

M. Sc. Programme in Geology (Four Semesters)

Syllabus for the M.Sc. Programme in Geology, approved by the Board of Studies in Geology, Department of Geology, University of Lucknow, in its meeting held on May 27, 2015, and applicable for students enrolled in July 2015 and onwards. This syllabus shall be applicable w. e. f. the Examination of December 2015.

For students enrolled in the year July 2014, the syllabus and pattern of examination shall be the same as already in vogue.

Eligibility of Candidates for admission to M.Sc. Programme in Geology:

Candidates who have passed the three year B.Sc. examination of the University of Lucknow or any other equivalent examination of other universities (considered as equivalent by the University of Lucknow) with **Geology as one of the major subjects in all the three years**, will be considered eligible for admission to the Four Semester M.Sc. Programme in Geology.

Syllabus and Evaluation for M.Sc. Programme in Geology:

The M.Sc. Programme in Geology shall be imparted to the students for two academic sessions consisting of four semesters as given below. Candidates will be examined through **Continuous Internal Assessment** and evaluated at the end of each semester in the different courses of **Theory, Practical, and Field Work**, and also as per the details and marks given against each Course of study.

The attendance in the Geological Field Work will be compulsory for all the students. After the field work, the students will be required to submit a detailed field report to the concerned teacher(s) for evaluation. The field work will be conducted during the first and third semesters. The semester breaks/ holidays/recess can also be utilized for the geological field work, as well as for the theory and practical classes.

The different Courses as detailed below shall be taught in the First, Second and Third Semesters, and there shall be Four Course Papers, a Practical Examination, and a Field work/ Semester Assignment Evaluation in each Semester. Viva-Voce examination will be held along with the Practical Examinations. Field Reports/ Semester Assignments will be evaluated as a part of the examination (100marks). In the Fourth Semester, however there will be a dissertation.

Student are required to have a minimum of 75% attendance to be eligible to appear in the examination.

Evaluation in the First, Second and Third Semesters:

For the **Continuous Internal Assessment** of the candidates, 30 marks shall be awarded by the teacher(s), teaching that Paper, for which the breakup of the marks will be as follows:

(a)	Class Test(s)	15 marks
(b)	Assignment(s)/ Presentation(s)	10 marks
(c)	Class Participation, interaction, punctuality, performance and aptitude	5 marks

Where more than one teacher is teaching a paper, the average of the marks awarded by all the teachers shall be considered.

For the **Semester End Examination**, the question paper for each course will be of 70 marks and consist of TWO Units. Unit- I shall be **COMPULSORY**, of 25 marks, and have five short answer type questions. Unit II will be of 45 marks and have five questions (descriptive type) out of which the candidates will be required to attempt any three questions. The duration of the examination shall be of three hours.

Evaluation in the Fourth Semester:

During the Fourth Semester, the students shall complete a Dissertation in Geology, submit a **Write-up**, make a **Presentation** (Power point), and there will be a **Viva-voce examination**. The evaluation will be on the basis of these activities:

Evaluation of the **Write-up** (450 marks),
Evaluation of the **Presentation** (50 marks) and

Viva-voce (100 marks).

The topics of the dissertation would be allotted by the department from a list of topics (to be prepared each year), for which, each Faculty Member would suggest Two/Three topics. Student would be allotted a topic and a Supervisor from this list on the basis of their combined merit of Semester I and II. The student would complete the dissertation under the Faculty who had suggested that topic. The Faculty member would also be an evaluator for the examination of the student.

Course – wise details of the Four Semesters:

SEMESTER I						
COURSE		Internal Assessment	Semester End Examination	Total Teaching	Total	
		Marks	Marks	Hours	Credits	Marks
CG-11	Mineralogy and Geochemistry	30	70	45	3	100
CG-12	Structural Geology and Tectonics	30	70	45	3	100
CG-13	Igneous Petrology	30	70	45	3	100
CG-14	Engineering Geology & Ground Water	30	70	45	3	100
CG-15	Practical: Laboratory Work & Viva-voce			120	4	100
CG-16	Field Work: Practical Training Including Case Study, Tutorials and Report Writing			120	4	100
SEMESTER II						
CG-21	Economic Geology, Mineral Exploration and Mining Methods	30	70	45	3	100
CG-22	Metamorphic Petrology and Geochronology	30	70	45	3	100
CG-23	Sedimentology and Applied Palaeontology	30	70	45	3	100
CG-24	Remote Sensing, GIS and Quaternary Geology	30	70	45	3	100
CG-25	Practical: Laboratory Work & Viva-voce			120	4	100
CG-26	Semester Assignment: Case Study and Tutorials			120	4	100
SEMESTER III						
CG-31	Geophysics and Petroleum Geology	30	70	45	3	100
CG-32	Environmental Geology and Natural Hazards	30	70	45	3	100
CG-33	Palaeontology	30	70	45	3	100
CG-34	Stratigraphy	30	70	45	3	100
CG-35	Practical: Laboratory Work & Viva-voce			120	4	100
CG-36	Field Work: Practical Training Including Case Study, Tutorials and Report Writing			120	4	100
SEMESTER IV						
		Time frame		Semester End Examinations		
		Hours	Marks	Credits	Marks	
CG-41	Dissertation Work: <i>A write-up of the work carried out for the project (duly typed and bound) as per schedule given below:</i> Formulation of the proposal Survey of Literature/ Library (Bibliography) Data collection and Generation Data analysis and Interpretation Writing of Report	300	300	16	450	
CG-42	Presentation: Power point Presentation of the Project Viva- Voce on the project/presentation	60	50 100	4	150	

Syllabus for the M. Sc. Programme in Geology
First Semester

(For the Examination of December 2015, and afterwards)

The courses and examination will be as follows:

<u>COURSE</u>		Internal	Semester End	Total	Total	
		Assessment	Examination	Teaching	Credits	Marks
		Marks	Marks	Hours		
CG-11	Mineralogy and Geochemistry	30	70	45	3	100
CG-12	Structural Geology and Tectonics	30	70	45	3	100
CG-13	Igneous Petrology	30	70	45	3	100
CG-14	Engineering Geology & Ground Water	30	70	45	3	100
CG-15	Practical: Laboratory Work & Viva-voce			120	4	100
CG-16	Field Work: Practical Training Including Case Study, Tutorials and Report Writing			120	4	100
					Total Marks for Theory	400
					Total Marks for Practical	100
					Total marks for Field Work	100
					GRAND TOTAL MARKS	600

CG-11 : Mineralogy and Geochemistry

Fundamentals of Mineral Chemistry: Co-ordination number and bonding forces; Principles of ionic substitution in minerals; Partition coefficient; Repetition theory; Symmetry elements, Hermann-Mauguin symbols; Plane lattices, Unit cell, Bravais lattices and space groups; Crystal forms.

Symmetry classes and crystal systems; Crystal structure: polymorphism, isomorphism, and mineraloids; Surface, Magnetic and Electrical properties of minerals; Twinning and Crystal imperfections; X-Ray Crystallography; Bragg's Law, Single crystal diffractometry; Powder diffractometry.

Silicate mineralogy: Tectosilicates; Nesosilicates, Sorosilicates, Cyclosilicates, Inosilicates, Phyllosilicates; Mineralogy of phosphates, carbonates sulphides and halide groups; Clay Minerals: Properties and occurrences; Gems and semi-precious stones.

Abundance of elements in the Cosmos and Earth; Geochemical differentiation of the earth; Goldschmidt's Geochemical classification of elements; Geochemical cycle; Application of Trace and Rare Earth Elements in Petrogenesis; Stable isotope Geochemistry.

CG-12 : Structural Geology and Tectonics

Mechanical properties of rocks; Stress and its components, stress in two and three dimensions; Mohr diagrams; Estimation of strain in naturally deformed rocks.

Mechanisms of rock deformation; Mechanics of folding and buckling; Superposed folding; Causes and dynamics of faulting; Time relationships between crystallisation and deformation.

Shear zones; Geometry and rock types of shear zones; Concept of petrofabrics and symmetry; Types of Tectonites; Fault geometries: Normal, Strike-slip and Thrust.

Causes of Plate motion; Mantle Plumes and Plume mechanics; Structure and tectonic evolution of the Himalaya; Anatomy of Mountain belts.

CG-13 : Igneous Petrology

Introduction to phase diagrams; Alkemade Theorem, Lever rule, Tangent Rule; Nature of Boundary curves Tributary and Distributary reaction points; Phase equilibria studies in the silicate systems: [Periclase – Silica], [Albite – Orthoclase – Water], [Albite – Potash feldspar – Silica – Water], [Diopside – Forsterite – Silica], [Nepheline – Kalsilite – Silica] .

Magma generation in the crust and mantle; Introduction to mantle metasomatism, Mantle heterogeneities; Classification of Granitoids and high Mg volcanic rocks in the light of IUGS recommendations.

Classification and composition of Meteorites including introduction to Lunar and Marsian meteorites; Large Igneous Provinces and mafic dyke swarms with particular reference to Bushveld & Skaergaard; Petrotectonic associations of rocks; Genesis of Andesites.

Petrogenesis of Granites, Massif Anorthosites, Kimberlites, Lamprophyres, Komatiites, Basalt, Carbonatites and Ophiolites with suitable Indian examples.

CG-14 : Engineering Geology & Ground Water

Engineering properties of rocks; Behaviour of rock on application of stresses; Tunnels: their type; Stress conditions in tunnels; Site selection for tunnel excavation and support.

Dams and their types; Geotechnical problems associated with bridges and dams; Site selection for dam construction; Case studies of Indian dams: Bhakra, Tehri, and Idduki Dams; Site selection for the construction of roads in hilly terrains.

Hydrological cycle; Occurrence of Groundwater; Genetic classification of water; Darcy's law; Water-bearing characteristics of rocks; Types and characteristics of Aquifers.

Artificial recharging of aquifers; Techniques of Ground water exploration; Saline water intrusion; Types of well; Ground water regimes of India.

CG-15: Laboratory Work

Study of the physical properties of rock forming minerals in hand specimens, with special reference to their origin and distribution. Stereographic projections and calculation of axial elements of zircon, apophyllite, beryl, calcite, barytes, orthoclase and hornblende. Study of X-ray diffractograms.

Interpretation of geological maps and sections; Structural problems using stereographic methods; π and σ diagrams.

Study of the optical properties of rock forming minerals in thin sections. Megascopic and microscopic study of important igneous rocks. Calculation of C.I.P.W. norms and Niggli values.

Every student shall be required to keep and maintain up-to-date record of practical work during the session properly signed by the teachers concerned and submit it to the Head of the Department at the time of the Practical Examination. Marks shall be assigned for these practical records

CG-16: Field Work

Every student shall be required to attend the field training and submit to the Head of the Department a record of field observations and specimens collected, properly labelled and arranged.

The marks awarded for the fieldwork shall be on the basis of these records, collections, and performance in the field.

Second Semester

(For the Examination of May 2016, and afterwards)

The courses and examination will be as follows:

<u>COURSE</u>		Internal Assessment	Semester End Examination	Total Teaching	Total	
		Marks	Marks	Hours	Credits	Marks
CG-21	Economic Geology, Mineral Exploration and Mining Methods	30	70	45	3	100
CG-22	Metamorphic Petrology and Geochronology	30	70	45	3	100
CG-23	Sedimentology and Applied Palaeontology	30	70	45	3	100
CG-24	Remote Sensing, GIS and Quaternary Geology	30	70	45	3	100
CG-25	Practical: Laboratory Work & Viva-voce			120	4	100
CG-26	Semester Assignment: Case Study and Tutorials			120	4	100
					Total Marks for Theory	400
					Total Marks for Practical	100
					Total marks for Semester Assignment	100
					GRAND TOTAL MARKS	600

CG-21: Economic Geology, Mineral Exploration and Mining Methods.

Processes of formation of ores; Magmatic deposits: Chromium and Platinum Group of Elements (PGE) deposits; Hydrothermal deposits: Porphyry Cu deposits and Gold in Archaean and Proterozoic terrains.

Placer deposits; Ores related to weathering processes: Bauxite and Laterite; Sediment hosted Copper, Lead-Zinc deposits; Iron and Manganese ores of Sedimentary affiliation; Manganese nodules.

Methods of mineral prospecting: Geological, Geochemical and Geobotanical; Methods of sampling, assaying and evaluation of mineral deposits; Tenor, grade and specification; Strategic, Critical and Essential minerals.

Coal and Uranium in India; Classification of mining methods; Open Cast mining; Underground mining; Ore-dressing; National Mineral Policy.

CG-22: Metamorphic Petrology and Geochronology

Textures and structures of Metamorphic rocks; Basic concept of P-T-t paths; Thermal metamorphism; Metamorphic concepts and classification of metamorphic facies and facies series; facies series of contact metamorphism — pelitic rocks; Mineral phase rule for open and closed systems; Introduction to ultra high temperature and ultra high pressure metamorphism.

Regional metamorphism in relation to Plate tectonics; Paired metamorphic belts; Metasomatism and metamorphic differentiation; Petrogenesis of granulites and Eclogites; Origin and structure of migmatites; ACF and AKF diagrams.

Metamorphism in: Eastern Ghats mobile belt, South India Granulite belt, Singhbhum, Dharwar, Aravalli, Central Indian Craton: Bastar and Bundelkhand, Lesser and Central Himalayan zones.

Radiometric dating methods: K – Ar, Ar – Ar dating; Rb – Sr isochron method; Sm – Nd dating; U – Th – Pb system; Concordia and Discordia diagrams; Radiocarbon, Fission Track (FT) and OSL dating techniques; Dendrochronology and Lichenometry.

CG-23: Sedimentology and Applied Palaeontology

Sediment characteristics and their analysis; Concept of flow regime and bedforms; Principles of facies analysis; Principles of sequence stratigraphy.

Facies models and depositional sequences of glacial, fluvial, lacustrine, delta, tidal flats, and deep-sea regions.

Genesis and classification of major sedimentary rocks: conglomerate, shale, sandstone carbonate and siliceous rocks; Diagenesis of sandstones, carbonates and evaporates. Important Sedimentary structures.

Study of microfossils with special reference to foraminifera, ostracods and conodonts and their applications;

Palynology and its application in palaeoclimatology, and hydrocarbon exploration.

CG-24: Remote Sensing, GIS and Quaternary Geology

Concepts of remote sensing; Electromagnetic spectrum and its interaction with atmosphere and earth surface objects; Atmospheric windows; Platforms; Sensors: active and passive; Sensors on LANDSAT; SPOT and IRS. Concepts of Photogrammetry; Types of aerial photographs; Principles of photo and image interpretation techniques; photo elements, geotechnical elements.

Introduction to Digital image processing; Image enhancement and classification; Raster, and Vector; Data types; Layer analysis; Concept of GIS; Application of GIS in Geology: Disaster Management and Hydrogeology; Microwave remote sensing: Principles and uses; Introduction to GPS system.

Basic concept of Landform evolution; Active tectonics and associated landforms; Exogenic processes: Fluvial, Aeolian, Glacial, Karst and Coastal; River basin and drainage network; Geomorphology of Indo-Gangetic Plain and Himalaya.

Quaternary time and its significance; Climatic cycles during Quaternary; Milankovic cycles; Terminal Pleistocene-Holocene climatic and sea level changes; Geomorphology and Quaternary climate studies of Thar Desert, Ganga Plain, Himalaya and Peninsular India; Use of Oxygen Isotopes in palaeoclimate studies.

CG-25: Laboratory work

Preparation of thin sections, Optical Experiments and Petrographic techniques.

Study of the physical properties of ore-forming minerals in hand specimens, with special reference to their origin and distribution. Ore microscopy and study of the following metallic ores under the ore-microscope: pyrite, chalcopyrite, magnetite, hematite, chromite, pyrolusite and psilomelane.

Megascopic and microscopic study of important metamorphic rocks.

Study of important sedimentary rocks in hand-specimens and thin sections with emphasis on diagenetic features.

Grain size determination and calculation of statistical parameters; Grain shape determination; Palaeocurrent analysis. Heavy mineral separation and identification under microscope, and provenance interpretation; Study of stromatolites. Study of important sedimentary structures.

Visual interpretation of lithology, structure and land use from aerial photographs and satellite data; Mapping from aerial photographs in different lithologies. Digital image processing. Application of GIS in geomorphological studies. Morphometric analysis of River and Channel.

Every student shall be required to keep and maintain up-to-date record of practical work during the session, properly signed by the teachers concerned and submit it to the Head of the Department at the time of their Practical Examination. Marks shall be assigned for these practical records.

CG-26: Semester Assignment

For the assignment work, students would be required to prepare and submit a write-up and give a Power Point Presentation on a topic assigned to them.

The marks awarded for the semester assignment work shall be on the basis of the write-up and presentation.

Third Semester

(For the Examination of December 2016, and afterwards)

The courses and examination will be as follows:

<u>COURSE</u>		Internal	Semester End	Total	Total	
		Assessment	Examination	Teaching	Credits	Marks
		Marks	Marks	Hours		
CG-31	Geophysics and Petroleum Geology	30	70	45	3	100
CG-32	Environmental Geology and Natural Hazards	30	70	45	3	100
CG-33	Palaeontology	30	70	45	3	100
CG-34	Stratigraphy	30	70	45	3	100
CG-35	Practical: Laboratory Work & Viva-voce			120	4	100
CG-36	Field Work: Practical Training Including Case Study, Tutorials and Report Writing			120	4	100
					Total Marks for Theory	400
					Total Marks for Practical	100
					Total marks for Field Work	100
					GRAND TOTAL MARKS	600

CG-31: Geophysics and Petroleum Geology

Geophysical features of the Earth; Seismic Structures; Seismic Belts; Geoid – Figure of the Earth.

Gravity - Densities of Rocks and Gravity Anomalies; Isostasy: Modern Concepts; Magnetism: Geomagnetism and Palaeomagnetism; Electrical Properties: Resistivity surveying; Vertical Electrical Sounding (VES); Electrical Imaging; Magnetotelluric Surveying (MT).

Geothermics: Heat flow pattern of the earth; Geophysical structure and geodynamics of the Indian Plate motion; Gravity and Magnetic Anomalies at Mid-oceanic ridges; APW Path and Plate motion; Instruments used in Geophysical Studies: Seismograph, Resistivity meter, Gravimeter, Ground Penetration Radar.

Introduction to Petroleum Geology; Genesis, Migration and occurrence of petroleum (Structural, Stratigraphic and Combination traps); Reservoir characteristics; Gas hydrates; Oil producing basins of India: Assam, Krishna-Godavari, Bombay, Cambay, and Rajasthan.

CG-32: Environmental Geology and Natural Hazards

Concepts and scope of Environmental Geology; Earth as a System; Ecosystem; Global Biogeochemical cycle; The Gaia hypothesis; Application of Geology to Sustainable Development; Environmental Impact Assessment (EIA); Terrain evaluation and Land-use planning; Environmental Protection Law.

Environmental Impact Mining; Sediment pollution; Surface and Groundwater pollution; Nitrate hazard, Fluorine and Arsenic pollution; Radioactive Waste Management; Fly-ash; Medical Geology.

Introduction to hazards; Floods their type and distribution, flood hazard zonation, mitigation of flood-prone areas; Storms and Tsunamis: causes and distribution; Cyclones in the Indian seas; Cyclone and Tsunami-prone zones of India.

Landslides: their types; Factors controlling landslides; Landslide hazard zonation mapping; Monitoring and control of Landslides; Seismic zonation map of India; Earthquake resistant structures; Avalanches.

CG-33: Palaeontology

Biostratigraphy; Palaeobiogeography; Palaeoecology; Classification, evolution and modes of life of major invertebrate groups: Mollusca (Bivalvia Gastropoda and Cephalopoda).

Classification, evolution and mode of life of Brachiopoda and Echinoidea.

Classification, evolution and geological history of Cnidaria, Trilobita; biological affinities and evolution of Graptolithina.

Evolution of man, elephant and horse and their fossils localities in India; Evolution and extinction of Dinosaurs; Siwalik Vertebrate fauna. Devonian flora, Gondwana flora, and Deccan Inter-trappean flora

CG-34: Stratigraphy

Stratigraphic concepts: Lithostratigraphy, Magnetostratigraphy, Allostratigraphy; Unmetamorphosed Proterozoic successions of India namely Vindhyan, Chattisgarh, Kaladgi, Cuddupah,.

Kurnool, Bhima, Marwar and Lesser Himalayan sedimentary belts; Precambrian-Cambrian boundary; Palaeogeography and important events of the Palaeozoic Era; Stratigraphy of the Himalaya.

Permian-Triassic boundary; Marine Triassic sequences of the Himalaya with special reference to Spiti Valley, Himachal Pradesh; Gondwana Supergroup. Principle of basin analysis; Sedimentary basins of India

Global events of Jurassic and Cretaceous periods; Jurassic successions of Western India; Cretaceous successions of Cauvery basin, South India and Narmada valley. Cretaceous-Tertiary boundary; Palaeogene and Neogene global events and successions in India; Neogene-Quaternary boundary.

CG-35: Laboratory work

Study and preparation of facies maps and percentage diagrams; Preparation and study of reservoir maps, isopach, isochore, and structure contour maps;

Environmental interpretation from topographical and geological maps.

Study and illustration of representative specimens of invertebrate fossils (Mollusca, Brachiopoda, Anthozoa, Echinoidea, Graptolithina and Trilobita). Study of important trace fossils and their ecological significance.

Palaeontologic exercises; Study of stratigraphic distribution of some age-diagnostic fossil forms of Indian sedimentary sequences.

Study of important vertebrate fossils; Study of Gondwana plant fossils

Exercises on stratigraphic column: recognition of age and stratigraphic horizons on the basis of geological specimens, and location of important fossils and formations on the map of India.

Every student shall be required to keep and maintain up-to-date record of practical work during the session, properly signed by the teachers concerned and submit it to the Head of the Department at the time of their Practical Examination. Marks shall be assigned for these practical records

CG-36: Field Work

Every student shall be required to attend the field training and submit to the Head of the Department a record of field observations and specimens collected, properly labelled and arranged.

The marks awarded for the fieldwork shall be on the basis of these records, collections, and performance in the field.

Fourth Semester
(For the Examination of May 2017, and afterwards)

The courses and examination will be as follows:

There shall be only a **Dissertation** in the Fourth Semester which shall be evaluated as follows:

<u>COURSE</u>		Time frame	Semester End Examinations		
		Hours	Marks	Credits	Marks
CG-41	Dissertation Work: <i>A write-up of the work carried out for the project (duly typed and bound) as per schedule given below:</i>	300	300	16	450
	Formulation of the proposal	40			
	Survey of Literature/ Library (Bibliography)	100			
	Data collection and Generation	100			
	Data analysis and Interpretation	30			
	Writing of Report	30			
CG-42	Presentation:	60		4	150
	Power point Presentation of the Project	Max. 1 Hr./ Student	50		
	Viva- Voce on the project/presentation	Max. 1 Hr./ Student	100		
GRAND TOTAL MARKS					600

During the IV Semester, the students shall undertake a Dissertation on a topic of Geology.

The topic of Dissertation shall be assigned to the students in the beginning of the Third Semester. Based on the overall merit of the student during previous two Semesters and Faculty available in the Department, they would be allotted a Dissertation topic and attached to a Faculty Member in the Department who would act as their Dissertation Supervisor. Each Faculty members shall be generally allotted two students (and not more than three students) each year.

The students shall remain in contact with their Supervisor, for a day-to-day progress of the work done by them. During the course of completion of the Dissertation work the students will be required to complete various assignments, given to them by their respective Supervisor, for the purpose of evaluation.

The students will be required to submit the Dissertation by the date specified to them in the Fourth Semester. This will be followed by a Presentation before the Faculty Members of the department and the Examiner(s) for the purpose of evaluation.

The Dissertation shall be of 600 Marks out of which 450 Marks will be for evaluation of the Dissertation Work (Thesis), 50 Marks for the Presentation followed by 100 Marks for Viva-voce Examination.

The **Dissertation thesis (CG-41)** will be evaluated by the respective Supervisors. Under special circumstances it may be evaluated by an examiner appointed by the Board of Studies.

For the **Presentation (CG-42)**, 50 Marks for the presentation and 100 Marks for the Viva-voce examination will be awarded by the Examiner(s) appointed by the Board of Studies of the Department each year.