KUMAUN UNIVERSITY NAINITAL
DETAILS OF UNDERGRADUATE SYLLABUS
GEOLOGY

Semester system course structure:

1. The course work shall be divided into six semesters with three papers in each semester.
2. Each paper in a semester will be of **80 marks** out of which **60 marks** for theory and **20 marks** are allotted for internal assessment (written test or assignments or both)
3. Each theory paper shall have two sections. S**ection A (35 marks)** consists of seven questions out of which five questions are to be attempted. Each question would be of 7 marks. S**ection B (25 marks)** consists of two questions of 12 ½ marks each with internal choice**.** All the questions have to be attempted.
4. Question paper shall cover the whole syllabus.
5. Practical in each semester will be of total **60 marks**, which includes marks for field training, sessional, attendance, practical records etc.
6. Practical examination will be evaluated by both external and internal examiner.
7. The duration of theory and practical examination shall be **03 hrs each.**

There shall be six semesters spread over three years with three papers in each semester at Undergraduate level. Each paper will be of three hours duration and there shall be one practical examination of three hours duration in each of them with session assessment in each practical and field training in odd semester practical. The session and field work will be assessed on the basis of class-work, practical record and field work performance. Each Theory = 60 marks End-Semester Examination + 20 marks Internal Assessment.

Semester	**Paper**	**Course (Paper Code)**
I	Paper- I	Physical Geology **(6106)**
	Paper- II	Structural Geology **(6107)**
	Paper-III	Crystallography **(6108)**
	Practical	Structural Geology + Crystallography **(6109)**

(Practical = 45 marks for written + 10 marks for Field training +5 marks for sessional)

II	Paper-I	Mineralogy **(6206)**
	Paper-II	Optical Mineralogy **(6207)**
	Paper-III	Elementary Geochemistry **(6208)**
	Practical	Mineralogy + Optical Mineralogy **(6209)**

(Practical = 55 marks for written + 05 marks for sessional)

III	Paper-I	Igneous and Metamorphic Petrology **(6306)**
	Paper-II	Sedimentary Petrology **(6307)**
	Paper-III	Elementary Groundwater Hydrology **(6308)**
	Practical	Igneous and Metamorphic +Sedimentary **(6309)**

(Practical = 45 marks for written + 10 marks for Field training +5 marks for sessional)

Semester	Paper	Course (Paper Code)
IV	Paper-I	Stratigraphy **(6406)**
	Paper-II	Palaeontology **(6407)**
	Paper-III	Elementary Oceanography **(6408)**
	Practical	Stratigraphy + Palaeontology **(6409)**

(Practical = 55 marks for written + 05 marks for sessional)

V	Paper-I	Economic Geology **(6506)**
	Paper-II	Fuel Geology **(6507)**
	Paper-III	Elementary Engineering Geology **(6508)**
	Practical	Economic Geology + Fuel Geology **(6509)**

(Practical = 45 marks for written + 10 marks for Field training +5 marks for sessional)

VI	Paper-I	Photogeology **(6606)**
	Paper-II	Elements of Mineral Exploration **(6607)**
	Paper-III	Environmental Geology **(6608)**
	Practical	Photogeology+Mineral Exploration **(6609)**

(Practical = 55 marks for written + 05 marks for session assessment)

SEMESTER I

Paper – I Physical Geology **MM 60**

Unit-I: Introduction to geology and its scope, Earth in space and solar system. Earth's shape, size, mass, density and its atmosphere. Various theories regarding the Earth's origin.
Unit-II: Internal structure of the Earth. Brief idea about the Earth's internal and external processes. Law of uniformitarianism.
Unit-III: Earthquakes: nature of seismic waves, their intensity and magnitude scale; Origin of earthquake and tsunami; Volcanoes: types, products and causes of volcanism.
Unit-IV: Weathering and erosion: factors, types and their effects. Soil and soil profile.

Books Recommended:

1. Arthur Holmes, 1992. Principles of Physical Geology. Chapman and Hall, London.
2. Miller, 1949. An Introduction to Physical Geology. East West Press Ltd.
3. Spencer, E.V., 1962. Basic concepts of Physical Geology. Oxford & IBH.
4. Mahapatra, G.B., 1994. A text book of Physical geology. CBS Publishers.

Paper – II Structural Geology **MM 60**

Unit-I: Introduction to Structural Geology; contours, topographic and geological maps; Elementary idea of bed, dip and strike; Outcrop, effects of various structures on outcrop. Clinometer/Brunton compass and its use.
Unit-II: Elementary idea of types of deformation; Folds: nomenclature and types of folds;
Unit-III: Faults: nomenclature, geometrical and genetic classifications, normal, thrust and slip faults;
Unit-IV: Definition, kinds and significance of joints, cleavage, lineation and unconformity.

Books Recommended:

1. Billings, M.P., 1972. Structural Geology. Prentice Hall.
2. Davis, G.R., 1984. Structural Geology of Rocks and Region. John Wiley
3. Hills, E.S., 1963. Elements of Structural Geology. Farrold and Sons, London.
4. Singh, R. P., 1995. Structural Geology, A Practical Approach. Ganga Kaveri Publ., Varanasi.

Paper –III Crystallography **MM 60**

Unit-I: Crystals and their characters. Crystal form, face, edge, solid angle. Interfacial angle and their measurements
Unit-II:Crystallographic axes and angles. Twinning and their types.
Unit-III: Crystal parameters, Weiss and Miller system of notations.
Unit-IV: Symmetry elements and description of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems.

Books Recommended:

1.Dana, E.S. and Ford, W.E., 2002. A textbook of Mineralogy (Reprints).
2.Flint, Y., 1975. Essential of crystallography, Mir Publishers.
3.Phillips, F.C., 1963. An introduction to crystallography. Wiley, New York.

Practical **MM 60**

Structural Geology
Reading of topographical maps, graphical solution of simple problems of dip, strike and width of outcrops. Three point problems. Completition of outcrops from partial data on contoured topographic maps. Study of geological maps, interpretation of outcrop patterns and preparation of geological cross section and geological history thereof.
Crystallography:
Study of symmetry elements of normal class of Isometric (cube, octahedron, rhombdodeca hedron, tetrahexahedron, trapezohedron); Tetragonal (zircon, visuvianite), Hexagonal (Beryl), Orthorhombic (barites) Monoclinic (gypsum, orthorhombic).
Geological Field Training
Students will be required to carry out one week field work in a suitable geological area to study the elementary aspects of field geology and submit a report thereon.

SEMESTER-II

Paper – I Mineralogy **MM 60**

Unit-I: Definition and physical properties of minerals
Unit-II: Isomorphism and Polymorphism
Unit-III: Concept of silicon tetrahedron and classification of silicates
Unit-IV:Chemical composition and diagnostic physical properties of minerals such as: Quartz, Orthoclase, Microcline, Hypersthene, Hornblende, Garnet, Muscovite, Biotite, Olivine

Paper-II Optical Mineralogy **MM 60**

Unit-I: Ordinary and plane polarized light, Isotropism and Anisotropism
Unit-II: Polarizing microscope, its parts and functioning;
Unit-III Common optical properties observed under ordinary, polarized lights and between crossed nicols.
Unit-IV: Optical properties of some common rock forming minerals (Quartz, Orthoclase, Microcline, Hypersthene, Olivine, Hornblende, Muscovite, Biotite, Garnet).

Books Recommended:

1. Berry, L.G., Mason, B. and Dietrich, R.V., 1982. Mineralogy. CBS Publ.
2. Nesse, D.W., 1986. Optical Mineralogy. McGraw Hill.
3. Read, H.H., 1968. Rutley's Element of Mineralogy (Rev. Ed.). Thomas Murby and Co.
4. Berry and Mason, 1961. Mineralogy. W.H. Freeman & Co.

Paper-III Elementary Geochemistry **MM 60**

Unit-I Properties of elements, chemical bonding, states of matter and atomic environment of elements.
Unit-II Geochemical classification of elements, the composition of different Earths' reservoirs. Elemental fractionation, transport, advection, diffusion.
Unit-III The solid Earth – geochemical variability of magma, melting of the mantle and growth of continental crust.

Unit-IV The Earth in the solar system, the formation of solar system, composition of the bulk silicate Earth and Meteorites. Geochemical behavior of selected elements like Si, Al, K, Na etc. during weathering of rocks.

Books Recommended

1. Mason, B. and Moore, C. B., 1982, Principles of Geochemistry, 4th Edition, New York.
2. Walther John. V. , Essentials of Geochemistry (student edition), Jones and Bartlett Publishers
3. Albarede, F., An Introduction to geochemistry, Cambridge publication.

Practical **MM 60**

Mineralogy:
Study of physical properties of minerals mentioned in theory course. Use of polarizing microscope; Study of optical properties of common rock forming minerals mentioned in theory course.

Optical Mineralogy:
Study of optical characteristic of minerals such as form, colour, relief, cleavage, pleochroism and extinction: Quartz, Orthoclase, Microcline, Hornblende, Olivine, Garnet, Biotite, Muscovite, and Augite

SEMESTER III

Paper –I Igneous and Metamorphic Petrology **MM 60**

Unit-I: Magma: definition, composition, types and origin; Forms and textures of igneous rocks; Reaction principle; Differentiation and Assimilation; Crystallization of unicomponent and bicomponent (mix-crystals); Bowen's reaction series.
Unit-II: Mineralogical and chemical classification of igneous rocks. Detailed petrographic description of Granite, Granodiorite, Rhyolite, Syenite, Phonolite, Diorite, Gabbro.
Unit-III: Process and products of. metamorphism; Type of metamorphism. Factors, zones and grade of metamorphism;
Unit-IV: Textures, structures and classification of metamorphic rocks. Petrographic details of some important metamorphic rocks such as - slate, schists, gneiss, quartzite, marble.

Books Recommended:

1. Turner, F.J. & Verhoogen, J., 1960, Igneous & Metamorphic petrology. McGraw Hill Co.
2. Bose, M.K., 1997. Igneous petrology. World press
3. Tyrell, G. W., 1989. Principles of Petrology. Methuren and Co (Students ed.).
4. Ehlers, WG, and Blatt, H., 1987. Petrology, Igneous, Sedimentary and Metamorphic rocks, CBS Publishers
5. Moorhouse, WW., 1969. The study of rocks in thin sections. Harper and sons.
6. Turner, F.J., 1980. Metamorphic petrology. McGraw Hill.
7. Mason, R., 1978. Petrology of Metamorphic Rocks. CBS Publ.
8. Winkler, H.G.C., 1967. Petrogenesis of Metamorphic Rocks. Narosa Publ.

Paper-II Sedimentary Petrology **MM 60**

Unit-I: Processes of formation of sedimentary rocks. Clastic and nonclastic sedimentary rocks.
Unit-II: Textures and structures of sedimentary rocks. Palaeocurrent and sediment dispersal
Unit-III: Concept of provenance and basins. Elementary knowledge about continental and oceanic sedimentary basins.Concept of sedimentary environments and facies.
Unit-IV: Petrographic details of important siliciclastic and carbonate rocks such as - conglomerate, breccia, sandstone, greywacke, shale, limestones.

Books Recommended:

1. Friedman & Sanders, 1978. Principles of Sedimentology. John Wiley and sons.
2. Pettijohn, F.J., 1975. Sedimentary rocks, Harper & Bros. 3rd Ed.
3. Prasad, C., 1980. A text book of sedimentology.
4. Sengupta. S., 1997. Introduction to sedimentology. Oxford-IBH.

Paper-III Elementary Ground water Hydrology **MM 60**

Unit-I: Definition of ground water hydrology, Hydrological cycle;
Unit-II:Hydrological parameters - Precipitation, evaporation, transpiration and infiltration.
Unit-III: Origin of groundwater; Vertical distribution of groundwater. Types of aquifers- Unconfined and confined aquifers. Water bearing properties of rocks - Porosity and Permeability; specific yield, specific retention.
Unit-IV: Groundwater provinces of India.

Practical **MM 60**

Igneous and Metamorphic Petrology
Study of common igneous and metamorphic rocks and their thin sections. Study of commom structures in igneous and metamorphic rocks.
Sedimentary Petrology
Study of common sedimentary rocks on the basis of their physical properties in hand specimen; and optical properties in thin sections. Study of common structures in sedimentary rocks
Geological Field Training
Students will be required to carry out one week field work in a suitable geological area to study the elementary aspects of field geology and submit a report thereon.

SEMESTER IV

Paper-I Straigraphy **MM 60**

Unit I: Definition, Principle of stratigraphy; Geological Time Scale and stratigraphic classification; Physiographic division of India.
Unit II: Study of following Precambrian succession: Dharwar, Cuddapha, Vindhyan and Delhi Supergroups; Brief idea of Palaeozoic succession of northwestern Himalaya; Triassic of Spiti; Mesozoic type seccession of Kutch and Rajasthan; Cretaceous of Tiruchirapalli;
Unit III: Study of following type localities: Gondwana and Deccan Trap.

Unit IV: Palaeogene-Neogene sequences of northwest Himalaya and Assam.

Books Recommended:

1. Wadia, D., 1973. Geology of India. Mc Graw Hill Book co.
2. Krishnan, M.S., 1982. Geology of India and Burma, 6th Edition. CBS Publ.
3. Ravindra Kumar, 1985. Fundamentals of Historical Geology & Stratigraphy of India. Wiley Eastern.

Paper-II Palaeontology **MM 60**

Unit-I: Palaeontology: definition, Fossils: definition, characters, binomial nomenclature in taxonomy, mode of preservation, condition of fossilization and significance of fossils.
Unit II: Morphology and geological distribution of gastropods brachiopods, pelecypods, cephalopods.
Unit III: Morphology and geological distribution of trilobite, echinoidea.
Unit IV Evolutionary history of horse; Morphology, distribution and significance of Gondwana flora.

Books Recommended:

1. Shrock, R.R. & Twenhoffel, W.H., 1952. Principles of Invertebrate Paleontology. CBS Publ.
2. Swinerton, HH., 1961. Outlines of Paleontology. Edward Arnold Publishers
3. Jain, P.C. & Anantharaman, M.S., 1983. Paleontology: Evolution & Animal Distribution.
4. Vishal Publ.
5. Lehmann, U., 1983. Fossil Invertebrate. Cambridge Univ. Press.
6. Rastogi, 1988. Organic evolution. Kedrnath and Ramnath Publ.

Paper-III Elementary Oceanography **MM 60**

Unit I: Relief of ocean floor (Continental Shelf, Continental Slope, Continental Rise, Abyssal Plain and associated features), Density of sea water, Salinity of sea water.
Unit II: Marine sediments and their classification (Lithogenous, Biogenous, Hydrogenous, Cosmogenous), Sea floor mineral resources, Submarine canyons.
Unit-III Marine microfossils and its geological and economic significance.
Unit IV: Coastal Geology: Coastal landforms—dunes, Spits and bars, estuaries, lagoons, deltas; Coral reefs and atolls, Coastal resources

Suggested Readings

1. Seibold, E and Berger, W. H. (1996) The sea floor: An introduction to marine geology. Springer
2. Kennett, J. (1982) Marine geology. Prentince Hall

Practical **MM 60**
Stratigrapgy
Preparation of lithostratigraphic maps of India showing distribution of important geological formations.

Palaeontology
Morphological characters, systematic position and age of fossil genera pertaining to gastropods brachiopods, pelecypods, cephalopods, trilobite and Echinacea.

SEMESTER V

Paper- I Economic Geology **MM 60**

Unit-I: Concept of ore and ore deposits, ore minerals and gangue minerals; Tenor of ores; Metallic and non-metallic ore minerals; Strategic, Critical and essential minerals.
Unit-II: Processes of formation of ore deposits; Magmatic, contact metasomatic, hydrothermal, sedimentation,
Unit-III: Study of important metallic (Cu, Pb, Zn Mn, Fe, Au, Al) and non-metallic (industrial) minerals (gypsum, magnesite, mica). Distribution of coal and petroleum in India.
Unit-IV: Mineral exploration: Elementary idea of geological and geophysical prospecting and mining

Books Recommended:

1. Brown, C. and Dey, A.K.1955. Indian Mineral Wealth. Oxford Univ.
2. Gokhale, K.V.G.K. and Rao, T.C., 1983. Ore Deposits of India. East West Press Pvt. Ltd.
3. Jense, M.L. and Bateman A.M., 1981. Economic Mineral Deposits. John Wiley and Sons.
4. Krishnnaswamy, S., 1979. India's Minerals Resources. Oxford and IBH Publ.
5. Deb, S., 1980. Industrial minerals and Rocks of India. Allied Publishers Pvt. Ltd.
6. Umeshwar Prasad, 2003. Economic Geology. CBS Publishers and distributers.
7. Sharma, N.L. and Ram, K.V.S., 1972. Introduction to India's Economic Minerals, Dhanbad.

Paper – II Fuel Geology **MM 60**

Unit I: Coal and Coal as fuel: Definition and Origin of Coal; Basic classification of coal; Introduction to lithotypes, microlithotypes and macerals in coal; Underground coal gasification;
Unit II: Petroleum and Petroleum as fuel: Chemical composition and physical properties of crudes; Origin of petroleum. Maturation of kerogen; Biogenic and Thermal effect; Petroleum reservoirs and Traps

Unit-III Reservoir rocks: Hydrocarbon traps: definition; anticlinal theory and trap theory; Classification of hydrocarbon traps - structural, stratigraphic and combination; Time of trap formation and time of hydrocarbon accumulation; Cap rocks - definition and general properties; Plate tectonics and global distribution of hydrocarbon reserves
Unit IV: Elementary knowledge of Nuclear Fuel

Books Recommended:

1. Textbook on coal geology by D. Chandra
2. Elements of Petroleum geology: R.C.Shelly, Second Edition, Academic Press
3. Sedimentary and petroleum geology: Bjorlykke, Springer-Verlag, 1989
4. Basin evolution and petroleum prospectivity of the continental margins of India: R. Bastia and

M. Radhakrishna, Elsevier Development in Petroleum Science, 2012
5. Coal Geology: Larry Thomas
6. Petroleum Formation and Occurrence: B.P.Tissot and D.H.Welte Publisher: Springer-Verlag
7. Petroleum Geology: F.K.North Allen and Unwin
8. Petroliferous basins of India: Publisher: KDMIPE, ONGC

Paper-III Elementary Engineering Geology MM 60

Unit-I: Engineering properties of rocks and Soils. Soil and Soil groups of India.
Unit-II: Dam, their types and geological and environmental considerations. Geological problems of reservoirs.
Unit-III: Geotechnical aspects of tunnels, bridges and hill roads.
Unit-IV: Causes, types and preventive measures of landslides.

Books Recommended:

1. Valdiya, K.S., 1987. Environmental Geology – Indian Context. Tata McGraw Hill.
2. Rajendran S., 2007. Mineral Exploration : Recent Strategies.
3. Dobrin, M.B. & Savit, CH., 1988. Introduction to Geophysical Prospecting, McGraw- Hill.
4. Arogyaswamy, R.N.P., 1973. Courses in Mining Geology. Oxford and IBH Publ.
5. Parasins, D.S., 1997. Principles of applied geophysics. Chapman Hall.
6. Krynine D.P. and Judd W.R., 1957. Principles of Engineering Geology & Geotechnics. McGraw-Hill Book
7. Kesavulu, N.C., 2009. A text book of engineering geology. Macmillan P publishing India Ltd.
8. Crozier. M.J., 1989. Landslides: causes, consequences and environment. Academic Press.
9. Readman, J.H., 1979. Techniques in Mineral exploration. Applied Science Publishres.
10. Bell, F.G., 1983. Fundamentals of Engineering Geology. Butterworth and Co.

Practical MM 60

Economic Geology

Study of ore and economic minerals in hand specimen; Preparation of maps showing distribution of important metallic and non-metallic deposits

Fuel Geology

Study of hand specimens of coal. Reserve estimation of coal ; Section correlation and identification of hydrocarbon prospect. Preparation of maps showing distribution of important coal and oil fields of India.

Geological Field training

Students will be required to carry out one week field work in a suitable geological area to study the elementary aspects of field geology and submit a report thereon'

SEMESTER VI

Paper- I Photogeology **MM 60**

Unit-I
Definition and scope of photogeology. EM radiation and EM spectrum. EM energy interactions with atmosphere and earth surface features.Film and digital aerial photography. Types of aerial photographs. Annotations on aerial photographs
Unit-II
Scale of aerial photographs. Relief distortions and vertical exaggeration in aerial photographs. Orthophotographs. Aerial photography mission. Tilt in aerial photographs. Stereoscopic vision in aerial photographs. Stereoscopes and their types.
Unit-III
Phototechnical and geotechnical elements of photo-interpretation. Aerial photo mosaics, their types and utility.
Unit-IV
Application potential of aerial photographs in land cover, landform, rock type and structure recognition,

Books Recommended:

1. Pandey, S.N., 1987. Principles and Application of Photogeology. Wiley Eastern, New Delhi.
2. Rampal K.K. 1999. Hand book of aerial photography and interpretation. Concept publication.

Paper-II Elements of Mineral Exploration **MM 60**

Unit-I
Mineral exploration: Surface and sub surface exploration methods including use of remote sensing techniques
Unit- II
Prospecting for economic minerals: drilling sampling and assaying.
Unit-III
Elementary knowledge of geological and geophysical prospecting. Gravity, electrical, magnetic airborne and seismic methods of exploration. Geobotanical and geochemical methods of exploration.
Unit-IV:
Elementary idea of mining and environmental considerations.

Books Recommended:

1. McKinstry, H.E., 1962: Mining Geology. II Ed. Asia Publishing House.
2. Clark, G.B., 1967: Elements of Mining. III Ed. John Wiley
3. Arogyaswami, R.P.N., 1996: Courses in Mining Geology. IV Ed. Oxford IBH.
4. Umathi, Exploration Geology.

Paper-III Environmental Geology **MM 60**

Unit-I

Scope and aims of environmental geology. Biosphere and man. Natural hazards- Earthquakes,volcanism, floods, avalanches, landslides and slope failures, Strategies and coping up with natural hazards

Unit-II

Climatology and global environment- Coastal, reverine, dessertic , tropical, cold and polar. Green house effect and global warming

Unit-III

Soil erosion and conservation. Preliminary idea of environmental implications of mining activities and their remedies.

Unit-IV

Elementary concept of watershed management. Land reclamation

Books Recommended:

1. Valdiya, K.S. 1987: Environmental Geology-Indian Context. Tata McGraw Hill
2. Keller, E.A. 1978: Environmental Geology, Bell and Howell, U.S.A.
3. Bryant, E., 1985: Natural Hazards, Cambridge University Press.
4. Patwardhan, A.M., 1999: The Dynamic Earth System. Printice Hall
5. Subramannian, V., 2001: Text book in Environmental Science, Narosa International
6. Bell, F.G., 1999: Geological Hazards. Routledge, London.
7. Smith, K., 1992: Environmental hazards. Routledge, London.

Practical **MM 60**

Photogeology

Identification of phototechnical and geotechnical elements of different landforms, land use/landcover classes and structure.

Mineral Exploration

Mineral Exercises in showing distribution of various mineral deposits on map of India. Laboratory exercises in solving exploration related problems.
