NATIONAL EDUCATION POLICY-2020

Syllabus

Bachelor (Research) of Science (Geology) / Master of Science (Geology)

Geology

DEPARTMENT OF GEOLOGY FACULTY OF SCIENCE KUMAUN UNIVERSITY, NAINITAL

Curriculum Design Committee, Uttarakhand

S. No.	Name & Designation	
1.	Prof. N.K. Joshi Vice-Chancellor, Sridev Suman Uttarakhand University, New Tehri	Chairman
2.	Vice-Chancellor, Kumaun University, Nainital	Member
3.	Prof. Jagat Singh Bisht Vice-Chancellor, Soban Singh Jeena University Almora	Member
4.	Prof. Surekha Dangwal Vice-Chancellor, Doon University, Dehradun	Member
5.	Prof. O. P. S. Negi Vice-Chancellor, Uttarakhand Open University, Haldwani	Member
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member
7.	Prof. K. D. Purohit Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member

List of Semester-wise Titles of the Papers in Geology (Major Elective Subject)					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory / Practical**	**Credits**
BACHELOR (RESEARCH) OF SCIENCE					
FOURTH YEAR	I		Advanced Structural Geology	Theory	04
			Advanced Mineralogy	Theory	04
			Geochemistry & Geochronology	Theory	04
			Geological Mapping	Field Training	04
			Practical	Practical	04
	II		Igneous Petrology	Theory	04
			Metamorphic Petrology	Theory	04
			Sedimentology	Theory	04
			Fuel Geology	Theory	04
			Practical	Practical	04
MASTER OF SCIENCE (GEOLOGY)					
FIFTH YEAR	III		Geodynamics	Theory	04
			Tectonic Geomorphology	Theory	04
			Micropalaeontology & Oceanography	Theory	04
			Field & Laboratory techniques in Geology	Field Training	04
			Practical	Practical	04
	IV		Applied Groundwater Hydrology	Theory	04
			Advanced Remote Sensing & GIS	Theory	04
			Project/Research Oriented Dissertation	Dissertation	08
			Practical	Practical	04

PROGRAMME PREREQUISITES

Candidates who have passed the three-year B.Sc. examination from any recognized university including Kumaun University or equivalent examination of other universities with Geology as one of the major subjects in all the three years can apply for admission to the **Four Semester M.Sc. Programme** in Geology.

PROGRAMME INTRODUCTION

Geology is an ever advancing and most popular branch of pure and applied science amongst the students having keen interest and curiosity in understanding the origin, evolution, nature, composition, structure and processes of the Earth and its environs through time. The identification of minerals, rocks, and fossils provide insights into the age, composition, structure, and paleoenvironment of the Earth, and life that thrived on it through the geological ages. This leads to understanding the physical processes of the Earth's spatio-temporal evolution and the availability of its natural resources and reserves. A thorough knowledge on various domains of geology is, thus, immensely useful in not only enriching our knowledge about various physical and historical aspects of the Earth's evolution and dynamics, but also in judiciously utilizing its precious natural resources as well as efficiently preventing or mitigating disasters that could be caused as a result of the Earth's powerful endogenic and exogenic processes.

The programme offers essentially the fundamental and advanced knowledge and technical skills on various domains of geology. Students would study core and applied aspects of, and recent technological advances in the subject field. The curriculum of the programme is designed in such a stepwise manner that the student can derive benefit at any stage of the programme even if the entire course is not completed; it begins with basic essential knowledge and gradually covers advanced aspects of the subject. At the end of every academic year, the student would have good knowledge of some basic and applied aspects of the subject, and this will keep on growing as the students proceeds further with the subject course. At a later stage of the course, the curriculum provides the student with an opportunity of carrying out field and/or laboratory based project work leading to a dissertation in a specialized domain of geology, which is actually a training of making a professional geologist competent in generating, analyzing, and synthesizing the data, to resolve geoscientific problems.

Candidates desirous to pursue their career in the fields of geoscience, disaster management, natural resource assessment and management, civil engineering construction projects, natural environment conservation, and allied fields can choose the offered courses in geology.

PROGRAMME OUTCOMES (POs)

The curricula of the subject of geology are designed keeping in view the following programme outcomes:

PO1	Enabling the students to understand the age, composition, structure, processes, and Evolutionary history of the Earth.
PO2	Enabling the students to identify, locate, explore, judiciously exploit, and manage various Earth resources like minerals, fossil fuel and natural gas, coal, building stones, weathered Crust and soils, underground and surface water etc.
PO3	Enabling the students to understand and assess the potential of natural processes in causing hazards and disasters.
PO4	Enabling the students to understand such geological conditions that make the terrain prone to natural and anthropogenic hazards.
PO5	Enabling the students to assess the suitability of terrain for various civil engineering constructions such as dams, reservoirs, bridges, tunnels, roads, railway lines, cable-cars, and buildings etc.
PO6	Enabling the students to formulate and execute guidelines for safe developmental activities in diverse geological terrains.
PO7	Motivating the students to take up higher studies and research to bringing out new knowledge yet to be understood the geological aspects of the Earth.

Programme specific outcomes (PSOs):

Bachelor (Research) of Science (Geology)/ Master of Science (Geology)

Programme Specific Prerequisites: To acquire *Bachelor of Science (Geology)/Master of Science*, in Geology, a student should have obtained three-year *Bachelor of Science* and *one year Bachelor (research) of Science* from any recognized university. Student should have research-oriented aptitude for gaining the advanced knowledge in the subject field so that he/she can apply the gained knowledge to resolve related research and professional issues.

PSOs: Under this programme, the students will gain in-depth, advanced knowledge on core branches of geology, as well as newly developed branches and techniques in the subject field, with particular focus on the applied aspects of it.

After completing this programme, the students will have wide-spectrum, in-depth knowledge in the subject of geology, covering basic principles, gradual advancements, and classical and recent concepts. The students will be able to identify, analyze, and solve different types of geological problems, to ensure developmental activities and optimum harnessing of the earth resources without adversely affecting the geo-

environment or endangering the terrain stability, and to analyze the vulnerability of any terrain to various types of geo-hazards. It will also instill in them the quest for better understanding of the subject through incessant pursuance and research.

COURSE STRUCTURE

Year	Semester	Course type	Credits	Teaching hours
First	I	Advanced Structural Geology	04	60
		Advanced Mineralogy	04	60
		Geochemistry & Geochronology	04	60
		Geological Mapping (Field training)	04	60
		Practical	04	60
	II	Igneous Petrology	04	60
		Metamorphic Petrology	04	60
		Sedimentology	04	60
		Fuel Geology	04	60
		Practical	04	60
Second	III	Geodynamics	04	60
		Tectonic Geomorphology	04	60
		Micropaleontology & Oceanography	04	60
		Field & Laboratory techniques in Geology (Field training)	04	60
		Practical	04	60
	IV	Applied Ground water Hydrology	04	60
		Advanced Remote Sensing & GIS	04	60
		Project/ Research Oriented Dissertation	08	120
		Practical	04	60

Semester I

Paper I: Advanced Structural Geology

Course outcome: Deformation is a continuous process occurring within the rocks in different range so this course will provide a better concept regarding such processes by providing indepth information about stress and strain. It will also give a better understanding towards the mechanisms responsible for the formation of different geological structures.		
Course type, paper & Credits	**Content**	**Teaching hours**
Theory Advanced Structural Geology	**Unit I:** Concept of stress and strain. Stress-strain relationships of elastic, plastic and viscous materials. Two dimensional strain and stress analyses. Types of strain ellipsoids; their propertiesandsignificance.Mechanical properties of rocks and their controlling factors. Theories of rock failure.	15
	Unit II: Mechanics of folding and buckling. Folds geometry and classification. Superimposed folds and their interference patterns. Causes and dynamics of faulting. Normal faults and strike – slip faults, thrust faults. Thin skinned deformation and decollement. Salt domes and diapers. Concept of balanced cross-sections.	15
	(4) **Unit III:** Joints, rock cleavage and foliations; their origin, domain character, relationship with major structures and geological significance. 15 Lineations and linear structures; their origin, relationship with major structures and significance.	
	Unit IV: Brittle and ductile shear zones; their geometry, strain pattern, kinematics, products and significance. Rotation of structural elements. Concept of petrofabric analysis. Use of stereographic and equal area projections for representing different types of fabric.	5

Suggested Reading:

- Turner, F.J. and Weiss, L.E.(2012).Structural Analysis of Metamorphic Tectonites. Literary Licensing, LLC.

- Ramsay, J.G.(1967). Folding and Fracturing of Rocks. Mc Graw Hill.
- Davis, G.H.(1984). Structural Geology of Rocks and Region. John Wiley.
- Ramsay, J.G. and Huber, M.I. (1983 and 1987).Techniques of Modern Structural Geology, Vol. I & II. Academic Press.
- Price, N.J. and Cosgrove, J.W.(1990). Analysis of Geological Structures. Cambridge
- Univ. Press.
- Bayle,B.(1992).Mechanics in Structural Geology. Springer Verlag
- Robert, D. Hatcher(1994).Structural Geology: Principles Concepts and Problems (2nd Edition)
- Ghosh, S.K.(1995). Structural Geology: Fundamentals of Modern Development. Pergamon.
- Pollard, D.D. and Fletcher R.C.(2005). Fundamentals of Structural Geology Cambridge University Press.
- Moores, E.and Twiss,R.J.(1995).Tectonics. Freeman.
- Twiss, R.J.and Moores, E.M.(2006).Structural Geology Second Edition, W.H.Freeman.
- Passchier, C.w.and Treuw R.a.J.(2005).Microtectonics, Springr.
- RichardH.Groshong(2008).3D Structural Geology: A Practical Guide to Quantitative Surface and Subsurface Map Interpretation. Springer
- Ragan,D.M (2009). Structural Geology: An introduction to Geometrical Techniques. Cambridge, University Press.
- Fossen, H. (2010). Structural Geology, Cambridge University Press
- Lisle,R.J. (2004). Geological Structures and Maps: A Practical Guide, Third edition. Elsevier
- Marshak, S. and Mitra,G.(1988). Basic Methods of Structural Geology, Printice Hall.
- Hobbs,B.E.,Means,W.D.andWilliams,P.F.(1976). An outline of Structural Geology John Wiley and Sons. New York.
- Lisle R.J. and Leyshon, P.R (2004). Stereographic Projection Techniques for Geologists and Civil Engineers, 2nd edition, Cambridge University Press.
- Rowland, S.M., Duebendorfer, E.M. and Schiefelbein, I.M.(2007). Structural Analysis and Synthesis: A Laboratory Course in Structural Geology 3rd edition, Wiley-Blackwell.

Suggested Online Link:

- https://www.classcentral.com/course/swayam-structural-geology-14312.

Paper II: Advanced Mineralogy

Course outcome: Minerals are essential constituents of rocks and hence mineral science plays prime and vital role in the study of geology and material science. They may be valuable if occurring in form of precious and semi-precious minerals and gemstones, and are commonly used in the industries and other fields. This course will provide a better understanding on natural occurrence, identification, structure, and genesis of

Silicate and non-silicate minerals, and their applications in different fields.

Course type, Paper & Credits	Content	Teaching hours
Theory Advanced Mineralogy (04)	**Unit I:** Structural classification of silicates; Study of following group of minerals with reference to chemical and structural formula, classification, atomic structure, chemistry, physical and optical properties, occurrences: Olivine, Garnet, Pyroxene, Amphibole, Mica, Feldspars, Feldspathoids, Silica and Al silicates, oxides and sulphides.	15
	Unit II: Formation of Uni-axial and Bi-axial interference figures, Interferencecolors, Pleochroism and determination of pleochroic scheme, Interference figures and determination of optic sign; Extinction; Uniaxial and Biaxial indicatrix and dispersion in minerals.	15
	Unit III: Petrographical microscope; Mica, Gypsum and Quartz plates; Universal stage and their uses in the determination of optical properties of minerals.	15
	Unit IV: Application of spectroscopic techniques in mineralogy - Raman and Mossbauer spectroscopy, An Overview of environmental and radiation mineralogy; biomineralization and gemology.	15

Suggested Reading:

- Battey, M.H.(1981).Mineralogy for students. Longman, London, New York.
- Berry, L.G. and Mason, B (1959). Mineralogy: concepts, descriptions, determinations, London Publication.
- Dana, E.S. and Ford, W.E.(2002). A textbook of Mineralogy (Reprint)
- Deer,W.A.,Howie,R.A.,andZussman,J.(1992). An Introduction to the rock forming minerals ,Harlow, Essex, England: New York, NY: Longman Scientific & Technical

- Sharma, R.S. and Sharma,A.(2014). Crystallography and mineralogy. Graduate Text Book Series, Geological Society of India, Bangalore.
- Gribble, C.D.(2005). Rutley's elements of Mineralogy, Springer.
- Klein, C. and Hurlbut, Jr. ,C.S.(1993). Manual of Mineralogy, John Wiley.
- Kerr, P.F.(1977).Optical Mineralogy, 4th Edition McGraw-Hill
- Putnis, Andrew(1992). Introduction to Mineral Sciences, Cambridge University Press.
- Winchell, A.N.(1962). Elements of Optical Mineralogy, John Wiley.
- Nesse, W. D. (2011). Introduction to Optical Mineralogy (Fourth Edition). Oxford University Press.

Suggested OnlineLink:

- https://www.classcentral.com/course/swayam-subject-geology-paper crystallography-mineralogy-17820.

Paper III

Geochemistry & Geochronology

Course outcome: This course is designed to understand high-T and low-T geochemical processes that operate in the earth's deeper and near-surface environments. The major task of geochemists is to know the physical and chemical laws governing the abundance, distribution and migration of chemical elements from one sphere to another sphere of the Earth i.e. chemical differentiation of the Earth. Dating the geological materials are utmost important for arranging the geological events in chronological order.

Course type, paper & Credits	Content	Teaching h ours
Theory Geochemistry & Geochronology (4)	**Unit I:** Composition of Earth and its constituents (Crust, mantle and core); Ionic and co-ordination number; Rules of ionic substitution, coupled substitution; Distribution coefficient: Captur admission and camouflage, Geochemical classification of elements; Behaviour of major and trace including rare earth elements during magmatic crystallization.	15
	Unit II: Near-Earth surface geochemical environment: Eh-pH diagram; Principle of chemical mass balance and rock- cycle; Chemical weathering of minerals and rocks.	15
	Unit III: Radiogenic isotopes in geochronology and petrogenesis: Rb-Sr, Sm-Nd, U-Pb isotopic system.	15
	Unit IV: Stable isotopes geochemistry, Fission Track (FT) and OSL dating techniques; Dendrochronology and Lichenometry.	15

Suggested Reading:

- Allegre, C.J. and Michard,G. (1974). Introduction to Geochemistry, Reidel, Holland.
- Evans, R.C.(1964). Introduction to Crystal Chemistry, Cambridge Univ.Press.
- Faure,G.(1998). Principles and applications of geochemistry ,2nd Edn., Prentice Hall, New Jersy, 593p.
- Faure,G.(1986). Principles of Isotope Geology, 2nd Edn., John Wiley.
- Albarde Francis(2003).Geochemistry-Introduction.CambridgeUniversityPress.
- Misra, K.C.(2012).Introduction to Geochemistry: Principles and Applications,Wiley- Blackwell.

- Alan P. Dickins (2005).Radiogenic Isotope Geology,. Cambridge University Press
- Hoefs, J.(1980).Stable Isotope Geochemistry, Springer and Verlag.
- Gunter Faure(1977). Principles of Isotope Geology by John Wiley & Sons Ltd.
- Krauskopf, K.B.(1967). Introduction to Geochemistry, Mc Graw Hill.
- Mason,B. and Moore, C.B.(1991). Introduction to Geochemistry, Wiley Eastern.
- Rollinson,H.R.(1993).Using geochemical data :Evaluation, Presentation, Interpretation, Longman, U.K.
- Gill, R. (2015) Chemical Fundamental of Geology, Wiley Blackwell

Suggested Online Link:

- https://www.classcentral.com/course/swayam-geology-geochemistry-14083

Paper IV: Geological Mapping

Course outcome: Geology is field and observational science. Geo-scientific hypothesis is framed in the field that can be tested through field data and laboratory investigations. This course will enable the students to explore practical aspect of geology such as preparation of geological maps, cross-section, and reconnaissance and detailed surveys for georesource exploration and environmental purposes etc.		
Course type, paper & Credits	**Content**	**Teaching hours**
Field training Geological Mapping (04)	The paper will be based on geological field training, in which the students will be trained on the following aspects: 1. Geological mapping techniques, understanding the interaction between topography and geologic structures. 2. Basics of field data collection, analyses, interpretation, and geological report writing. **(Note:** Marks will be evaluated on the basis of student's field training report.)	120

Practical

Practical (04)	**Section A:** Advanced Structural Geology: Study of naturally deformed rocks in hand specimens, Geometrical analysis of folds and faults. Preparation and interpretation of geological maps, Applications of stereographic and equal area projections, Strain analysis using oriented thin sections.	120
	Section B: Advanced Mineralogy: Study of physical and optical properties of important rock forming minerals; Determination of An content of plagioclase feldspars; Determination of elongation and optic sign of minerals; Determination of Pleochroism and absorption schemes.	
	Section C: Geochemistry & Geochronology: Construction of geochemical variation diagrams (Spider diagrams; Harker's variation diagrams; addition-substraction diagrams); Calculation of stoichriometric formula from chemical analysis of minerals.	

Semester II

Paper I: Igneous Petrology

Course outcome: This course will provide in-depth knowledge about the origin and evolution of igneous rocks in diverse tectonic environments through a number of major and subsidiary magmatic processes. The petrogenesis of igneous rocks can be very well demonstrated in the light of modern phase equilibria experimental works. Igneous rocks, also called primary rocks, are most abundant and were formed throughout the Earth's evolutionary history that essentially make-up the continents as a stable platform to live on it. Students will come to know about the igneous processes and world class examples of igneous provinces, complexes and suites of India.

Course type, paper & Credits	Content	Teaching hours
Theory Igneous Petrology (04)	**Unit I:** Magma generation in the mantle, their nature and evolution; Magmatic processes: Partial melting, fractional crystallization, magma mixing, assimilation, liquid immiscibility, and other subsidiary processes.	15
	Unit II: Petrography and genetic interpretation of igneous textures in terms of rate of nucleation and crystal growth; IUGS classification schemes and nomenclature of igneous rocks: Ultramafic, mafic and felsic igneous rocks; total-alkali- silica (TAS)classification of volcanic igneous rocks.	15
	Unit III: Study of phase equilibria in binary (Diopside-Anorthite,Forsterite-Silica, Nepheline-Silica, Forsterite-Fayalite; Albite-Anorthite; Orthoclase-Albite) and ternary (Diopside-Nepheline-Silica,Diopside-Albite-Anorthite, Anorthite-Forsterite-Silica;Fayalite-Leucite-Silica, Orthoclase-Albite- Silica) silicate systems in the light of modern experimental works.	15
	Unit IV: Petrogenesis and tectonic setting of major igneous rocktypes and suites: Ultramafic rocks, komatiite, lamprophyres, kimberlite, ophiolite, flood basalt, anorthosite, Tonalite-Trondhjemite-Granodiorite(TTG), granitoids, alkaline rocks and carbonatites with special reference to Indian examples.	15

Suggested Reading:

- Phillpotts, A.R.(1994). Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.

- Best, M.G.(2003). Igneous and Metamorphic Petrology, 2nd Edition, Blackwell.
- Bose, M.K.(1997). Igneous Petrology, World Press, Kolkata.
- Cox,K.G., Bell, J.D. and Pankhurst, R.J. (1979). Interpretation of Igneous Rocks, Unwin Hyman, London
- Frost,B.R.and Frost,C.D.(2014). Essentials of Igneous and Metamorphic Petrology, Cambridge University Press
- McBirney, A.R.(1993). Igneous petrology. Jones & Bartlet Publication.
- LeMaitre, R.W.(2002). Igneous Rocks: A Classification and Glossary of Terms, Cambridge
- UniversityPress.
- Wilson,M.(1993). Igneous Petrogenesis, Chapman and Hall, London.
- Kumar,S, and Singh,R.N.(2014). Modelling of Magmatic and Allied Processes. Springer, Switzerland.
- Powell,R.(1978).Equilibrium thermodynamics in Petrology : An Introduction, Harper & Row Publishers, London.
- Winter,J.D. (2001). An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
- Wood, B.J. and Fraser,D.G.(1976). Elementary Thermodynamics for Geologists, Oxford University Press, London.
- Gill, R. (2015). Chemical Fundamental of Geology, Wiley Blackwell
- Hibbard, M. J. (1995). Petrography to petrogenesis. MacMillan USA

Suggested Online Link:

- https://www.classcentral.com/course/swayam-petrology-14084
- E-pathshala.https://epgp.inflibnet.ac.in/

Paper II
Metamorphic Petrology

Course outcome: This course will allow students to gain in-depth knowledge about the origin of metamorphic rocks from different protoliths. The identification of structures, textures and mineral assemblages provide information on involved reactions under different pressures and temperature regimes, and its implication on understanding the metamorphic evolutionary history and geodynamics of mobile belts thorough time. Some noted Indian examples will be demonstrated.

Course type, paper & Credits	Content	Teaching hours
Theory Metamorphic Petrology (04)	**Unit I:** Mineralogical Phase rule of open and closed systems; Types of metamorphism; Textures of regional and contact metamorphic rocks; Deformation and metamorphism; Nature and types of metamorphic reactions; Concept and classification of metamorphic facies; Facies series; Graphical representation of minerals in ACF, AKF, AFM and A'F'M' diagrams; Time relation between phases of Deformation and metamorphic crystallization.	15
	Unit II: Description of each facies of low pressure, medium to high pressure and very high pressure with special reference to characteristics minerals, subdivisions into zones / sub- facies, mineral assemblages, metamorphic reactions and pressure temperature conditions of metamorphism. Introduction to Ultra-high temperature and Ultra-high pressure metamorphism. Metamorphism of shale, mafic and calcareous rocks.	15
	Unit III: Isograds and Reaction Isograds; Schreinmakers rule and construction of Petrogenetic grids; Metamorphic differentiation; Anatexis and origin of migmatites; Paired metamo rphic belts	15
	Unit IV: Gibb's free energy; Entropy; Enthalpy; Clausius- Clapeyron equation; Geothermobarometry; Pressure-Temperature-Time (P-T-t) paths.	15

Suggested Readings:

- Turner, F.J.(1980). Metamorphic Petrology, Mc Graw Hill, New York.

- Yardlley, B.W.D.(1989). An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.
- Yardley, B.W.D., Mackenzie, W.S. and Guilford,C.(1995). Atlas of Metamorphic Rocks and their textures, Longman Scientific & Technical, England.
- Philopotts,A.R.(1994). Principles of Igneous and Metamorphic Petrology, Prentice Hall.
- Kretz,R.(1994). Metamorphic Crystallization, John Wiley.
- Bucher, K. and Frey,M.(2002). Petrogenesis of Metamorphic Rocks (7^{th} Rev.Ed.), Springer–Verlag.
- Powell,R.(1978). Equilibrium thermodynamics in Petrology : An Introduction,
- Harper and Row Publ., London.
- Wood,B.J. and Fraser,D.G.(1976). Elementary Thermodynamics for Geologists, Oxford University Press.
- Rastogy,R.P. and Mishra,R.R.1993: An Introduction to Chemical Thermodynamics, Vikash Publishing House.
- Spry,A.(1976).Metamorphic Textures, Pergamon Press.
- Sharma,R.S.(2016).Metamorphic Petrology: Concepts and Methods, Geological Society of India
- Winter,J.D.(2001).An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
- Winkler,H.G.F.(2013).Petrogenesis of Metamorphic rocks, Springer New York, Ebook.
- Barker,A.J.(1998).Introduction to Metamorphic textures and Micro-textures,
- Miyashiro,A.(1994).Metamorphic Petrology, Taylor & Francis.

Suggested Online Link:

- https://www.classcentral.com/course/swayam-petrology-14084
- https://www.classcentral.com/course/swayam-geology-metamorphic- petrology-thermodynamics-22994
- E-pathshala.https://epgp.inflibnet.ac.in/

Paper III
Sedimentology

Course outcome: The course in-depth knowledge about the types and origin of sedimentary rocks, and source-to-sink sedimentary processes. It emphasizes upon the modern concepts of palaeo-environmental analysis, as well as provenance determination of sedimentary rocks. The course content deals with all the essential aspects required in exploring oil and natural gas, underground water, mechanically concentrated mineral deposits (placer deposits), and building stones.

Course type, paper & Credits	Conten t	Teaching hours
Theory Sedimentology (04)	**Unit I:** Sedimenatary texture, textural parameters and their significance. Textural and compositional maturity. Fluid flow concepts, sediment transport, bedforms and sedimentary structures. Allogenic and autogenic controls on sedimentation. Palaeocurrent analysis and its significance.	15
	Unit II: Concept of sedimentary facies, facies associations, and facies model. Characteristics, processes, and facies of fluvial, lacustrine, deltaic, esturine, tidal flat, lagoonal, barrier beach, and deep-sea sedimentary environments. Tectonic classification of sedimentary basins.	15
	UnitIII: Typesandpetrogenesisof conglomerates, sandstones, and argillites. Problem of greywacke. plate tectonics and sandstone composition. Classification and genesisof limestonesanddolomites. Evaporites: Gypsum and anhydrite.	15
	Unit IV: Digenesis–Physical and chemical processes. Diagenetic stages and regimes Evidences of diagenesis in sandstones, mud rocks and carbonate rocks. Provenance of sedimentary rocks. Provenance reconstruction of sandstones through petrographic, petrofacies, and heavy mineral analyses.	15

Suggested Reading:

- Blatt,H., Middleton, G.V.and Murray,R.C.(1980).Origin of sedimentary rocks. Prentice Hall Inc.
- Collins,J.D. and Thompson,D.B.(1982). Sedimentary structures. George Allen and Unwin, London.
- Lindholm,R.C.(1987).A practical approach to sedimentology.Allen and Unwin, London.

- Miall,A.D.(2000).Principles of basin analysis, Springer-Verlag.
- Pettijohn, F.J.(1975). Sedimentary rocks (3rd Ed),Harper and Row Publ., NewDelhi.
- Reading,H.G.(1997).Sedimentary environments and facies, Blackwell Scientific Publication.
- Reineck,H.E. and Singh,I.B.(1973).Depositional sedimentary Environments, Springer-Verlag.
- Selley, R.C.(2000).Applied Sedimentology, Academic Press.
- Tucker,M.E.(1981).Sedimentary Petrology: An introduction. Wiley and sons, New York.
- Tucker,M.E.(1990).CarbonateSedimentology, Blackwell Scientific Publication.

Paper IV Fuel
Geology

Course outcome: This course will enable students to explore various fossil fuels including coal, petroleum and gas regarding their formation and mode of occurrence. The prospecting and exploration techniques of radioactive minerals will also help students to enhance their knowledge about nuclear energy. All these sources form base for a country's development so it will be beneficial for the students as they can contribute for its development by choosing a carrier related to fuel energy.

Course type, paper & Credits	Content	Teaching hours
Fuel Geology (4)	**Unit I:** Introduction: Sources of energy, Coal Geology: Introduction, origin and distribution of coal, Bio-chemical and dynamo-chemical changes in coal formation. .Grade and Rank of coal Macroscopic and Microscopic constituents, Macerals and micro-lithotypes, Physical and chemical properties. Indian classification.	15
	Unit II: Petroleum Geology: Composition and physical properties of petroleum, Origin of Petroleum; Kerogen and their types. Migration of natural hydrocarbon. Petroleum Reservoir: source rock, reservoir rock, cap rocks. Traps: Structural, stratigraphic and combination traps.	15
	Unit III: Distribution of Oil and Natural gas, and Coal in India. Coal fields and Petroliferous basins of India.	15
	Unit IV: Nuclear Fuel: Minerology, Geochemistry, mode of occurrence; Distribution of radioactive minerals in India; Radiogenic waste disposal—geological constrains. Gas-hydrates. Elementary idea about non-conventional energy resources	15

SuggestedReading:

- Barker,C.(1996):ThermalModelingofPetroleumGeneration,ElsevierScience.
- Jahn,F.,Cook,M.and Graham,M.(1998): Hydrocarbon Exploration and Production, Eslevier Science.
- Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer-Verlag.
- North, F.K. (1985): Petroleum Geology, Allen Unwin. Selley, R.C. (1998): Elements of petroleum geology, AcademicPress.
- Tissot,B.P.andWelte,D.H.(1984): Petroleum formation and occurrence, Springer–Verlag.

- Chandra, D., Singh, R.M. and Singh M.P.,(2000): Text book of coal (Indian context),Tara Book Agency, Varanasi.
- Scott, A.C., (1987): Coal and coal bearing strata: Recent Advances, BlackwellScientifics Publications.
- IsabelSuárez RuizJohnCrelling .(2008). Applied Coal Petrology: The Role of Petrology in Coal Utilization, Academic Press.
- Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P., (1998).Organic Petrology, Gebruder Borntraeger, Stuttgart.
- Singh, M.P. (1998). Coal and organic Petrology. Hindustan Publishing Corporation, NewDelhi.
- Stach,E., Mackowsky,M-Th., Taylor,G.H., Chandra,D., Teichumullelr,M. and Teichmulle, R.(1982). Stach Textbook of Coal petrology. Gebruder Borntraeger, Stuttgart.
- Holson, G.D. and Tiratso, E.N.(1985). Introduction to Petroleum Geology .Gulf Publishing, Houston, Texas.
- Tissot,B.P. and Welte,D.H.(1984). Petroleum Formation and Occurrence, Springer–Verlalg.
- North,F.K.(1985). Petroleum Geology. Allen Unwin.
- Selley, R.C.(1998).Elements of Petroleum Geology. Academic press.
- Durrance,E.M. (1986). Radioactivity in Geology-principles and application. Ellis Hoorwool.
- Dahlkamp,F.J.(1993).Uranium Ore Deposits. Springer Verlag.
- Boyle,R.W.(1982).Geochemical prospecting for Thorium and Uranium deposits, Elsevier.

Suggested Online Link

- https://www.my-mooc.com/en/mooc/geoscience-earth-its-resources-delftx-geo101x/.
- https://www.mooc-list.com/course/oil-gas-industry-operations-and-markets-coursera

Practical

Practical (04)	**Section A :** Igneous Petrology: Megascopic and microscopic studies of major igneous rock types. CIPW normative mineral calculation. Introduction to software: Sinclass, GCDkit, MELT, R-Crust.	120
	Section B: Metamorphic Petrology: Study of metamorphic rocks of different metamorphic facies in hand specimens.Calculation of ACF, AKF, AFM and A'F'M values from the given chemical data / structural formula of minerals and their graphical representation. Study of metamorphic rocks in thin sections with reference to texture/structure, time relation between phases of deformation and metamorphic crystallization, mineral association, parent rock, metamorphic facies/sub- facies/zones to which rock can be assigned and representation of assemblage in ACF, AKF, AFM and A'F'M' diagrams. Estimation of pressure and temperature from important models of Geothermobarometry.	
	Section C: Sedimentology: Detailed study of clastic and non- clastic rocks in hand specimen. Study of sedimentary structures hand specimen inform-process context. Petrography of important rock types with emphasis on depositional setting, provenance and diagenesis. Heavy mineral identification with regard to their significance in provenance interpretation. Study of important facies models.	
	Section D: Fuel Geology : Study of hand specimen of coal, Reserve estimation of coal.	

Semester III

Paper I Geodynamics

Course outcome: This subject covers the dynamic processes of the solid earth which is responsible for large-scale tectonics and evolution of the earth through deep time. The course introduces advanced topics in Plate Tectonics that have shaped the earth, its deep interior and processes such as earthquakes, volcanoes, lithosphere and asthenosphere interaction vis-á-vis mantle dynamics; Evolution of continental-oceanic crust and orogenic belts and their relationship to continental amalgamation and fragmentation.

Course type, paper & Credits	Content	Teaching hours
Theory Geodynamics (04)	**Unit I:** Planetary evolution of the earth and its internal structure. Heterogeneity of the earth crust. Major tectonic features of the Oceanic and Continental crust. Isostacy and epeirogeny.	15
	Unit II: Gravity and magnetic anomalies and heat flow patterns at Mid- Ocean ridges, deep sea trenches, continental shield areas and mountain chains. Continental drift-geological and geophysical evidence, mechanics, objections, present status. Nature of plate margins.	15
	Unit III: Palaeomagnetism, magnetostratigraphy seafloor spreading, mechanics of plate motion and Plate Tectonics. Island arcs, oceanic islands, hotspots and plume tectonics. Seismic belts of the earth vis-á-vis plate movements. Concept of seismic tomography.	15
	Unit IV: Orogeny, geodynamic evolution of Indian cratons and mobile belts. Structure and origin of the Himalaya. Metallogeny in relation to plate tectonics. Neotectonic Movements concepts and evidence.	15

Suggested Reading:

- Valdiya, K.S.(1984).Aspects of tectonics, Tata McGraw-Hill Pub. Co., NewDelhi.
- KeareyP., Klepeis,K.A. and Vine, F.J.(2009).Global Tectonics, John Wiley & Sons, Ltd., Publication. E-book available
- Valdiya, K.S. (2010).Making of India. Macmillam Publishers, India.
- Windley,B.F.(1984).EvolvingContinents(2nd edition),Wiley–Blackwell publisher.

- Condie,K.C.(1976).PlateTectonics,1st edition,ElsevierScience.E-bookavailable.
- Condie, K. (1989) Plate Tectonics and Crustal Evolution. Pergamon Press, Oxford, 476 p.
- Cox,A. and Hart,R.B.(1986). Plate Tectonics, Blackwell Publishing.
- Moores,E. and Twiss, R.J.(1995).Tectonics, Waveland Press Freeman.
- Keary,P. and Vine, F.J.(1990). Global Tectonics-Balckwell Publishing.
- Storetvedt, K.N.(1997).Our Evolving Planet: Earth's History in New Perspective-Bergen(Norway),Alma Mater Fortag
- Valdiya,K.S.(1998).Dynamic Himalaya-Universal Press, Hyderabad12.
- Summerfield, M.A.,2000:Geomorphology and Global Tectonics-Springer Verlag
- Turcotte,D.L and Schubert,G.(2002). Geodyanamics, second edition., Cambridge University Press.

Suggested Online Link:

- https://www.mooc-list.com/course/planet-earth-and-you-coursera
- https://www.mooc-list.com/course/dynamic-earth-course-educators-coursera

Paper II: Tectonic Geomorphology

Course outcome: This course pertains to studying the active terrain deformation in response to activities on structural discontinuities of the earth, and/or climatic fluctuations, and/or isostatic adjustments of the earth. The course will enable the students to indentify active tectonic structures of an area and measure extent of activities of them on the basis of their geomorphic signature. Knowledge on such aspects of an area are quite useful in analyzing the hazard proneness and vulnerability of any area, as well as assessing the safety of any geo-
Engineering project therein.

Course type, paper & Credits	Content	Teaching hours
Theory Tectonic Geomorphology (04)	**Unit I:** Definition and scope of tectonic geomorphology .Landscape evolution. Davis', Penck's, and Hack's models of landscape evolution. Modern concepts of landscape evolution. Concept of Form-Process relationship inLandscape evolution.	15
	Unit II: Geomorphic Markers of active tectonics: Planar and Linear. Landforms of active strike-slip faults, normal faults, reverse faults and folds. River response to active tectonics. Sudden (coseismic) versus gradual modifications in river systems. Tectonic modifications of alluvial and bedrock-channel e drivers: longitudinal profiles, river pattern, sinuosity, drainage patterns and drainage anomalies. Effects of base level.	15
	Unit III: Geomorphic Indices of active tectonics – Morphometric analysis : mountain-front sinuosity, hypsometric curve and hypsometric integral, stream- length gradient index, and valley-floor width to valley height ratio, basin elongation ratio, basin shape, relief ratio, drainage basin asymmetry factor, transverse topography symmetry factor.	15
	Unit IV: Introduction to geodesy. Fundamentals of ground- based and space geodetic techniques of measuring active tectonic deformations: Alignment arrays, Trilateration nets, Dry-tiltnets, electronic distance measurement (EDM) systems, Very long beam interferometry (VLBI), Radar Interferometry, and Global Positioning System(GPS)	15

Suggested Reading:

- Burbank, D.W. and Anderson, R.S.(2011). Tectonic Geomorphology 2nd Edition. Blackwell Science.
- Burbank,D.W.and Anderson,R.S.(2001). Tectonic Geomorphology 1st Edition. Blackwell Science.
- Keller,E.A.and Pinter,N.(1996). Active tectonics : Earthquakes, Uplift, and Landscape. Prentice Hall
- Bull, William.(2009).Tectonically active landscapes. Wiley-Blackwell
- Schumm, S.A, Dumont,J.F. and Holbrook, J.M.(2000). Active tectonics and alluvial rivers. Cambridge University Press.
- Bull,W. (2007). Tectonic Geomorphology of Mountains : A new approach to palaeo-seismology. Blackwell Publishing.
- Small, R.J. (1978). Study of Landforms: A Textbook of geomorphology (2ndEdition), Cambridge University Press.
- Halis,J.R.(1983). Applied Geomorphology.
- Sharma, H.S.(1990). Indian Geomorphology. Concept Publishing Co. New Delhi.
- Thornbury,W.D. (2004). PrinciplesofGeomorphology.2nd edition CBS Publication.
- Kale, V.S. and Avijit Gupta(2010). Introduction to geomorphology. University Press
- Bloom,A.L.(2011).Geomorphology : A systematic analysis of Late Cenozoic Landforms 3rd Edition. Rawat Publications.
- Condie, Kent. C.(1989).Plate Tectonics and CrustalEvolution.3rd Edition. Butterworth-HeinemannLtd.
- Windlley, B.(1995).The Evolving Continents.3rd Edition Wiley-Blackwell.
- Davies,G.F.(1999).Dynamic Earth : Plates, Plumes and Mantle Convection. Cambridge University Press.
- Keller,E.A and Pinter,N (2001).ActiveTectonics.2ndEdition.PearsonPublications.
- Kearey, P., Klepeis, K A and Vine, F.J (2009).Global Tectonics 3rd Edition. Wiley-Blackwell.
- Burbank, D.W. and Anderson, R.S. (2016).Tectonic Geomorphology. Wiley India.

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Paper III: Micropalaeontology & Oceanography

Course outcome: This course will enable students todevelop skills regarding modern techniques and methods employed in micropalaeontology and marine life. It will provide idea about the different Ocean Drilling Programs. The students will gain anadvanced knowledge on applications of microfossils and will be able to interpret atmospheric and oceanic circulation systems so as to analyze their driving forces .This all will also help them to evaluate a relationship between ocean chemistry and climate change.

Course type, paper & Credits	Content	Teaching hours
Theory Micro-palaeontology & Oceanography (04)	**Unit I:** Definition and scope of the subject; Relationship of micropaleontology with ocean sciences; Modern field and laboratory techniques in the study of microfossils (collection, sampling and processing techniques, scanning electron microscopy and mass spectrometry); Concepts of micro paleontological indicators useful in understanding geological evolution, environmental changes and biostratigraphic correlation.	15
	Unit II: Morphology, geological distribution, evolution, significance and applications of organic-walled microfossils (acritarchs, dinoflagellates, spores and pollens) and inorganic walled microfossils (Foraminifers, Ostracoda, Calcareous Nannofossils, Radiolaria, Diatoms, silicoflaglets and Conodonts). Application of Micropaleontology in hydrocarbon exploration, paleoceanography, paleoclimatology and tracinghistory of marine pollution. Interpretaion of seafloor tectonism from micro-paleontological evidence.	15
	Unit III. History and development of Oceanography. Methods of measuring properties of seawater (horizontal and vertical distribution of temperature, salinity, dissolved gases in sea water; density stratification in oceans). Depositional processes and distribution of Calcareous oozes, silicious oozes, and pelagic sediments in oceans. Ocean drilling Programmes (DSDP, ODP, IODP) and its major accomplishments.	15

	Unit IV: Ocean circulation, surface circulation and concept of mixed layers.Coriolis force and Ekman spiral Thermocline and Pycnocline, concept of upwelling and downwelling of ocean water. ElNino, La Nina. Deep Ocean circulation. Formation of bottomwater, watermasses of the world ocean and sea sediments.	15

Suggested Reading:

- Garrisson T and Ellis, R. (2016). Oceaanography : An invitation to marine Science. National Geographic Learning.
- Trujillo,A.P and Thurman, H.V. (2011). Essentials of Oceanography. Prentice Hall (10^{th} edition)
- Armstrong, and Brasier, M. (2005). Microfossils. Blackwell Publishing (2^{nd} edition)
- Saraswati, P.K.and Srinivasan, M.S.(2016).Micropaleontology : Principles and Applications, Springer.
- Arnold(2002). Quaternary Environmental Micropaleontology (Ed. Simon K.Haslett), Oxford
- Haq B.U.and Boersma, A.(1998).Introduction to Marine Micropaleontology, Elsvier.
- Pinet, P.R.(1992): Oceanography: An introduction to the Planet Oceanus, West Pub,Co
- Bignot,G.,Grahm and Trottman (1985). Elements of Micropaleontoogy, London.
- DavidTolmazin(1985).Elements of Dyanamic Oceanography, Allen and Unwin
- GrantGross,M.(1977).Oceanography; A view of the Earth, Prentice Hall.
- JohnHoughton(1997).Global Warming, Cambridge Univ. Press.
- Jones,T.P.and Rowe,T.P.(1999). Fossil plants and spores, Modern Techniques, Geological Soc. Of London.

Paper IV: Field & Laboratory techniques in Geology

Course outcome: Geology is field and observational science. Geo-scientific hypothesis is framed in the field that can be tested through field data and laboratory investigations. This course will enable the students to explore practical aspect of geology such as preparation of geological maps, cross-section, and reconnaissance and detailed surveys for georesource exploration and environmental purposes etc.		
Course type, paper & Credits	**Content**	**Teaching hours**
Field and Lab training Field & Laboratory techniques in Geology (4)	The paper will be based on training on geological field, laboratory techniques, andvarious instruments used in geological analysis. During fieldwork the students will be exposed to terrains of different geological characteristics, different types of mines, natural resource exploration sites, various types of geohazard sites. Students will prepare geological reports on the basis of their training, which will be evaluated for the marking. (**Note:** Marks will be evaluated on the basis of student's field training report.)	120

Practical

Practical (04)	Section A: Tectonic Geomorphology: Exercises on mapping of Tectonic geomorphological features and computation of geomorphic indices, using map and remote sensing data.	120
	Section B: Micropaleontology and Oceanography : Surface and Deep Ocean circulation, Upwelling, Indian Monsoon circulation. Techniques of separation of microfossil from the matrix. Study of representative genera of microfossils, Preparation of bio-zonation charts.	

Semester IV
Paper I
Applied Groundwater Hydrology

Course outcome: This course has a direct relationship to society as it provides a deep information regarding the most important factor required for a life to sustain i.e water. Groundwater is the purest form of water that can be yielded from rocks. It provides a better knowledge about its origin, prospecting and extraction. It explains the laws Governing ground water flow and various methods of ground water exploration.

Course type, paper & Credits	Content	Teaching hours
Theory Applied Groundwater Hydrology (04)	**Unit I:** Ground Water origin, type and occurrence, renewable and non-renewable ground water resources. Sub surface movement and Concept of depth to water level and water table contour maps. Water table and piezometric surface. Water bearing properties of rocks and aquifer parameters : porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, intrinsic permeability, storage coefficient, storativity, specific storage. Introduction to hydrogeology of India, and the groundwater provinces of India.	15
	Unit II: Theory of groundwater flow, numerical solutions for steady state linear groundwater flow in confined and unconfined aquifers and Dupuit's assumption for unconfined flow. Numerical solutions for steady state radial flow to a well in confined (Thiem's equation) and unconfined aquifers (Dupuit'sequation).Numerical solutions for unsteady state groundwater flow condition. Evaluation of aquifer parameters of confined Aquifer using Theis and Jacob methods.	15
	Unit III: Quality of Groundwater: Chemical characteristics of ground water in relation to various uses-domestic, irrigation and industrial purposes. Groundwater contamination and pollution from natural (geogenic) and anthropogenic sources. Graphical presentation of water quality data. Saline water intrusion in aquifers and its prevention. Ground water quality in different provinces of India	15
	Unit IV: Geological and geophysical methods of ground water exploration. Geologic and geomorphic controls on groundwater.	15

Suggested Reading:

- Todd,D.K.(1980).Ground water Hydrology-John Wiley.
- Davis,S.N. and DeWiest, R.J.M.(1966).Hydrogeology-John Wiley.
- Freeze,R.A. and Cherry,J.A.(1979).Ground Water-Prentice Hall.
- Fetter,C.W.(1990).Applied Hydrogeology-Merill Publishing.
- Ragunath,N.M.(1982).Ground Water-Wiley Eastern.
- Karanth, K.R.(1987).Groundwater Assessment-Development and Management- Tata McGraw Hill.
- Alley, W.M.(1993). Regional Ground Water Quality-VNR, NewYork.
- Subramaniam,V.(2000).Water-Kingston Publication, London.
- Hiscock,K.M.andBense,V.F.(2014).Hydrogeology: Principles and Practice 2nd Edition, Wiley-Blackwell.
- Raghunath,H.M.(1983).Ground Water, Viley Eastern Ltd.,Calcutta.
- Driscoll,F.G.(1988).Groundwater and Wells, UOP, Johnson Div. St. Paul. Min.USA.

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Paper II

Advanced Remote Sensing & GIS

Course outcome: This course pertains to recent technologies of Remote Sensing and Geographical Information System (GIS). The course introduces various types of remote sensing data in different ranges of the electromagnetic spectrum, and the basic concepts and potential of GIS in geological investigations. It develops skills in students for interpreting visual and digital remote sensing image from different spectral bands, and Use them to understand the various physical processes operating on earth's surface through integration of other sources' data in a GIS.

Course type, paper & Credits	Content	Teaching hours
Theory Advanced Remote Sensing & GIS (04)	.**Unit I:** Atmospheric scattering and absorption; Concepts of Optical, NIR, SWIR, TIR and RADAR remote sensing; Satellite and Aerial remote sensing platforms; Spectral Reflectance curves of soil, water and vegetation.	15
	Unit II: Types and characteristics of sensors. Concepts of mono- band, multispectral and hyperspectral remote sensing. Basics of optical, thermal and microwave remote sensing. Basic concept of LiDAR. Characteristics of IRS sensors.	15
	Unit III: The structure of Digital Image. Conceptual aspects of Digital Image Processing. Basic processes of image rectification, enhancement and classification. Definition and components of Geographic Information System (GIS). Raster and vector data formats. Basic knowledge about data acquisition, manipulation, analyses and representation In GIS.	15
	Unit IV: Application of remote sensing and GIS in geomorphological investigations, tectonic investigations, lithological mapping, groundwater exploration, mineral exploration, Oil & Gas exploration and geohazard management.	15

Suggested Readings:

- Lillesand,T.M.,Kiefer,R.W.and Chapman,J.(2015): Remote Sensing and Image Interpretation,7th Edition.Wiley
- Gupta,R.P.(2003).Remote Sensing Geology.2nd Edition. Springer

- Drury,S.A.(1993).Image Interpretation in Geology.2nd Edition.Chapman & Hall
- Jensen,J.R.(2000).Remote Sensing of the Environment, An earth Resource Perspective. Pearson Education.
- DeMersM.N.(2008). Fundamentals of geographic Information System. 4th Edition.Wiley
- Richards,J.A. and Jia,X.(2006).Remote Sensing Digital Image Analysis: An Introduction. 4th Edition,Springer
- George Joseph(2005).Fundamentals of Remote Sensing 2nd edition: Universities Press
- Gopi,S, Sathikumar,R and Madhu,N(2006). Advanced Surveying total station GIS and Remote Sensing, PearsonEducation
- Sabins,F.F.(2007).Remote Sensing Principles and Interpretations 3rd Edition, Waveland Pr Inc.
- LillesT.M., Kiefer,R.W.and Chipman,J.(2008). Remote Sensing and Image Interpretation. 6th Edition, John Wiley and Sons.
- Bhatia,S.C.(2008).Fundamentals of Remote Sensing Atlantic Publications.
- Bhatta,B.(2011).Remote Sensing and GIS 2nd Edition, Oxford University Press
- Sabins,F.F.(2012).Remote Sensing Principles and Practice 3rd Edition, Levant Books
- Jensen,JR.(2013).Remote Sensing of the Environment: An Earth Resource Perspective 2nd Edition, Pearson India.

Suggested Online Link:

- https://www.classcentral.com/course/swayam-photogeology-remote-sensing-45165

Paper III

Project Oriented Dissertation

Course outcome: This course will enable students to choose any branch in geology and select a problem for research. During this course student will apply the knowledge gained so far in resolving geological problems by carrying out research work followed by presentation of work. It will help the student to apply all his/her skills and work practically by using different techniques including field and laboratory work.		
Course type, paper & Credits	**Content**	**Teaching hours**
Research and Dissertation Project Oriented Dissertation (8)	The students will be assigned a minor research topic to write a dissertation, under the supervision of a guide (faculty of the department). The dissertation will be evaluated by combined team of external examiner and internal examiner (guide of the specific dissertation)	240

Practical

Practical (04)	**Section A:** Applied Groundwater Hydrology : Preparation of ground water flow directions, Estimation of aquifer parameters using different mathematical equations, plotting groundwater quality properties (Hill & piper diagram, Durov plot and SAR plotting), Plot hydrological provinces In India.	120
	Section B: Advanced Remote Sensing & GIS: Determination of the scale of aerial photographs and imageries. Visual interpretation of aerial photographs and imageries for geomorphological, lithological, tectonic and geological mapping.	