## First Semester for 2-Year P.G. Program

| **Entry requirement** | 3-year bachelor's degree (120 credits) and candidates who met the entrance requirement, including specified levels of attainment, in the program admission regulations | | | | |
|---|---|---|---|---|---|
| **Semester** | **Course Category** | **Course Title** | **Credits** | | **Total Credits** |
| | | | T | P | |
| I | Discipline-Specific Core | Geohydrology DSC-01 | 5 | - | 5 |
| | | Structural & Tectonics DSC-02 | 5 | - | 5 |
| | | Engineering Geology DSC-03 | 5 | - | 5 |
| | | DSC Practical -DSC-04 (DSC:01+02+03) | - | 3 | 3 |
| | Discipline-Specific Elective (Any one) | DSE-1 (A) Quaternary Geology / /(B) Remote Sensing and GIS | 4 | 2 | 6 |
| Total | | | 19 | 5 | 24 |

**Note: 1.** ***In lieu of elective (Theory and practical 4+2 credits), the departments may offer any one course i.e. dissertation/project work of 6 credits***

***2. In lieu of only Elective Practical (2 credits) the departments may offer 2 credit additional course (Field work/Project).***

21/5/25

Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25

Dean
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

# Second Semester for 2-Year P.G. Program

| Semester | Course Category | Course Title | Credits | | Total Credits |
|---|---|---|---|---|---|
| | | | T | P | |
| II | Discipline-Specific Core (DSC) | Igneous & Metamorphic Petrology-DSC-05 | 5 | - | 5 |
| | | Mineral Exploration & Mining Geology-DSC-06 | 5 | - | 5 |
| | | Sedimentology -DSC-07 | 5 | - | 5 |
| | | DSC Practical DSC-08 (DSC:05+06+07) | - | 3 | 3 |
| | Discipline-Specific Elective (DSE) | DSE-02A (i)Paleoclimatology/(ii)Natural Hazards/(iii)Himalayan Geology | 4 | - | 6 |
| | | DSE-02B Geological Fieldwork | | 2 | |
| Total | | | 19 | 5 | 24 |
| NHEQF Level-6 | ***Student on exit after successfully completing the first year of a two-year PG programme (i.e., securing a minimum of 48 credits will be awarded a "Postgraduate Diploma" for one year, in the related field/discipline/subject.*** | | | | |

21/5/25

Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25

Dean.
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

## Third semester for 2-year P.G. Program

| Semester | Course Category | Course Title | Credits | | Total Credits |
|---|---|---|---|---|---|
| | | | T | P | |
| III | Discipline-Specific Core (DSC) | Mineralogy & Crystallography DSC-09 | 5 | - | 5 |
| | | Geomorphology DSC-10 | 5 | - | 5 |
| | | Precambrian Stratigraphy - DSC-11 | 5 | - | 5 |
| | | DSC Practical DSC-12 (DSC09+10+11) | - | 3 | 3 |
| | Discipline-Specific Elective (Any one) (DSE) | DSE-03 (A) Glaciology/(B) Global Tectonics | 4 | 2 | 6 |
| Total | | | 19 | 5 | 24 |

21/5/25

Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25

Dean
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

## Fourth semester for 2-year P.G. Program

| Semester | Course Category | Course Title | Credits | | Total Credits |
|---|---|---|---|---|---|
| | | | T | P | |
| IV | Discipline-Specific Core (DSC) | Phanerozoic Stratigraphy-DSC-13 | 5 | - | 5 |
| | | Ore Genesis and Indian Mineral Deposits - DSC-14 | 5 | - | 5 |
| | | Palaeontology -DSC-15 | 5 | - | 5 |
| | | DSC Practical DSC-16 (DSC017+13+14) | - | 3 | 3 |
| | Discipline-Specific Elective (DSE) | DSE-04A Dissertation | 4 | - | 6 |
| | | DSE-04B Geological Field Training | - | 2 | |
| Total | | | 19 | 5 | 24 |
| **NHEQF Level- 6.5** | ***Students who successfully complete a two-year PG programme (i.e., securing a minimum of 96 credits will be awarded a "Postgraduate Degree" in the related field/discipline/subject.*** | | | | |

**Note: 1.** ***In lieu of elective (Theory and practical= 4+2 credits) the departments may offer any one course i.e. dissertation/project work of 6 credits***

***2. In lieu of only Discipline Elective Practical (2 credits) the departments may offer 2 credit additional course (Field work/Project).***

***Note: Out of the courses offered across the four semesters of 2-year P.G. programme, in each semester, at least two courses should be skill-based. If the department is unable to offer the minimum of two skill-based courses in a given semester, it may compensate by offering additional/extra skill-based courses in the other semester."***

21/5/25

Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25

Dean
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

## M.Sc. PG Semester I
## Discipline Specific Core (DSC-01)/Geohydrology
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Origin, occurrence, and distribution of groundwater, hydrological cycle, hydrological properties of rocks, water table fluctuations, Springs, groundwater provinces of India.
**Unit II:** Theory of groundwater flow, Darcy's law and its application and limitation, permeability determination, types of well, unconfined, confined
**Unit III:** Groundwater quality, physical and chemical properties, problems of arsenic and fluorides, groundwater contaminations.
**Unit IV:** Surface geophysical methods – electrical (resistivity), seismic, gravity methods, Groundwater problems and management, artificial recharge, and groundwater legislations.

**Books Recommended:**


- Bouver, H. (1978): Groundwater Hydrology, McGraw-Hill.
- Fetter, C.W. (1990): Applied Hydrogeology, CBS Pub. New Delhi.
- Todd, D.K. (1988): Ground Water Hydrology, John Wiley & Sons, New York.
- Davies, S.N. and Dc-West, R.J.N. (1966): Hydrology, John Wiley & Sons, New York.
- Raghunath, H.M. (1983): Ground Water, Wiley Eastern Ltd., Calcutta.


## M.Sc. PG Semester I
## Discipline Specific Core (DSC-02)/ Structure and Tectonics
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Stress and strain relationship of elastic, plastic, and viscous material, factors affecting the behaviour of rocks, kinematic analysis, Mohr's Circles, and strain and stress ellipsoids. Measurement of strain in deformed rocks.
**Unit II:** Classifications and mechanics of folds, faults, joints, unconformities, boudins, cleavage, lineation, foliation.
**Unit III:** Concept of Plate Tectonics, tectonic history of India, and origin of the Himalaya. Major tectonic features of the oceanic and continental crusts. Seismotectonic/geodynamics of the Indian plate.
**Unit IV:** Mid-oceanic ridges, Deep-sea trenches; Palaeomagnetism, Sea-floor spreading, Island arcs, Oceanic islands, and Volcanic arcs.

**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. (1983,1987): The Techniques of Modern Structural Geology-I & II, Strain Analysis, Academic Press.
- Hobbs, B.E., Means, W.D. & Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons publ.
- Turner, F.J. & Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw-Hill publ.
- Condie Kent, C. (1989): Plate Tectonics and Crustal Evolution.
- W. J. Kious & Robert I.T.: This dynamic 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.
- Valdiya, K.S. 1998: Dynamics Himalaya. Univ. Press.


Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25
Dean
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

## M.Sc. PG Semester I
## Discipline Specific Core (DSC-03)/Engineering Geology
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Engineering properties of rocks. Building stones and their distribution in India.
**Unit II:** Dam, Types and their Geological and Environmental considerations. Reservoirs, their Geological problems
**Unit III:** Tunnels- Geological and Structural considerations of tunnelling, Landslides- Classification, Causes and Preventive Measures
**Unit IV:** Bridges; Type and Foundation problems. Soils and Soils groups of India.

**Books Recommended:**


- Bangar, K.M. (2012): Principles of Engineering Geology. Standard Publishers Distr. India.
- Bell, F.G. (2007): Engineering Geology. Butterworth-Heinemann, Elsevier.
- Reddy, D.V. (2010): Engineering Geology. Vikas Publishing House, India.
- Kesavulu, N. Chenna (2009): Engineering Geology. Macmillan India Ltd.
- Verma, B.P. (2002): Rock Mechanics for Engineers. Khanna Publishers, New Delhi.
- Singh, Parbin (2008): Engineering and General Geology. S.K. Kataria & Sons.
- Gokhale, K.V.G.K. (2004): Geology and Engineering. CBS Publishers & Distributors.
- Punmia, B.C. (2005): Soil Mechanics and Foundations. Laxmi Publications, New Delhi.
- Ranjan, Gopal & Rao, A.S.R. (2007): Basic and Applied Soil Mechanics. New Age Publ.
- Bindra, S.P. (2007): Bridge Engineering. Dhanpat Rai Publications.


## M.Sc. PG Semester I
## Discipline Specific Core Practical (DSC-04)/(DSC01+02+03)
## Total Credits-03; Total marks 100 (60 End Term + 40 Sessional)

**Geohydrology (20+10)**
Delineation of hydrological boundaries on water table, contour maps, and permeability estimation., Analysis of hydrographs and estimation of infiltration capacity, Estimation and interpretation of TDS, Exercise on groundwater exploration using remote sensing techniques.
**Structure and Tectonics (20+15)**
Preparation and interpretation of geological maps and sections, Exercises on strain measurements, Study of various tectonic models, Stereographic presentation of structural data
**Engineering Geology (20+15)**
Study of Soil Profiles, Building stones, Engineering properties and Identification, Plain Table Survey (Radiation and Intersection methods)

## M.Sc. PG Semester I
## Discipline Specific Elective (DSE-01)
## Total Credits-06; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**DSE-01A Quaternary Geology Theory Total credits: 04**
**Unit I:** Quaternary stratigraphy, Earth's Climate and climate cycles in the Quaternary, glaciation events, etc.
**Unit II:** Quaternary archives and landforms: Glacier, Fluvial, Cave deposits, marine, and lake sediments.
**Unit III:** Dating techniques in Quaternary: Carbon-14 dating, Optical Dating etc.

21/5/24

Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

Dean
School of Earth Sciences
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

**Unit IV:** Major paleoclimatic and paleo-geographic events in the Quaternary period with special emphasis on the Indian Subcontinent; Quaternary successions in India.

**Book Recommended:**

- Duff, P.M.D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
- Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
- Gross, M. G. (1977). Oceanography: A view of the earth.
- Invitation to Oceanography (2009), Paul R. Pinet, Jones& Bartlett Learning.
- Trujilo, A. and Thurman, H. (2012) Essentials of Oceanography, 12th Edition, Pearson.

**DSE-01A Quaternary Geology Practical Total credits: 2**

Identification of various landforms associated with the Quaternary Period, surveying of geological features using DGPS and GPR, Reconstruction of Paleoclimate using Physical and biological proxies.

**DSE-01B Remote Sensing and GIS Theory Total credits: 04**

**Unit I.** Fundamental concepts of Remote Sensing; applications in geosciences
**Unit II.** Aerial photography, photogrammetry concepts, and remote sensing Satellites
**Unit III.** Visual interpretation of aerial photo/satellite images: Photo-recognition elements.
**Unit IV.** Fundamentals of Geographical Information Systems (GIS).

**Books Recommended:**

- F.F. Sabine: Remote Sensing- Principles and Interpretation
- Lillesand R. M. and Kiefer R.W.: Remote Sensing and Image Interpretation
- R. P. Gupta: Remote Sensing
- Demers, M. N.: Fundamentals of Geographic Information Systems
- Bonham Carter G. F.: Fundamentals of Geographic Information Systems for Geoscientists

**Remote Sensing and GIS (DSC-01B) Practical Total credits: 02**

Aerial Photo interpretation, identification of rock types and associated landforms, Introduction to DIP and GIS software's, Digital Image Processing exercises including analysis of satellite data, Creating a FCC from raw data, Registration of satellite data with a toposheet, Enhancing the satellite images, Generating NDVI images and its interpretation, Classification of images. DEM analysis: generating slope map, aspect map and drainage network map and its applications.

## M.Sc. PG Semester II

## Discipline Specific Core (DSC-05)/Igneous & Metamorphic Petrology

## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I: Magmatic differentiation – mechanisms and effects, magmatic crystallization – Bowen's** reaction principle. Texture and structures, classification of igneous rocks (only IUGS), granite and other granitoid rocks, and ophiolite
**Unit II:** Gibbs phase rule, component, and degree of freedom, application of the Phase rule in bi-component and tri-component magma; crystallization of bi- and tri-component magma (An-Al-Di system and An–Di–Fo system).
**Unit III:** Petrogenesis and petrography of the following rocks: Aplite, Anorthosite, Andesite, Basalt, Carbonatite, Charnockite, Diorite, Dunite, Dacite, Dolerite, Foidolite, Gabbro, Granite,

Head 21/5/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25
Dean
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

Granodiorite, Hornblendite, Ijolite, Kimberlite, Komatiite, Lamprophyre, Monzonite, Pegmatite, Phonolite, Peridotite, Syenite, Trachyte.

**Unit IV:** Metamorphic process, agents, grade and type of metamorphism, Metamorphic zones and Facies. Metamorphic structure and fabrics, Metamorphic differentiation.

**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.
- Phillpots A.: Introduction to igneous and metamorphic petrology, Prentice Hall Pub.
- Turner, F.J. & Verhoeven, J.: Igneous & Metamorphic petrology CBS Publications.
- Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
- Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science

## M.Sc. PG Semester II
## Discipline Specific Core (DSC-06)/Mineral Exploration & Mining Geology
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Mineral Prospecting and Exploration- Prospecting and Stages of mineral exploration: reconnaissance to feasibility. Geological, geophysical, and geochemical methods. Role of hyperspectral remote sensing in Mineral exploration.

**Unit-II:** Ore Reserve Estimation- Sampling techniques and resource evaluation. Classification of mineral resources and reserves. Grade estimation methods: egotistic and interpolation.

**Unit III:** Mining Methods- Surface mining: open-pit and strip mining. Underground mining with special reference to coal mining.

**Unit- IV:** Mining process and Environmental issues- Environmental impacts of mining and mitigation measures. Mining cycle and reclamation practices. Mining Policies and regulations in India.

**Books Recommended:**

- Charles J. Moon, Michael K.G. Whateley, and Anthony M. Evans: Introduction to Mineral Exploration
- Walter L. Pohl: Economic Geology: Principles and Practice
- John Ridley: Ore Deposit Geology
- Hugh Exton McKinstry: Mining Geology
- Marat Abzalov: Applied Mining Geology
- Herbert Edwin Hawkes and John S. Webb: Geochemistry in Mineral Exploration
- Anthony M. Evans: Ore Geology and Industrial Minerals: An Introduction
- Eoin MacDonald: Handbook of Gold Exploration and Evaluation

## M.Sc. PG Semester II
## Discipline Specific Core (DSC-07)/ Sedimentology
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Process of sedimentation, structure, texture, and general classification of sedimentary rocks, depositional environment, sedimentary facies, provenance, and paleocurrent.

**Unit II:** Sedimentary basins and their classification, basin analysis (Map, Cross-sections, Petro-facies, Geological history, Application.

**Unit III:** Plate tectonics and sedimentation (sedimentation- divergent margins, convergent and

Head 21/5/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25
Dean
School of Earth Sciences
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

transform margins)
**Unit IV:** Petrography of Clastic and Non-Clastic Rocks

**Books Recommended:**


- Pettijohn, F. J. Sedimentary rocks (McGraw-Hill, New Delhi.
- Verma, V. K. & Prasad, C., Sedimentology (Harman Publ. House, New Delhi).
- Folk, R. L. Petrology of sedimentary rocks, Hemphills, Austin, Texas.
- Blatt, H., Midleton, G., and Murray, R., Origin of Sedimentary Rocks, Prentice Hall.
- Reineck, H.E., and Singh, I.B., Depositional Sedimentary Environments, Springer
- Best, Myron G., Igneous and Metamorphic Petrology (C B S Pub., New Delhi).
- Blatt, Harvey; Tracy, Robert J.; Owens, Brent (2005), Petrology: igneous, sedimentary, and metamorphic (New York: W. H. Freeman).


**M.Sc. PG Semester II**
**Discipline Specific Core Practical (DSC-08)/(DSC-05+06+07)**
**Total Credits-03; Total marks 100 (60 End Term Theory + 40 Sessional**

**Igneous & Metamorphic Petrology (30+20)**
Study of important igneous & metamorphic rocks in thin sections and in hand specimen: Anorthosite, Andesite, Basalt, Carbonatite, Charnockite, Diorite, Dunite, Dacite, Dolerite, Gabbro, Granite, Kimberlite, Komatiite, Lamprophyre, Monzonite, Pegmatite, Phonolite, Peridotite, Syenite, Trachyte, Shale, Slate, Phyllite, Schist, Quartzite, Gneiss; NORM calculation, Plotting of modal data in IUGS classification diagram for plutonic rocks (Streckeisen diagram)
**Mineral Exploration & Mining Geology (15+10)**
Interpretation of exploration data, Study of ore in hand specimens, Calculation of ore grade, and reserve estimation
**Sedimentology (15+10)**
Sedimentary rocks in hand specimens and thin sections, Size and shape analysis, Heavy mineral identification, Paleocurrent analysis

**M.Sc. PG Semester II**
**Discipline Specific Elective (DSE-02)**
**Total Credits-06; Total marks 100 (60 End Term Theory + 40 Geological Fieldwork)**

**DSE-02A (i) Palaeoclimatology**
**Total Credits-04; Total marks 60 (End Term Theory)**

**Unit I:** Elements of weather and climate: Definition of weather, climate, and climate variability, Components of the climate system: atmosphere, hydrosphere, cryosphere, lithosphere, biosphere
**Unit II:** Evidence of climate change (temperature rise, melting glaciers, sea-level rise), Impacts on ecosystems, biodiversity, and species migration, impacts on water resources, agriculture, and food security, use of gases, and the greenhouse effect
**Unit III:** Observation of climate changes in India, Impact on monsoon systems, Sea-level rise and coastal hazards, Climate change and natural disasters (floods, droughts, cyclones)
**Unit IV:** Historical Climate variability (glacial-interglacial cycles, Holocene changes), tools to study past climate: ice-cores, tree rings, sediment cores, fossils.

**Books Recommended:**

Head 21/5/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25
Dean
School of Earth Scien
H.N.B. Garhwal Univer
(A Central University)
Srinagar (Garhwal)-246
Uttarakhand

- Houghton, J. (2015): Global Warming: The Complete Briefing. Cambridge University Press.
- McMichael, A. (2017): Climate Change and Human Health. WHO Publication.
- Shukla, P.R. et al. (2003): Climate Change and India: Vulnerability and Adaptation. Universities Press.
- D.S. Upadhyay (1995): Cold Climate Hydrometeorology.


## DSE-02A(ii) Natural Hazards
## Total Credits-04; Total marks 60 (End Term Theory)

**Unit I:** Definition and Types of Natural Hazards; Geological, Atmospheric, and Other Natural Hazards.
**Unit II:** Processes Involved in Natural Hazards; Vulcanism, Crustal deformation, Isostatic Adjustment, Weathering, Erosion, and Atmospheric circulation.
**Unit III:** Primary, Secondary, and Tertiary Effects of Natural Hazards. Disaster Risk Reduction.
**Unit IV:** Awareness, Policies, and Remedial Measures.

**Books Recommended:**


- K. S. Valdiya: Environmental Geology, Indian Context.
- E. A. Keller: Environmental Geology.
- P. T. Flawn: Environmental Geology
- K.S. Valdiya: Dynamics Himalaya


## DSE-02A(iii) Himalayan Geology
## Total Credits-04; Total marks 60 (End Term Theory)

**Unit I:** Introduction, Physiography, and Origin of the Himalaya
**Unit II:** Geographical Geological classification of the Himalaya
**Unit III:** Detailed geology of Lesser, Middle, and Upper Himalaya
**Unit IV:** Various tectonic boundaries and major geological features of the Himalaya

**Books Recommended:**


- Valdiya, K.S. (1998): Dynamics of the Himalaya. University Press, India.
- Gupta, H.K. (2002): The Himalayan Geology. Unwin Hyman, London.
- Jain, S. & Gansser, A. (2004): Tectonics of the Himalayan Belt. Springer.
- Gansser, A. (1964): Geology of the Himalayas. Interscience Publishers, New York.


## M.Sc. PG Semester II/Discipline Specific Elective (DSE-02B)
## Total Credits-02; Total marks 40
## DSE-2B- Geological Fieldwork

Students must carry out at least 15 days of field work in the petrological and mineralogically important regions and/or mining areas of India, and submit a report of their field work to the department for evaluation.

Head 21/5/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/25
Dean
School of Earth Scien
H.N.B. Garhwal Univers ty
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

## M.Sc. PG Semester III
## Discipline Specific Core (DSC-09)/Mineralogy & Crystallography
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Structures and types of atoms, types of chemical bonding, coordination number, Introduction to space group, space lattices, lattice defects
**Unit II:** Description of 32 classes of crystal systems. Different types of crystal projections-spherical and stereographic, crystal imperfections, Twinning, and twinning laws.
**Unit III:** Structures and classifications and occurrence of silicates: carbonates, halides, hydroxides, native elements, oxides, phosphates, silicates, and sulfides groups.
**Unit IV:** Mineralogy of uniaxial and biaxial crystals, Extinction, pleochroism, dispersion, interference figures, birefringence, optical indicatrix.

**Books Recommended:**


- Dana, E.S. & Ford, W.E.: A Textbook of Mineralogy, Wiley Eastern Ltd.
- Berry, L.G., Mason, B. & Dietrich, R.V.: Mineralogy, CBS Publishers.
- Kerr, P.F.: Optical mineralogy, McGraw-Hill Publ.
- Moorhouse, W.W.: Optical Mineralogy.
- Sands, D.E. (1975): An Introduction to Crystallography,
- W.A. Benjamine Inc., N. Y. Phillips, F.C.: Introduction to Crystallography.
- Evans, R.C. (1964): Introduction to Crystal Chemistry, Cambridge Uni. Press.
- Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
- Nesse, W. D. (2011). Introduction to Optical Mineralogy (Fourth Edition). Oxford University Press.
- Putnis, A. (1992): Introduction to Mineral Sciences. Cambridge University Press.
- Whalstrom, E.E. (1969): Optical Crystallography. John Wiley & Sons
- Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.


## M.Sc. PG Semester III
## Discipline Specific Core (DSC-10)/Geomorphology
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I: Definition, scope,** and fundamentals concept of Geomorphology, Endogenic geomorphic processes; Diastrophism, Exogenic geomorphic processes, Weathering, Mass wasting, Erosion.
**Unit II:** Geomorphic cycle and its interpretations, Brief study of: Causes of rejuvenation, Peneplanation, Relief of Ocean floor, Drainage patterns and their Significance.
**Unit III:** Geological work of natural agencies: Wind action, Aeolian, Underground water and karst topography, Glacial processes and landforms, Fluvial processes and landforms.
**Unit IV:** Geomorphic features of India, Extra peninsular, Peninsular, Indo-Gangetic plain, Brief study of the physiography and Geomorphology of Uttarakhand

**Books Recommended:**


- J.C. Doornkamp and C.A.M. King: Numerical Analysis in Geomorphology
- William Thornbarry: Textbook of Geomorphology
- Burchfiel, Foster, Keller, Melorn, et al.: Physical Geology; the structures and the Process of the Earth.
- A.H. Strahler and A. N. Strahler: Modern Physical Geography
- Arthur Holms: Textbook on Geomorphology


Head 21/5/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174.

Dean 21/5/25
School of Earth Sciences
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

## M.Sc. PG Semester III

## Discipline Specific Core (DSC-11)/Precambrian Stratigraphy

## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Principles of stratigraphy and correlation, geological time scale, nomenclature of modern stratigraphic code, Walter's law, Facies concept in stratigraphy.
**Unit II:** Precambrian and its subdivisions, Tectonic divisions of India, a brief idea of Magnetostratigraphy &Seismic stratigraphy,
**Unit III:** Precambrian stratigraphy of Extra Peninsular India and Peninsular India.
**Unit IV**: Precambrian-Cambrian boundary with special reference to Indian examples.

**Books Recommended:**


- Danbar, 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 Subcommission on Stratigraphic Classification of the 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.
- Indian Stratigraphy by Datta
- Stratigraphy and Geology by Pankaj Srivastavas


## M.Sc. PG Semester III

## Discipline Specific Core Practical (DSC-12)/(DSC09+10+11)

## Total Credits-03; Total marks 100 (60 End Term Practical + 40 Sessional Practical)

**Mineralogy & Crystallography (20+15):**
Study of symmetry elements of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic, and Triclinic systems, Study of physical properties of minerals mentioned in theory course, Use of polarizing microscope, Study of optical properties of common rock-forming minerals
**Precambrian Stratigraphy (20+10)**
Exercise on stratigraphic/lithostratigraphic classification, Exercise on stratigraphic correlation, Preparation of paleogeographic map.
**Geomorphology (20+15)**
Preparation of Geomorphological Maps, Identification of different Geomorphic Elements with the help of contour Maps, Preparation of Composite, Longitudinal and Cross profiles, Morpho-statistical analysis of IIIrd order Drainage Basins

## M.Sc. PG Semester III

## Discipline Specific Elective (DSE-03)/Total Credits-06; Total marks 100

**DSE-03A Glaciology Theory Total credits: 04**

Head 21/5/24
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/5/24
Dean
School of Earth Sciences
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal) 246174
Uttarakhand

**Unit I:** Introduction, importance, and implication of glaciological studies, Inventory of Himalayan glaciers; Identification system of glaciers, Physics of ice and snow, engineering properties of glacial material

**Unit II:** Glacial morphology, glacial deposits and paleoglaciation; Hydrometry of glaciated basins, suspended sediment transport, glacial hydrochemistry.

**Unit III:** Mass balance studies; Net balance, Ablation, accumulation, and snow density measurements, Relationship of mass balance to climate, Snow melt processes.

**Unit IV:** Application of remote sensing techniques in glaciology, Application of advanced surveying techniques, Global positioning system, geodetic techniques.

**Books Recommended:**


- K.M. Cuffey and W.S.B. Paterson, The physics of glaciers. Fourth edition. Amsterdam, etc., Academic Press, 2010.
- Benn, Douglas I. and Evans, David J. A., Glaciers and Glaciation, Hodder Education Publishers, 1997.
- Paterson, S.B., The physics of glaciers, second edition. Oxford: Pergamon Press, 1981.
- M.J. Siegert, Ice Sheets and Glaciers in the 21st Century, Springer, 2020.
- David R. Bartholomaus, J.J.C. Stone, Glacier Mass-Balance variations and Climate Change: A practical guide, Elsevier.
- Andreas M.P. and D. Oerlemans, Mass balance of Glaciers: A study of the balances, Variations, and Climatic Implications, Elsevier.
- Francesco Zamboni, Alberto L.B.G.B., The Glacier Mass Balance and Climate Change, Cambridge Univ. Press.
- Michael Waterson, Glaciology and Global Warming, Cambridge Univ. Press, 2018
- Bryn Hubbard and Neil F. Glasser, Field Techniques in Glaciology and Glacial Geomorphology, Wiley, 2005.
- K. Raina, Deepak Srivastava, Glacier Atlas of India, Geological Society of India, 2008.
- P. Martini, M. E. Brookfield, S, Sadura, Principles of Glacial Geomorphology and Geology, Pearson, 2001.
- Charles S Wright, Glaciology, Legare Street Press, 2021.


**DSE-03A Glaciology Practical Total credits: 02**

Calculation of heat balance equation, Exercise on mass balance, flow movement/discharge and suspended sediment transport. Interpretation of glacial morphological maps and study of meteorological and microclimatic parameters

**DSE-03B Global Tectonics Theory Total credits: 04**

**Unit I:** Earth as a dynamic system; Elementary ideas of continental drift, sea floor-spreading and mid-oceanic ridges, Plaeomagenism and its application.

**Unit II:** Geosynclines classification and evolution; Plate tectonics concept, plate margins and orogeny.

**Unit III:** Indian Plate; configuration and characters of Indian Plate margins.

**Unit IV:** Himalayan orogeny and tectonic models

**Book Recommended:**


- Allen P. (1997): Earth Surface Processes, Blackwell
- Bloom A. I. (1998): Geomorphology: A systematic analysis of Landforms (3rd edition), Pearson Education Inc.
- Keary, P., and Vine, F. C. (1997): Global Tectonics, Blackwell
- Kale V.S. and Gupta A. (2001): Tectonics, Freeman Publication


Head 21/1/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

Dean 21/1/25
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand

- Moores, E., and Twiss, R. J. (1995): Tectonics, Freeman Publications.
- Patwardhan A. M. (1999): Dynamic Earth System, Printace Hall Publication
- Sommerfield M. A. (2000): Geomorphology and Global tectonics, Spriger verlag
- Valdiya K S. (1988): Dynamic Himalaya, University Press, Hyderabad
- Thronburry W.D. (2002): Principles of Geomorphology, CBS Publications


**DSE-03B Global Tectonics Practical Total credits: 02**

Study of various models related to plate tectonics, Stereographic presentation of structural data, Plotting of various plate boundaries in the world map.

## M.Sc. PG Semester IV
## Discipline Specific Core (DSC-13)/Phanerozoic Stratigraphy
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I**: Palaeozoic rock of the Himalaya with special reference to Kashmir, Spiti, Kumaun, and their correlation. Permian/Triassic boundary sections of India

**Unit II**: Jurassic Sedimentary Basin of Kutch and Jaisalmer, Cretaceous stratigraphy of the Cauvery Basin & Narmada Valley, Deccan Volcanic Provenance,
Cretaceous/Palaeogene boundary section of India.

**Unit III:** Gondwana Supergroup: palaeogeography, paleoclimate, and stratigraphy of Indian sequence and economic importance.

**Unit IV:** Cenozoic sequence of India, Deccan volcanics, Quaternary stratigraphy of India.

**Books Recommended:**


- 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. John Wiley and Sons Pub.
- 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
- Indian stratigraphy of Dutta.
- Stratigraphy and geology of India by Pankaj Srivastava.


## M.Sc. PG Semester IV
## Discipline Specific Core (DSC-14)/Ore Genesis and Indian Mineral Deposits
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Definition, classification, and Types of Ore Deposits: magmatic, hydrothermal, sedimentary, Contact-Metasomatism, and metamorphic origins.
Mineral economics: national and global perspectives.

**Unit II:** Processes of ore formation: magmatic differentiation, hydrothermal solutions, sedimentation, and weathering.
Residual and supergene enrichment processes.

**Unit III:** Controls on ore deposition: structural, lithological, and stratigraphic factors.
Major metallic mineral deposits in India: iron, Manganese, copper, Aluminium, Magnesium, lead-zinc, gold, Chromium, Tungsten, Molybdenum.

Head 21/5/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

Dean 21/5/25
School of Earth Sci
H.N.B. Garhwal Univer
(A Central University)
Srinagar (Garhwal)-246
Uttarakhand

**Unit IV:** Major non-metallic mineral deposits in India: Coal, Petroleum, Mica, limestone, asbestos, barite, Graphite, gypsum, refractories, abrasive, ceramic, fertilizers, cement, paints, pigments, and gemstone. Strategic and critical minerals of India.

**Books Recommended:**

- W. L. Pohl: Economic Geology
- A. M. Evans: Ore Geology and Industrial Minerals
- M. L. Jensen and A. M. Bateman: Economic Mineral Deposits
- G. and Park: Geology of Ore Deposits
- L. Robb: Ore Genesis: A Holistic Approach
- G. Bhandari: Indian Mineral Resources
- L. Thomas: Coal Geology
- M.D. Leach: Sediment-Hosted Lead-Zinc Sulphide Deposits
- F. Pirajno: Hydrothermal Processes and Mineral Systems
- Arogyaswami: Atlas of Economic Mineral Deposits

## M.Sc. PG Semester IV
## Discipline Specific Core (DSC-15)/Palaeontology
## Total Credits-05; Total marks 100 (60 End Term Theory + 40 Sessional Theory)

**Unit I:** Processes and modes of fossilization: permineralization, carbonization, molds and casts, and exceptional preservation. Principles of classification and taxonomy, and the types of fossils.
**Unit II:** Morphological features and characteristics of major invertebrate groups: molluscs (gastropods, bivalves, cephalopods)
**Unit III:** Morphological features and characteristics of major invertebrate groups: echinoderms (crinoids, echinoids), brachiopods, arthropods (trilobites).
**Unit IV:** Evolutionary trends and key transitions in major invertebrate groups, including origin and diversification.
Overview of important fossiliferous formations e. g Cretaceous-Tertiary successions in India,

**Books Recommended:**

- E.N.K. Clarkson: Invertebrate Paleontology and Evolution
- Raup and Stanley: Principles of Paleontology
- Boardman, Cheetham, and Rowell: Fossil Invertebrates
- R.C. Moore: Treatise on Invertebrate Paleontology
- Fastovsky and Weishampel: The Evolution and Extinction of the Dinosaurs
- Fossils: A Guide to Prehistoric Life by Richard Fortey.
- Ian Tattersall: Paleontology: A Brief History of Life
- D. R. Prothero: The Story of Life in 25 Fossils
- P. Selden and J. Nudds: Fossil Ecosystems of North America
- D.H. Erwin and R.L. Anstey: Evolutionary Paleobiology

## M.Sc. PG Semester IV/Discipline Specific Core Practical (DSC-16)
## (DSC13+14+15)
## Total Credits-03; Total marks 100 (60 End Term Practical + 40 Sessional Practical)

**Phanerozoic Stratigraphy (20+15)**

Head 21/1/25
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

21/1/25
Dean
School of Earth Sc
H.N.B. Garhwal Univ
(A Central Univers
Srinagar (Garhwal)-246
Uttarakhand

Study of paleogeographic map of Phanerozoic, Study and understanding of plate movements through important periods during Phanerozoic, Chronological study of important stratigraphic rocks.

**Ore Genesis and Indian Mineral Deposits (20+10)**

Study of hand specimens of economic minerals and ores, Preparation of mineral maps of India, Ore microscopic study of textures and mineral assemblages.

**Palaeontology (20+15)**

Identification and morphological study of invertebrate fossils from various groups, Analysis of functional morphology and ecological adaptations

**M.Sc. PG Semester IV**
**Discipline Specific Elective (DSE-04)**
**Total Credits-06; Total marks 100 (60+40)**

**DSE-04A Dissertation Total Credits-4**

Students will carry a 06 credits dissertation in geology typically involves in-depth research on a specific topic within the field of earth science. The departmental committee will provide the topic and supervisor to the students. The student will also be involved in the process of finalising the topic of the dissertation. However, it will depend on the facilities and expertise available in the department. The decision of the departmental committee will be final in this process. The candidate must submit a dissertation thesis to the department, which will be evaluated by the external expert, followed by a viva voce.

**DSE-04B Geological Field work Total credits -2**

Students must carry out at least 15 days of field work in the paleontologically, stratigraphically, and economically important regions of India and submit a report of their field work to the department for evaluation.

Head
Department of Geology
H.N.B. Garhwal University
Srinagar (Uttarakhand) 246174

Dean
School of Earth Science
H.N.B. Garhwal University
(A Central University)
Srinagar (Garhwal)-246174
Uttarakhand