

# **SHRI GURU RAM RAI UNIVERSITY**

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017)



## **Syllabus of M.Sc. Geology**

**Effective from Academic Session  
2017-2018**

## M.Sc. Geology

## Semester-1(July-December)

Course No.	Core Courses	L	T	P	Credit
MGLC101	General Geology and Geomorphology	4	0	0	4
MGLC102	Structural Geology	4	0	0	4
MGLC103	Mineralogy	4	0	0	4
MGLC104	General and Invertebrate Paleontology	4	0	0	4
MGLL105	Lab Course I based on C101&C102	0	0	3	3
MGLL106	Lab Course II based on C103&C104	0	0	3	3
	<b>Total credits</b>				22

## Semester-2(January-June)

Course No.	Core Courses	L	T	P	Credit
MGLC201	Crystallography	4	0	0	4
MGLC202	Geotectonics	4	0	0	4
MGLC203	Micropaleontology, Vertebrate Paleontology and Palaeobotany	4	0	0	4
MGLC204	Stratigraphy	4	0	0	4
MGLC205	Geological Field Training tour	0	0	3	3
MGLL206	Lab Course based on C201 to C204	0	0	3	3
	<b>Total credits</b>				22

## Semester-3(July-December)

Course No.	Core Courses/ Elective	L	T	P	Credit
MGLC301	Igneous Petrology & Geochemistry	4	0	0	4
MGLC302	Engineering Geology	4	0	0	4
MGLL303	Lab Course I based on C301&C302	0	0	3	3
MGLE304	Sedimentary and Metamorphic Petrology	4	0	0	4
MGLE305	Mineral Exploration and Mining	4	0	0	4
MGLL306	Lab Course II based on E304&E305	0	0	3	3
MGLS307	Petroleum Geology				3
	<b>Total credits (excluding Self-study Course)</b>				22

## Semester-4(January-June)

Course No.	Core Courses/ Elective	L	T	P	Credit
MGLC401	Geohydrology	4	0	0	4
MGLC402	Ore Genesis and Indian mineral deposits	4	0	0	4
MGLL403	Lab Course based on C401&C402	0	0	3	3
MGLE404	Geological Field Training tour	0	0	3	3
MGLE405	Project/ Dissertation	0	0	6	6
	<b>Total credits</b>				20
	<b>Grand Total credits (excluding Self-study Course)</b>				86

**Semester-1**

**MGLC101: General Geology and Geomorphology**

**Unit 1:-** Basic concepts and Application of geomorphology in Applied Geomorphology and paleogeomorphology.

**Unit 2:-** Elementary idea of cosmogeny, Interior of earth, geochronology, theories of isostasy, ocean bottom topography cycle of erosion, landscape evolution, rock weathering, soil formation and classification of soils.

**Unit 3:-** Geosynclines, their classification and evolution, orogeny and epeiorogeny, volcanoes, earthquakes, island arcs, rift valleys and grabens.

**Unit 4:-** Glacial, Aeolian, fluvial and costal landscapes of India, karst topography, landforms of Himalayas.

**Unit 5:-** Drainage development and slope morphometry, quaternary geomorphology, geomorphology and geomorphic hazards of Uttarakhand.

**Books recommended**

- Thornbury, W.D. (1980): Principle of Geomorphology, Wiley Eastern Ltd. New York.
- Holmes, A. (1992): Holmes Principles of Physical Geology, Chapman & Hall publ.
- Halis, J.R. (1983): Applied Geomorphology.
- Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co. New Delhi.
- Agrawal, L. C. Introduction to Geomorphology.
- Gass, I.G. et al. (1982): Understanding the Earth, Artemis Press (Pvt.) Ltd. U.K.
- Windley, B. (1973): The Evolving continents, John Wiley & Sons publ.
- Condie, Kent. C. (1982): Plate Tectonics & Crustal Evolution, Pergamon Press .
- Savindra singh , geomorphology, pravalika pub. Allahabad.

**MGLC102: Structural Geology**

**Unit 1:-** Definition and scope of structural geology, properties of rocks and factors affecting the behavior of rocks.

**Unit 2:-** Theory of stress and strain, kinematic analysis, Mohr's Circles, strain and stress ellipsoids. Strain marker and Measurement of strain in deformed rocks.

**Unit 3:-** Geometry and Classification of fold & Mechanics of folding and buckling, Flexure fold; flexural slip folds, flexural flow folds, passive folds and distribution of strains in folds.

**Unit 4:-** Geometry and Causes and dynamics of faulting: Strike-slip Faults, Normal Faults, Thrust Faults; joints, foliations, unconformities, Mylonites and Cataclastics.

**Unit 5:-** Basic idea about petrofabrics and use of Universal stage, diapers and salt domes, cleavage, lineation.

**Books recommended**

- Davies, A.Z.: Structural Geology.
- Ghosh, S. K.: Structural Geology, Fundamental and Modern Concepts, Pergamon Press.
- Ramsay J. G. (1967): Folding and fracturing of Rocks, McGraw Hill Pub.
- Ramsay J.G. & Huber M. I. (1983): The Techniques of Modern Structural Geology-I, Strain Analysis, Academic Press.
- Ramsay J.G. & Huber M. I., (1987): The Techniques of Modern Structural Geology-II, Strain Analysis, Academic Press.
- Hobbs, B.E., Means, W.D. & Williams, P.F. (1976): An outlines of Structural Geology, John Wiley and Sons publ.
- Turner, F.J. & Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill publ.
- Jain, A,K , advance structural analysis, nem chand and bros.

**MGLC103: Mineralogy**

**Unit 1:-** structures and types of atoms, types of chemical bonding, chemical properties of minerals.

**Unit 2:-** Structures and classification of Silicates, Physical properties of minerals.

**Unit 3:-** A detail study of important silicates with reference to general and structure formulae, classification, atomic structures, chemistry including substitution of element and mode of occurrence.

a) Neosilicates/orthosilicates: olivine group and Garnet group.

b) Sorosilicate: melilite group

c) Cyclosilicate: beryl

- d) Inosilicate: pyroxene and amphibole group.
- e) Phyllosilicate: kaolinite group.
- f) Tectosilicate: feldspar group.
- g) quartz and non-silicate: carbonate, oxide , sulphide.

**Unit 4:-** Properties of uniaxial and biaxial crystal.

**Books Recommended:**

- Moor house, W.W.: Optical Mineralogy.
- Dana, E.S. & Ford, W.E.: A Text book of Mineralogy, Wiley Eastern Ltd.
- Phillips, W.R & Guffen, D.T- Optical mineralogy.
- Barry & Mason- Mineralogy.
- Kerr, P.F.: Optical mineralogy, McGraw Hill publ.
- Deer, W.A, Howie, R.A. & Zussman, J.: An Introduction to rock forming minerals, ELBS & Longman.
- Dexter perkin,optical mineralogy
- Alexander N. winchill ,element of optical mineralogy, ulan press pub.
- Babu .S.K and sinha.D.K , mineralogy ,CBS pub.

**MGLC104: General and Invertebrate Paleontology**

**Unit 1:-**Modern Taxonomy, Identification of fossils, collection of fossils, types of fossils, and mode of preservation, uses of fossils.

**Unit 2:-**Biostratigraphy, Paleoecology, origin of life and organic evolution.

**Unit 3:-**Early Precambrian life, Ediacaran fossil assemblage and organo-sedimentary structures.

**Unit 4:-**Classification, Morphology, Evolutionary trend and geological history of major invertebrate group: Mollusca (Bivalve, Gastropoda and Cephalopoda), Brachipoda, Arthropoda, Echinoidea and Graptolite.

**Unit 5:-**Zoogeographic provenance, dispersal and extinction.

**Books recommended:**

- Clarkson, E. N.K. (1998): Invertebrate Paleontology and Evolution.
- Smith, A.B. (1994): Systematic and fossil record- Documenting Evolutionary patterns.

- Stearn, C.W. and Carroll, R.L. (1989): Paleontology the record of life, John Willey Publ.
- Raup, D.M. and Stanley, S.M (1985) Principles of Paleontology (CBS Publication).
- Jain, P.C. & Anantharaman, M.S., 1983. Paleontology: Evolution & Animal Distribution. Vishal
- Henry Woods, invertebrate paleontology,
- Shrock and Twenhofel, principle of invertebrate paleontology ,

**MGLL105: Lab Course I based on C101&C102**

**(MGLC101): General Geology and Geomorphology**

- Analysis of geomorphological features from various morphogenetic regions of India; preparation of geomorphological maps on different scales (1:2, 50,000 & 1:50,000).
- Preparation of longitudinal and cross valley profiles.
- Altimetric analysis, hypsometric analysis, exercises related to measurements of runoff dynamics, sediment and solute dynamics.
- Morphometry of drainage basins, analysis of orientation structures.

**(MGLC102): Structural Geology**

- Preparation and interpretation of geological maps and sections.
- Structural problems.

**MGLL106: Lab Course II based on C103&C104**

**(MGLC103): Mineralogy**

- Study of minerals in hand specimen
- Microscopic study of rock forming minerals.

**(MGLC104): General & Invertebrate Paleontology**

- Study of important invertebrate fossil belonging to brachiopoda, bivalve, gastropoda, cephalopoda, trilobita and echinods.

**Sessional and Viva-voice**

**Semester- II**

**MGLC201: Crystallography**

**Unit 1:-**Introduction to space group, space lattices, lattice defects, symmetry elements.

**Unit 2:-**Historical development of X-ray crystallography, Bragg equation, goniometer.

**Unit 3:-**Description of normal classes and important sub-classes.

**Unit 4:-**Different type of crystal projection and crystal imperfections.

**Unit 5:-**Twinning and twinning laws – common types of twins and their examples.

**Books recommended:**

- Wahlstrom-optical crystallography.
- Sands, D.E. (1975): An Introduction to Crystallography, W.A. Benjamin Inc., N.Y.
- Phillips, F.C.: Introduction to Crystallography.
- Evans, R.C. (1964): Introduction to Crystal Chemistry, Cambridge Uni. Press.
- Dana, mineralogy
- Perkinson. D, mineralogy

**MGLC202: Geotectonics**

**Unit 1:-**Evidence of continental drift, mechanics, objections and present status, Concept of Plate Tectonics and Sea floor spreading.

**Unit 2:-** Major tectonic features of the oceanic and continental crust, island arcs, oceanic islands and volcanic arcs, Gravity and magnetic anomalies at mid oceanic ridges, Origin and significance of Mid-Oceanic Ridges and Trenches.

**Unit 3:-** Seismic belts of the earth & seismicity and mountain chains, their global distribution and evolution.

**Unit 4:-** Palaeo-magnetism, Polar Wandering and reversal of earth's magnetic field.

**Unit 5:-** Origin of Himalaya, Tectonic history of India & geodynamics of Indian plate.

**Books recommended**

- Condie Kent, C. (1989): Plate Tectonics and Crustal Evolution.
- W. J. Kious & Robert I.T.: This dynamic of Earth: the story of Plate Tectonics USGS publ.
- Moores, E. & Twiss, R.J., 1995: Tectonics. Freeman publ.
- Keary, P. & Vine, F.J. 1990: Global Tectonics. Blackwell scientific publ.

- Storetvedt, K.N. 1997: Our Evolving Planet. Earth History in new perspective.
- Valdiya, K.S. 1998: Dynamics Himalaya. Univ. Press.

**MGLC203: Micropaleontology, vertebrate paleontology and Palaeobotany**

**Unit 1:-**Microfossils; types of microfossils and its Importance, Collection and preparation of microfossils.

**Unit 2:-** Micro-paleontology: morphology, Palaeo-ecology and geological distribution of foraminifera, conodonts, ostracodes, radiolaria and diatoms.

**Unit 3:-** Vertebrate life through ages and landmarks in their evolution, evolutionary trends in man, horse and elephant.

**Unit 4:-** Palaeobotany: Morphology, distribution and significance of Gondwana flora.

**Unit 5:-** Palynology: Morphology and significance of pollen and spores.

**Books recommended:**

- Romer, A.S. 1966. Vertebrate Paleontology, Chicago Univ. Press.
- Swinnerton, H.H. (1950) An outline of palaeontology.
- Arnold, C.A. (1947) An Introduction to palaeobotany, Mc Graw Hill.
- Armstrong, H. & Brasier M. (2005): Micro fossils. Black Well pub.
- Colbert, E.H.(1984) Evolution of the vertebrates. Willey Eastern Ltd.

**MGLC204: Stratigraphy**

**Unit 1:-**Principle of Stratigraphy & Geological time scale, stratigraphic correlation, nomenclature of modern stratigraphic code, Walther's Law, Basic principles of seismic stratigraphy, sequence Stratigraphy and magneto stratigraphy.

**Unit 2:-** Archean and Precambrian stratigraphy of peninsular India.

**Unit 3:-** Phanerozoic stratigraphy of Peninsular India.

**Unit 4:-** Precambrian and Phanerozoic stratigraphy of Himalaya and Indo-Gangetic Plain.

**Unit 5:-** Precambrian-Cambrian, Permian-Triassic, Cretaceous- Tertiary boundaries (with Indian examples), Reconstruction of paleogeography and palaeoclimates.

**Books recommended**

- Dunbar, C.O. & Rodgers, J. (1957): Principles of Stratigraphy, John Wiley & Sons.
- Krumbein, W. C. & Sloss, L.L. (1963): Stratigraphy and sedimentation.

- Freeman, W. H. & Kummel, Co. (1961): History of the earth.
- Hollis D. Hedbug (Ed.) International stratigraphic guide - International sub commission on stratigraphic classification of IUGS commission on stratigraphy John Wiley and Sons
- Naqvi, S.M. & Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford Univ. Press.
- Schoch, Robert, M. (1989): Stratigraphy-Principles and Methods, Van Nostrand Reinhold, New York.
- Kumar, R. (1984): Fundamentals of Historical Geology & Stratigraphy of India.
- Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publishers & Distributors, Delhi.
- Valdiya, K.S. (2009): The Making Of India: Geodynamic Evolution. Macmillan Publishers India
- Ramakrishnan M. and Vaidyanadhan,(2008 &2010) Geology of India (Vol. 1 & 2), GSI pub.

**MGLC205: Geological field mapping and 3 days tour**

**MGLL206: Lab Course based on C201 to C204**

**(MGLC201): Crystallography**

Crystal model and projection

**(MGLC202): Geotectonics**

Stereographic presentation of structural data

**(MGLC203): Micropaleontology, vertebrate paleontology and Palaeobotany**

Study of important Microfossils,

Study of Vertebrate fossils and Gondwana Flora

**(MGLC204): Stratigraphy**

- Study of palaeo-geographic maps of Precambrian and Phanerozoic
- Chronological study of important rocks

**Sessional and Viva-voice**

**Semester-III****MGLC301: Igneous Petrology & Geo Chemistry**

**Unit 1:-**Magmatic processes: fractional crystallization, magma mixing, crystal setting, liquid immiscibility, assimilation, differentiation, and effects, magmatic crystallization – Bowens reaction principle.

**Unit 2:-**Gibbs phase rule – definition of phase, component and degree of freedom, application of Phase rule in bi-component and tri component magma. The Phase equilibrium of binary (Ab-An, Ab-Or, Di-An), ternary magma (An-Al-Di system and An- Di – Fo, system).

**Unit 3:-**Texture and structures, IUGS classification of the volcanic and plutonic Igneous rocks, and ophiolite

**Unit 4:-**Petrogenesis and petrography of the following rocks:- Aplite, Anorthosite, Andesite, Basalt, Carbonatite, Charnockite, Diorite, Dunite, Dolerite, Gabbro, Granite, Granodiorite, Kimberlite, Komatiite, Lamprophyre, Pegmatite, Peridotite, Syenite, Trachyte.

**Unit 5:-**Introduction of Geochemistry, Chemical composition and properties of Earth's layers. Atmosphere: its layers, chemical composition and chemistry of Atmosphere and hydrosphere. Geochemical classification of elements, meteorite and their classification.

**Books recommended**

- Gupta, A.K. (1998): Igneous Rocks Allied Publishers Ltd., New Delhi.
- Jackson: Textbook of lithology.
- Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology
- McBirney, A.R. (1984): Igneous Petrology, Freeman Cooper & Co. California.
- Phillips A.: Introduction to igneous and metamorphic petrology, Prentice Hall Pub.
- Turner, F.J. & Verhoogen, J.: Igneous & Metamorphic petrology CBS Publications.
- Bose, M.K. (1997): Igneous Petrology, World Press, Kolkatta.
- Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
- Mason, geochemistry
- Krauskopf, geochemistry

**MGLC302: Engineering Geology**

**Unit 1:-**Role of Engineering geology in civil construction and mining industry; Engineering properties of rocks ;physical characters of building stones, concrete and other aggregates.

**Unit 2:-**Geological considering for evaluation of dam and reservoir site.

**Unit 3:-**Geotechnical investigation of tunnels – type, methods and problems and road.

**Unit 4:-**Landslides – classification, causes and preventive methods. Bridges – types and foundation problems, influence of geological conditions on foundation and design of buildings.

**Books recommended:**

- Krynine D. P. & Judd W. R. (1998): Principles of engineering geology & geo-techniques.
- Gupta, H. K. & Rastogi, B. K. (1976): Dams and Earthquakes, Elsevier and Scientific Pub. Co.
- Clarke: Reservoir engineering.
- Bell, F. G. (1983): Fundamentals of engineering geology, Butterworth's, London.
- Schuttz, J.R and Cleaves , A.B.(1951) Geology in Engineering, John Willey and Sons, New York.

**MGLL303: Lab Course I based on C301&C302**

**MGLC301): Igneous Petrology & Geo Chemistry**

- Megascopic study of different types of igneous rocks.
- Microscopic study of important igneous rocks.
- Plotting of modal data is IUGS diagram.

**(MGLL302): Engineering Geology**

- Study of properties of common rocks with reference to their utility in engineering projects. Study of maps and models of important engineering structures, dam sites and tunnels. Interpretation of geological maps for landslides problems.
- Survey of a plot using Chain, Prismatic compass, Plane table, GPS data collection and plotting.

**MGLE304: Sedimentary & Metamorphic Petrology**

**Unit 1:-**Origin of Terrigenous Clastic and Non-Clastic grains; weathering and its products, structure, texture of sedimentary rocks.

**Unit 2:-** Petrography and a diagenesis origin of sandstone, limestone, shale, mudstone, arkose, breccia.

**Unit 3:-** Sedimentary facies, depositional environments, provenance and palaeo-current.

**Unit 4:-** Factors controlling metamorphism; Texture and structures of metamorphic rocks.

**Unit 5:-** Metamorphic grades and Index minerals, types of metamorphism, law of thermodynamics and Gibbs Equation.

**Unit 6:-** Metamorphic Facies : Zeolite, Blue-schist, Green-schist - Amphibolite, Granulite, Eclogite and contact metamorphic facies.

**Books recommended:**

- Pettijohn, F. J. Sedimentary rocks ( McGraw-Hill, New Delhi)
- Blatt, H., Middleton, G and Murray, R., Origin of Sedimentary Rocks, Prentice Hall
- Verma, V. K. And Prasad, C., Sedimentology (Harman Publishing House, New Delhi)
- Collins, J.D., and Thompson, D.B. (1982): Sedimentary structures. George Allen and Unwin, London.
- Pettijohn, F.J. (1975): Sedimentary Rocks. 3<sup>rd</sup> Edn. Harper and Row Publ., New Delhi.
- Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley & Sons,
- Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology New York.
- Bucher, K. and Martin, F. 2002: Petrogenesis of Metamorphic Rocks, Springer-Verlag, 7<sup>th</sup> Revised Edition.
- Yardley, B.W.D. 1989: An Introduction to Metamorphic petrology, Longman scientific & Technical, New York.
- Spry, A. 1976: Metamorphic Texture, Pergamon Press.

**MGLE305: Mineral Exploration and Mining Geology**

**Unit 1:-** Prospecting for economic minerals, sampling assaying and evaluation of mineral deposits, geological and geo-botanical techniques of prospecting.

**Unit 2:-** Gravity method: principle of gravimeters, gravity field surveys, various types of corrections applied to gravity data, Resistivity method: basic principles, various types of electrode configuration, field procedure: profiling and sounding and magnetic, seismic and radioactive methods.

**Unit 3:-** Brief outline of well-logging techniques and their methods, Drilling and type of drilling methods, Application of remote sensing in mineral exploration.

**Unit 4:-**Planning, exploration and exploratory mining of surface and underground mineral deposits involve shaft sinking, drifting, cross cutting, winzing, stoping, room and pillaring, top-slicing, sub caves and block caving.

**Unit 5:-**Cycles of surface and underground mining operations, coal mining and Mining hazards: mine inundation, fire and rock burst.

**Books recommended**

- P.K. Banerjee and S. Ghosh (1997): Elements of prospecting for non-fuel mineral deposits.
- Bagchi, T.C., Sengupta, D.K. & Rao, S.L.V.N. (1979): Elements of Prospecting and Exploration.
- Sinha, R.K. & Sharma, N.L. (1976): Mineral Economics.
- Arogyaswami, R.N.P. (1996): Courses in Mining Geology

**MGLL306: Lab Course II based on E304&E305****(MGLE304): Sedimentary & Metamorphic Petrology**

- Study of sedimentary and metamorphic rocks in thin sections with emphasis on texture, structure and mineral composition.
- Study of sedimentary and metamorphic rocks in hand specimen.
- Graphic construction of ACF, AKF and AFM diagrams.

**(MGLE305): Mineral Exploration and Mining Geology**

- Preparation of mineral maps of India.
- Graphical representation of production, export and import of important minerals.
- Calculation of grade and ore reserves.
- Interpretation of remote sensing data for mineral exploration.

**MGLS307: Self Study Course****Petroleum Geology**

**Unit 1:-**Physical and chemical properties of natural gas, oil and bitumen, their mode of occurrence, kerogen-shales, origin of petroleum, coal bed methane and gashydrate.

**Unit 2:-**Reservoir rocks, their classification, important characters, structures and mechanics, migration of oil and gas, Gussove`s theory of oil and gas pools.

**Unit 3:-**Oil traps, their classification and characters, Surface indication of oil, geological, geophysical and geochemical prospecting for hydrocarbons.

**Unit 4:-**Drilling and well logging for oil, well completion, secondary recovery.

**Unit 5:-**Geographical distribution of petroleum resources in world, Status of hydrocarbon exploration in India, important petroliferous basins of India,

### IV Semester

#### MGLC401: Geohydrology

**Unit 1:-**Occurrence and distribution of groundwater, hydrological cycle, hydrological properties of rocks, water table fluctuations.

**Unit 2:-**Theory of groundwater flow, Darcy's law and its application, determination of permeability, types of well; unconfined, confined flow condition, types and characteristics of Aquifers.

**Unit 3:-**Groundwater quality, problems of arsenic and fluorides, groundwater contaminations, groundwater conditions of India.

**Unit 4:-**Methods of artificial groundwater recharge, method of rainwater harvesting, groundwater legislation, groundwater provinces of India.

**Unit 5:-**Geological and geophysical methods – electrical (resistivity), seismic, gravity and magnetic methods.

#### **Books recommended:**

- Todd, D.K. (1980): Ground Water Hydrology, John Wiley & Sons, New York.
- Bouver, H. (1978): Groundwater Hydrology, McGraw Hill.
- Davies, S.N. and De-West, R.J.N. (1966): Hydrology, John Wiley & Sons, New York.
- Deming, D. (2002).Introduction to hydrogeology. McGraw Hill.

#### MGLC402: Ore genesis and Indian mineral deposits

**Unit 1:-**Processes of ore formation, Structural, physico-chemical and stratigraphic controls of ore localization, wall rock alteration, Ore bearing fluids, their origin and migration, mineralization and tectonism.

**Unit 2:-**Indian distribution and characters of metallic ore deposits of copper, gold, lead and zinc, aluminium, magnesium, iron, manganese, chromium, tungsten, molybdenum.

**Unit 3:-**Indian distribution and characters of non metallic minerals: coal and petroleum, mica, asbestos, barite, graphite, gypsum, refractories, abrasives, ceramics, fertilizers, cement, paints-pigments and gem stones.

**Unit 4:-**Metallogenic epochs and provinces of Indian subcontinent, Paragenesis, zoning, mineral deposits of Indian oceans.

**Unit 5:-**National mineral policy and mineral conservation; India's status in mineral production, international aspects, future prospects, strategic, critical and essential minerals, mineral resources of Uttarakhand.

**Books recommended**

- Chatterjee, K.K. (1993): An Introduction to Mineral Economics, Wiley Eastern Ltd.
- Karanth, R.V. (2000): Gems and gem Industry in India, Geol. Soc. India, Bangalore.
- Krishnaswamy, S. (1979): India's Mineral Resources, Oxford and IBH Co.
- Tiwari, S. K.: Ore Geology, economic mineral and mineral economics Vol.-2.
- Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
- Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
- Barnes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley.
- Guilbert, J.M. and Park, Jr.C.F. (1986): The Geology of Ore Deposits, Freeman.
- Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
- Jensen and Bateman Economic minerals
- U.Prasad -Economic Mineral Deposits

**MGLL403: Lab Course based on C401&C402****MGLC401: Geohydrology**

- Delineation of hydrological boundaries on water table, contour maps and estimation of permeability.
- Analysis of hydrographs and estimation of infiltration capacity.
- Chemical analysis of water in evaluation of aquifer parameters.
- Step drawdown tests, electric resistivity sounding for delineation of fresh and saline aquifers.
- Exercise on ground water exploration using remote sensing techniques.

**MGLC402: Ore genesis and Indian mineral deposits**

- Study of economic minerals in hand specimen.
- Study of geological maps and sections of important oilfields of India and world. Calculation of oil reserves.

- Preparation of mineral maps of India. Graphical representation of production, export and import of important minerals. Calculation of grade and ore reserves. Interpretation of remote sensing data for mineral exploration.

**MGLE404: Geological Field Training**

Students will be required to visit geologically important areas including mines, dams, oil fields, fossiliferous sequences and laboratories/institutes of repute and submit a report thereon, under the supervision of a faculty member. The field work should be maximum 07 days.

**MGLE405: Project oriented Dissertation**

The area of dissertation shall be assigned to the students at the end of second semester based on the expertise available in the Department. The project oriented dissertation must be submitted by the end of fourth semester. During the course of completion of dissertation work the students will be required to complete various assignments given to them by their respective supervisors or the Head of Department for the purpose of their evaluation.

Beside classroom seminars, the students will have to present their dissertation work in the form of seminar before the board of examiners including the supervisors which will be followed by viva voce examination.