering: biophysical and biochemical. Mix processes: spheroidal, exfoliation and differential weathering. Soil–definition, types and formation process of soils- Soil Horizon Wind as a Geological Agent: erosional methods: deflation, corrosion and its impact. Erosional features-By abrasion: undercut hills, cave rock, mushroom rock, mesa, yardang, ventifacts. By Deflation: desert pavement, deflation hallows. Transportation-saltation, suspension and traction. Deposition-causes and types, pile and sheets deposits-dune formation, migration and different forms. Desert: description, kinds and desert features: plains, bajadas and pediment.	15	CO2
III	Work of Glaciers: Types of glaciers: cirque, valley, piedmonts and continental glaciers- Glacial movement-erosional processes-erosional features-	15	CO3

	depositional features. Work of sea and its deposits: waves, breakers, rip-current, long-shore current. Processes of erosion, erosional features: wave cut terraces, sea cave and arch, headland, stacks, transportation and various depositional features: beaches and barriers, spits and bars, deltas, wave-built terraces. Ocean deposits: shallow water and deep-water deposits.		
IV	Development of drainage system and work of stream: channel characteristics- stream erosion characteristics, types of streams, drainage patterns, Erosional features-valleys, river piracy, waterfalls, cascade, water gaps, pot holes and plunge pools, river terraces, meanders, ox-bow lakes, pediments and peneplains, transportation methods, causes of stream deposition, depositional features-deltas, point bars, natural levees, alluvial fans, floodplain, back swamps, and braided rivers. Types of streams and drainage patterns. Work of Ground water: movement of ground water due to gravity and pressure difference- ground water discharge-springs, wells and artesian wells and springs, thermal springs. Erosion by ground water and erosional features. Transportation by ground water, deposition by ground water and forms of deposits.	15	CO4
V	Plate tectonics: Historical background –Characteristics of plates – Major plates – plate movements – Plate boundaries: divergent: mid-oceanic ridges, continental rift, triple junction, geological characters; convergent: ocean – ocean, ocean – continent, continent – continent convergence, geological characters and transform fault boundary - causes for the plate movement. Volcanoes: classification: based on state of the volcano, structure of volcano, kind of material erupted, eruptive force and location of volcano. Products of volcano: Gases, liquids, and solids. Earthquake- Definition - causes- classification-seismic waves: Body waves and surface waves-earthquake detection and measurement–determination of epicenter – scale of earthquake: intensity and magnitude scale- effects of earthquakes– Tsunami-causes and effects.	15	CO5
	Total	**75**	
The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular Unit. There will be equal number of Course objectives and Course outcomes. The blooms taxonomy verbs will be given as a separate annexure for your reference. Each course outcome should be mapped with the POs. The mapping of each CO can be done with any number of POs.			

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the origin of galaxy and solar system, interior of the earth and age of the earth	PO1
CO2	Rock weathering and wind as a geological agent	PO1, PO2
CO3	Geological Agents: Glaciers and Sea	PO3, PO6
CO4	Geological Agents: River and Groundwater	PO4, PO5, PO6
CO5	Various dynamic activities of Earth	PO3, PO8
Text Books (Latest Editions)		
1.	Radhakrishnan, V, General Geology, V.V.P. Publishers, Tuticorin (1996)	
2.	Arthur Holmes, Principles of Physical Geology: Thomas Nelson & sons London. (1992)	
3.	Patwardhan, A. M., Dynamic Earth System, Prentice Hall, New Delhi (1999)	
4.	Mukherjee A.K, Principles of Geology, EW Press, Kolkata (1990)	
5.	Reed, J.S. & T.H. Wicander, Essentials of Geology, McGraw Hill., New York (2005)	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Charles C. Plummer, Diane H. Carlson and Lisa Hammersley (2019). 'Physical Geology' (16thEd). McGraw-Hill Education.	
2.	Strahler A. M (1965). Introduction to Physical Geology. Wiley.	
3.	Gass, I.G., Smith, P.S & Wilson, R.C.L., 2ndEdt., (1972), Understanding the Earth, The English Language Books Society, London	
4.	Robert, S.A. and Suzanne, P.A., (2010) Geomorphology – The mechanics and chemistry of landscapes. Cambridge University Press.	
5.	Mahapatra, G. B. (2018). Textbook of Physical Geology. India: CBS Publishers & Distributors.	
Web Resources		
1.	https://opentextbc.ca/geology/	
2.	https://serc.carleton.edu/geo2yc/courses/46478.html	
3.	Geo.libretexts.org	
4.	www.nationalgeographic.org	
5.	Solarsysytem.nasa.gov	

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.
The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	General Geology Practical	Core	Y	-	-	-	3	3	25	75	100

Course Objectives	
CO1	To understand various laws of Geology through activity.
CO2	To know the changes happen on the earth through time
CO3	To realize the application of Density and gravity concept in Geology
CO4	To know the velocity, distance and time of changes on earth
CO5	To understand the concepts of topographic map

Unit	Details	No. of Hours	Course Objectives
I	Identifying the geological events of an area using geological laws: Conformity, Unconformity, Law of superposition, Law of cross-cutting.	09	CO1
II	Calculating changes through time : in Plate tectonics, Stream and Groundwater, Glaciers, mountain building and erosion.	09	CO2
III	Density and Specific Gravity in the Geosciences: in Isostasy, Plate tectonics, Minerals and Rocks.	09	CO3
IV	Velocity, Distance and Time: in Geophysics, Groundwater studies, Climate change, Plate tectonics. Density in rocks and Minerals.	09	CO4
V	Relief and Gradient Analysis from topographic maps. Construction of topographic profiles from a topographic map.	09	CO5
	Total	**45**	

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Each course outcome should be mapped with the POs.
The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	To understand various laws of Geology through activity.	PO1
CO2	To know the changes happen on the earth through time	PO1, PO2
CO3	To realize the application of Density and gravity concept in Geology	PO3, PO6
CO4	To know the velocity, distance and time of changes on earth	PO4, PO5, PO6

CO5	To understand the concepts of topographic map	PO3, PO8
Text Books (Latest Editions)		
1.	Radhakrishnan, V, General Geology, V.V.P. Publishers, Tuticorin (1996)	
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3.	Patwardhan, A. M., Dynamic Earth System, Prentice Hall, New Delhi (1999)	
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5.	Mahapatra, G. B. (2018). Textbook of Physical Geology. India: CBS Publishers & Distributors.	
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2.	https://serc.carleton.edu/geo2yc/courses/46478.html	
3.	Geo.libretexts.org	
4.	www.nationalgeographic.org	
5.	Solarsysytem.nasa.gov	

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- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Field Techniques in Geology	SEC-1	Y	-	-	-	2	2	25	75	100
Course Objectives											
CO1	The main objective of this course is to understand the importance of field studies.										
CO2	To study the various field measurements using basic equipment.										
CO3	To understand the various changes in the earth surface.										
CO4	To study concepts of various sample types and sampling techniques.										
CO5	To understand the field data representation and fled report preparation methos.										

Unit	Details	No. of Hours	Course Objectives
I	Importance of Field study in Geology – Geological Mapping: Definition, types of maps (Topography, Cadastral, and Revenue), scale of the map, representative fraction, legends (geographical and geological), mapping techniques (Toposheet, satellite imagery, base map preparation)	06	CO1
II	Field instruments: The Brunton compass, components of compass, taking bearing using compass and its uses. The Clinometer, components of clinometer, taking measurement using clinometer. Basic field equipment (geological hammer, pocket knife, hand lens, notebook, pen, marker, and sample bags)	06	CO2
III	Geological sampling (minerals, rock, fossils, and waters samples): Aims and objectives of the field work, selecting the field area, types of sampling (Surface sampling. Channel/ Grooves sampling, Chip sampling, Grab sampling/Muck sampling, Wagon sampling, Bulk sampling, Core sampling, Sludge sampling), preparing sketches and taking photographs, recording the observations	06	CO3
IV	Study of outcrops to distinguish between loose boulders and in-situ outcrops, importance of rock contacts, mapping by following rock contacts. Observations of contacts concealed under soil or vegetation (open wells, road cuttings, open quarry, open mines), determination of dip and strike of strata, field correlation.	06	CO4
V	Preparation of a geological report: i) Compilation of field data, ii) Preparation of a report (quotations and footnotes, illustrations, table of contents and index).	06	CO5
	Total	**30**	

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The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	The main objective of this course is to understand the importance of field studies	PO1
CO2	To study the various field measurements using basic equipment	PO1, PO2
CO3	To understand the various changes in the earth surface	PO4, PO6
CO4	To study concepts of various sample types and sampling techniques.	PO4, PO5, PO6
CO5	To understand the field data representation and fled report preparation methos.	PO3, PO8

Text Books
(Latest Editions)

1.	Robert R. Compton, (1962). Manual of Field Geology.John Wiley & Sons, Inc., London
2.	Frederick H. Lahee, (1917). Field Geology. New York: McGraw-Hill; London: Hill
3.	Mukherjee A. K, (1990). Principles of Geology. E W Press, Kolkata
4.	Marland, P. Billings, (2016), Structural Geology 3rd Edition, Pearson Education
5.	Reed, J.S. &T.H. Wicander, Essentials of Geology, McGraw Hill., New York (2005)

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Gross, M. G. (1977). Oceanography: A view of the earth.
2.	Principles of Geomorphology; William D. Thornbury, (2004) CBS Publishers and Distributors, New Delhi.
3.	Gokhale N.W (2009). A Guide to Field Geology. CBS Publishers & Distributors, New Delhi
4.	DeSitter, L. U. (1956). Structural geology, Mc Graw Hill, New York
5.	Radhakrishnan, V, General Geology, V.V.P. Publishers, Tuticorin (1996)

Web Resources

1.	" https://www.geolsoc.org.uk/FieldResources.
2.	https://serc.carleton.edu/NAGTWorkshops/structure/resources.html
3.	Geo.libretexts.org
4.	https://uh.edu/~jbutler/anon/anoncoursestructure.html
5.	https://geopad.ucr.edu/resources

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CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Foundation Course		Y	-	-	-	2	2	25	75	100

Course Objectives	
CO1	To understand elements of physics related to geology.
CO2	To understand the elements of solar system and various spheres of earth.
CO3	To describe the concepts of chemistry to understand geological processes.
CO4	To study the concepts of place, time, calendar and seasons.
CO5	To know the concept of geological time scale.

Unit	Details	No. of Hours	Course Objectives
I	Definition of Geology, various branches of Geology, Development of Geology. Place and Time: Latitude and longitude, determination of latitude and longitude. Concept of time and magnitude of geological time. The seasons and calendar, precession of the earth's axis.	06	CO1
II	The solar system and planetary motion, major planet classifications and orbits. Earth as a system: Geosphere, Hydrosphere, Biosphere, Atmosphere and its interactions between them.	06	CO2
III	Atmospheric circulation -Weather and climatic changes, Earth's heat budget, Oceanic current system, and effect of Coriolis force. Concepts of eustasy, Earth-Atmosphere-Ocean interaction, Wave erosion and beach processes.	06	CO3
IV	Components of Hydrologic cycle, rock cycles and its process. Climate changes – Natural causes.	06	CO4
V	Geological time scale, Fossils, types of fossils, basic concepts of relative and radiometric dating.	06	CO5
	Total	**30**	

The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular Unit. There will be equal number of Course objectives and Course outcomes. The blooms taxonomy verbs will be given as a separate annexure for your reference. Each course outcome should be mapped with the POs. The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Understand the properties of Earth	PO1
CO2	To understand the elements of solar system and various spheres of earth.	PO1, PO2
CO3	To describe the concepts of chemistry to understand geological processes.	PO4, PO6
CO4	To study the concepts of place, time, calendar and	PO4, PO5, PO6

	seasons.	
CO5	To know the concept of geological time scale.	PO3, PO8
Text Books (Latest Edition)		
1.	Shipman. J. T, Wilson J.D, Higgins C.A and Lou Bo (2021). An Introduction to Physical Science. Cengage	
2.	Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.	
3.	Jerry Wilson, James Shipman and Charles Higgins (2015). An Introduction to Physical Science. Brooks/Cole, 14th Edition.	
4.	Todd, D.K. (2008). Groundwater Hydrology.5thed. Wiley. New Delhi.	
5.	Reed, J.S. &T.H. Wicander, Essentials of Geology, McGraw Hill., New York (2005)	
References Books (Latest edition, and the style as given below must be strictly adhered to)		
1.	Haydn A. "Chip" Fox (2021) Science in our Lives an Introduction to Physical Science.	
2.	James T. Shipman, Jerry D. Wilson, Charles A. Higgins and Omar Toores (2015) An Introduction to Physical Science. Books Cole Cengage learning.	
3.	National Geographic (2008) Introduction to Physical Science. McGrew-Hill Company.	
4.	Richard E. Chapman (2002) Physics for Geologists. CRC Press.	
5.	Radhakrishnan, V, (1996) General Geology, V.V.P. Publishers, Tuticorin.	
Web Resources		
1.	https://opengeology.org/textbook/	
2.	https://egcc.libguides.com/geology/websites.	
3.	Geo.libretexts.org	
4.	www.nationalgeographic.org	
5.	Solarsysytem.nasa.gov	

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.
The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level
-

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

SECOND SEMESTER

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Mineralogy and Crystallography	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
CO1	Remember the basic various physical properties, optical properties
CO2	To describe the concepts of basic statistics
CO3	To understand the physical, optical and other properties to determine the different groups and crystal systems.
CO4	To understand the crystal parameters in minerals and crystal models
CO5	To understand the industrial applications and economic importance of various minerals.

Unit	Details	No. of Hours	Course Objectives
I	Mineralogy: Definition, Characters and Uses -Physical Properties of Minerals: Colour, streak, lustre, hardness, habit, cleavage, fracture, Odour, fluorescence and Phosphorescence, feel, tenacity, specific gravity, magnetism. Chemistry of minerals: general principals of chemical properties of minerals: atom, ions, molecules, atomic number, mass number, valence, ionic radii–bonding in minerals–atomic substitution and solid solution-Isomorphism, polymorphism and pseudomorphism. Classification of minerals: Classification schemes, Chemical Classification of Minerals, Structural classification of silicates.	15	CO1
II	Rock Forming Minerals Group: Physical properties, chemical composition, classification, diagnostic properties and mode of occurrence of the following groups: Quartz, Feldspar, Feldspathoid, Amphibole, Pyroxene, Olivine, Mica and Garnet.	15	CO2
III	Optical Mineralogy: Properties of Light: Nature of light-ordinary and plane polarised light- Light interaction with matter; reflection, defuse reflection, refraction, double refraction, refractive Index, total reflection, dispersion, relative retardation and birefringence. Polarising Microscope: Parts of polarising microscope and its uses - Study of optical properties of minerals: Optical properties under plane Polarised Light: Form, Colour, relief, Refractive Index, Cleavage, Inclusion and Alteration, Pleochroism, Twinkling. Optical properties between cross nicol: Isotropism/Anisotropism, Interference	15	CO3

	colors, Extinction, Twinning, Zoning**.** Construction of Nicol prism-Preparation of Thin Section.		
IV	Definition for crystal – Morphological characters of crystals – Faces – Forms – Edge, Solid angle – Interfacial angle – Uses of Contact Goniometer. Law of constancy of the Interfacial angles, Symmetry elements, crystallographic axes – Miller indices – Law of rational indices. Definition of Holohedral, Hemimorphic, Enantiomorphic and Hemihedral.	15	CO4
V	Crystal Systems: Classification of crystal systems-Classification of crystals into seven systems. Morphological study of seven crystallographic systems with special reference to the elements of symmetry of their normal class. Cubic system–Normal (Galena type)-Tetragonal system – Zircon type - Hexagonal system – Beryl type - Trigonal system- Calcite type - Orthorhombic system – Barytes type - Monoclinic system – Gypsum type –Triclinic system– Axinite type. Twinning in crystals and its types.	15	CO5
	Total	**75**	

The course outcome is based on the course objectives. Each course objective will have a course outcome. This will elucidate what the student will acquaint once he completes that particular Unit. There will be equal number of Course objectives and Course outcomes.
The blooms taxonomy verbs will be given as a separate annexure for your reference.
Each course outcome should be mapped with the POs.
The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Understand the physical and optical properties of minerals.	PO1
CO2	Helps to classify the minerals into different groups.	PO1, PO2
CO3	Able to identify different minerals using physical and optical properties.	PO4, PO6
CO4	Understand the symmetry elements and symmetry element of crystals.	PO4, PO5, PO6
CO5	Apply the understanding of physical, optical and other properties to determine the different groups and crystal systems.	PO3, PO8

Text Books

1.	Read, H.H. (1916). Routley's elements of Mineralogy, Thomas Murphy & co,. London.
2.	Ford, W.E. (1988). Dana's Text book of Mineralogy. Wiley. New Delhi. (Reprint).
3.	Deer, Howie and Zussman (1964). An introduction to rock-forming minerals. Orient Longman, London.

4.	Naidu, P.R.J. (1967). Optical Mineralogy.
5.	Introduction to Mineralogy by William D. Nesse, Edition: 2nd, Oxford University Press, 2012
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Kerr, Paul. (1977). Optical mineralogy, McGraw hill, New York.
2.	Mineralogy by Perkins, 3rd Ed, Pearson Education, India, 2015
3.	Manual of Mineralogy" by Klein C and Hurlbut C S, John Wiley and Sons Ltd, 1985
4.	Advanced Characterization of Industrial Minerals by G. Christdis, Mineralogical Society of Great Britain & Ireland. 2011
5.	Basics of Crystallography, Mineralogy and Geochemistry: A concise Text book by B.S.Rathore, Notion Press, 2021
Web Resources	
1.	https://opengeology.org/Mineralogy/
2.	https://serc.carleton.edu/NAGTWorkshops/mineralogy/index.html
3.	https://nu.kz.libguides.com/crystallography_guide/resources
4.	https://www.freebookcentre.net/EarthSciences/Mineralogy-Books.html
5.	http://www.minsocam.org/msa/dgttxt/

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.
The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

First year: Semester-II

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Mineralogy and Crystallography Practical	Core	Y	-	-	-	3	3	25	75	100

Course Objectives	
CO1	Apply the basic physical properties of minerals in its identification.
CO2	To evaluate the minerals based on megascopic identification.
CO3	To understand the mineral character under light.
CO4	To study various class and forms of crystal systems.
CO5	To determine various crystallographic properties of crystals with suitable examples.

Unit	Details	No. of Hours	Course Objectives
I	Megascopic Identification and description of the following silicate mineral groups. Quartz and its varieties, Feldspar group, Feldspathoids.	09	CO1
II	Megascopic identification and description of the following: Pyroxene group, Amphibole group, Epidote group, Mica group, Garnet group and Alumino Silicates.	09	CO2
III	Microscopic identification and Description of the following: Quartz, Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Nepheline, Leucite, Enstatite, Hypersthene, Glaucophane, Biotite, Muscovite, Olivine, Epidote, Garnet, Apatite, Zircon, Sphene, Tourmaline, Calcite, Andalusite, Kyanite, Sillimanite, Staurolite, and Cordierite.	09	CO3
IV	Isometric System: Normal Class – Galena, Fluorite, Magnetite, Garnet, and Leucite, Copper- Pyritohedral class – Pyrite, Tetrahedral Class – Tetrahedrite. Tetragonal System: Normal Class – Zircon, Vesuvianite, Cassiterite, and Rutile. Tripyramidal – Scheelite, Meionite Sphenidal Class – Chalcopyrite. Hexagonal System: Normal Class – Beryl, Tripyramidal – Apatite, Hemimorphic – Zincite, Rhombohedral Normal – Calcite, Trapezohedral Class – Quartz.	09	CO4
V	Orthorhombic System: Normal – Barite, Sulphur, Stibnite, Topaz, Staurolite, and Aragonite. Hemimorphic – Calymene, Sphenoidal Class – Epsomite. Monoclinic System: Normal – Gypsum, Pyroxenes and Amphiboles. Triclinic System: Normal – Axinite, Albite, and Rhodonite. Twin Crystals: Contact and penetration twins of fluorite, Iron cross twin of pyrite, Knee type twin of cassiterite, Polysynthetic twin of aragonite, Cyclic twin of cerussite,	09	CO5

	Swallow tail of gypsum, Twins of Carlsbad, Baveno, Manebach, Albite law of Albite.		
	Total	**45**	

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The blooms taxonomy verbs will be given as a separate annexure for your reference.
Each course outcome should be mapped with the POs.
The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	The main objective of this course is to enumerate the fundamental aspects of Mineralogy in such a way as to stimulate the minds of the post-graduate students.	PO1
CO2	To describe the concepts of Mineralogy is essential to comprehend the concepts of Petrology.	PO1, PO2
CO3	To explain the importance of instrumentation techniques for better analysis	PO4, PO6
CO4	To compare and contrast between the fascinating plethora of colorful minerals and crystals, this discipline requires good knowledge of Chemistry, and poses several intriguing questions, leading to sustained interest in this subject	PO4, PO5, PO6
CO5	Can evaluate the accuracy and summaries the methods adapted for certain practical activities.	PO3, PO8

Text Books
(Latest Editions)

1.	Mineralogy – Dexter Perkins (2014), 3rd edition, Pearson New International Edition.
2.	Principles of Geomorphology; William D. Thornbury, (2004) CBS Publishers and Distributors, New Delhi.
3.	Agashe, S.N, Paleo botany, Oxford & IBH. Delhi(1995)
4.	Stewart W.N. & G.W. Rothwell, Palaeobotany, Cambridge University Press. D 2005)
5.	Moore R.C. et al., Invertebrate Fossils. CBS. Delhi (1952).

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Introduction to Mineralogy – William D. Nesse (2000), Oxford University press, New York. USA.
2.	Textbook of Mineralogy – E.S. Dana, (2000), 3rd edition, CBS Publishers & Distributers, New Delhi.
3.	Crystals and Crystal Structures – Richard J. D. Tilley (2006), John Wiley & Sons, England.
4.	Introduction to Mineralogy, Crystallography & Petrology – Carl W. Correns (1967), 2nd edition, Springer
5.	Colbert E.H. et al., Evolution of the Vertebrates, Wiley. New Delhi (2002)

Web Resources	
1.	"Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005. Retrieved 2006-01-10.
2.	Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London.
3.	Digitalatlas.cose.ISU.edu>geo>basics>fossil
4.	www.sciencedirect.com>topic>hemichordata
5.	w.qm.qid.au>biodiscovery>corals

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.
The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Natural Hazards and Mitigation	SEC	Y	-	-	-	2	2	25	75	100

Course Objectives	
CO1	Remember the concepts of hazards
CO2	Understand the causes and consequences of earthquake
CO3	Apply the knowledge for prevention techniques for natural hazards.
CO4	Analyze the various natural hazards and its impact and preparation of hazards map
CO5	Evaluate the risk reduction techniques and methods

Unit	Details	No. of Hours	Course Objectives
I	Introduction to natural hazards and disasters, historical background -The lithosphere and related hazards Atmospheric hazards, Hydrosphere and Related hazards, Human impact on natural disaster, Mitigating hazards, Plate tectonics and related hazards	06	CO1
II	Climatical hazards – climate change – atmospheric circulation – Definition, types, causes, effects and preventing techniques of large scale and small scale storm hazards – drought hazards – flooding hazards. Fire related hazards	06	CO2
III	Definition, types, causes, effects and prevention techniques of earthquake hazard, landslide hazards, volcanic eruptions and tsunami. Health and population related hazards.	06	CO3
IV	Marine Hazards: Marine pollution, ocean wave hazards, sea ice hazards, sea level rise hazards, ocean morphological changes, beach erosion hazards, marine transport hazards, marine exploration hazards, and prevention techniques for marine hazards.	06	CO4
V	Disaster management in India risk, Vulnerability and hazard mitigation through capacity building legislative responsibilities of disaster management; disaster mapping, assessment pre-disaster risk & vulnerability reduction, post disaster recovery, rehabilitation disaster related infrastructure development. Remote-sensing and GIS applications in hazards monitoring.	06	CO5
	Total	**30**	

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Each course outcome should be mapped with the POs.
The mapping of each CO can be done with any number of POs.

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Remember the concepts of hazards	PO1
CO2	Understand the causes and consequences of earthquake	PO1, PO2
CO3	Apply the knowledge for prevention techniques for natural hazards.	PO4, PO6
CO4	Analyze the various natural hazards and its impact and preparation of hazards map	PO4, PO5, PO6
CO5	Evaluate the risk reduction techniques and methods	PO3, PO8
Text Books (Latest Editions)		
1.	Monroe, J. S., Wicander, R., and Hazlett, R. (2007). Physical Geology: Exploring the Earth. Sixth Edition.	
2.	Strahler, A. Introduction to Physical Geology. Pub. John Wiley & Sons, Inc. page 632.	
3.	Hyndman, D., and Hyndman, D. (2011). Natural Hazards and Disasters. Third Edition. Pages 571.	
4.	Keller, E. D. (2012). Introduction to Environmental Geology. Printice Hall. Page 801.	
5.	Holmes, A & P. L. Duff. (1996). Principles of Physical Geology, 4th revised Edition, ELBS, London	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Radhakrishnan, V. (1996). General Geology, V.V.P. Publishers, Tuticorin.	
2.	Mahapatra, G. P. (1994). Physical Geology, CBS Publishers, New Delhi.	
3.	Porter, S. C & B. J. Skinner. J. (1995). The Dynamic Earth, John Wiley & Sons, New York.	
4.	Leet, D & Judson, S (1987). Physical Geology, McGraw Hill. New Jersey.	
5.	Patwardhan, A. M. (1999). Dynamic Earth System, Prentice Hall, New Delhi	
Web Resources		
1.	"Age of the Earth". U.S. Geological Survey. 1997. Archived from the original on 23 December 2005. Retrieved 2006-01-10.	
2.	Dalrymple, G. Brent (2001). "The age of the Earth in the twentieth century: a problem (mostly) solved". Special Publications, Geological Society of London.	
3.	Geo.libretexts.org	
4.	Solarsysytem.nasa.gov	

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.
The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Remote Sensing and GIS	SEC	Y	-	-	-	2	2	25	75	100
Course Objectives											
CO1	Remember the Indian satellite types										
CO2	Understand the various photo recognition elements from remotely sensed data										
CO3	Apply the concepts of platforms and satellite orbits										
CO4	Analyze the remote sensing principles and photo recognition elements to identify various features										
CO5	Evaluate the GIS components and vector and raster data										

Unit	Details	No. of Hours	Course Objectives
I	Remote sensing: Definition, Basic concepts and principles of remote sensing, advantages and limitations - components of remote sensing - Electromagnetic Radiation: Properties of EMR, Electromagnetic Spectrum – Atmosphere Interaction: Refraction, Scattering, and Absorption. Electromagnetic energy-Earth Interaction: Reflection, Transmission – Spectral signature: Spectral signature of vegetation, spectral signature of soil, Spectral signature of water, Spectral signature of minerals and rocks.	06	CO1
II	Remote Sensing Platforms: Terrestrial Platforms, Airborne Platforms, Space borne Platforms- Types of Satellites: Astronomical Satellites, Communication Satellites, Weather Satellites, Earth Observation Satellites, Navigation Satellites, Reconnaissance Satellites - Orbits and their Types: Geosynchronous Orbit, Sun synchronous Orbit- Sensor System: Multi spectral Imaging Sensor System, Thermal Remote Sensing System, Microwave Imaging System -Image Resolution-Types of Image Resolutions: Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal Resolution.	06	CO2
III	Aerial photographs – scales and types of aerial photographs - photo interpretation techniques – applications of aerial photographs. Mosaics: controlled and uncontrolled mosaics – advantage and disadvantages – application of mosaics in geology studies. Types of data products – types of image interpretation – basic elements of image interpretation – visual interpretation keys.	06	CO3
IV	GIS definition - history of GIS – Components of GIS – Hardware, Software, Data, People and Procedure. – GIS sub systems - Data types: Spatial data: raster, vector, TIN	06	CO4

	– Nonspatial data. Coordinate systems: Geographic coordinate system, datum and map projection and its types, projected coordinate systems.		
V	Vector Data Model: Spaghetti Vector Model, Topological Vector Models. Raster data models: Simple Raster Arrays, Hierarchical Raster Structures, Types of Raster GIS Models, Compact Raster Data Models. Attribute data model: Hiearchial, network, relational and object-oriented model. Data Base Management System: functions of DBMS, components of DBMS, data file management: simple list, ordered sequential files, indexed files.	06	CO5
	Total	**30**	

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The blooms taxonomy verbs will be given as a separate annexure for your reference.
Each course outcome should be mapped with the POs.
The mapping of each CO can be done with any number of POs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Remember the Indian satellite types	PO1
CO2	Understand the various photo recognition elements from remotely sensed data	PO1, PO2
CO3	Apply the concepts of platforms and satellite orbits	PO4, PO6
CO4	Analyze the remote sensing principles and photo recognition elements to identify various features	PO4, PO5, PO6
CO5	Evaluate the GIS components and vector and raster data	PO3, PO8

Text Books
(Latest Editions)

1.	Curran, P. B. (1985). Principles of Remote Sensing. ELBS. London.
2.	Lillisand, T. M & R. W. Kiefer. (2000). Remote Sensing and Image Interpretation. Wiley, Delhi.
3.	Drury, S. D. (1993). Image Interpretation in Geology. Allen & Unwin. London.
4.	Reddy, A. (2010). Principles of Remote Sensing and GIS. CBS. Delhi.
5.	Miller, V. C. (1961). Photogeology. McGraw Hill. New York.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Pandey, S. N. (1989). Principles and Applications of Photogeology. Wiley Eastern. New Delhi.
2.	Gupta, R. P. (1990). Remote Sensing Geology, Springer Verlag.
3.	Benhardsen, T., (2002). Geographic Information Systems: an Introduction, John Wiley & Sons, New York.
4.	Guha, P.K., (2008). Remote Sensing for the Beginner, Second Edition, East-West press pvt.ltd, New Delhi.178 pp.
5.	Ian Heywood, Sarah Corrdius and Stevecarver, 2000. An introduction to

	Geographic Information system. Longman Ltd, New York.
Web Resources	
1.	A Canada Centre for Remote Sensing Remote Sensing Tutorial
2.	https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/resource/tutor/ fundam/pdf/fundamentals_e.pdf
3.	https://open.umn.edu/opentextbooks/textbooks/67
4.	Jonathan Campbell and Michael Shin (2011) Essentials of Geographic Information Systems

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.

The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- Remember and Understanding – Lower level
- Apply and Analyze – Medium Level
- Evaluate and Create – Strong Level

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO1	3	3	2	3	3	3	2	2
CO2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	1	1
CO5	3	3	3	3	2	2	2	3

S-Strong (3), M-Medium (2), L-Low (1)