

Department of Geology
Sri Dev Suman Uttarakhand University
Badshahithaul, Tehri Garhwal



SYLLABUS
of
Geology
for
First Three Years of Higher Education
UG - Geology SYLLABUS
(Under National Education Policy-2020)

2022

BOARD OF STUDIES (BOS) IN Geology (Under NEP-2020)
Faculty of Science
Sri Dev Suman Uttarakhand University, Badshahithaul, Tehri
Garhwal

Proceedings of BOS

Date: 10-08-2022

A meeting of BOS in Geology under the Faculty of Science was held on 10-08-2022 at Pt. L.M.S. Campus, Rishikesh, Sri Dev Suman Uttarakhand Univ. from 10:45 AM onwards. During the inauguration programme, members were welcomed and introduced.

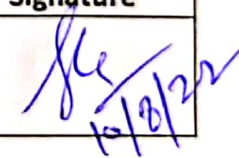
AGENDA & RESOLUTION OF THE MEETING

| Agenda Item | Resolution |
|---|--|
| 1. Approval of the common minimum syllabus of UG-Geology under National Education Policy-2020 | 1. Following discussion, members/experts approved the common minimum syllabus of UG-Geology under National Education Policy-2020 |
| | B.Sc. I Semester, Physical and Structural Geology, Topic-Land forms of India in nut shell was added in Unit: II B.Sc. III Semester, Petrology, Topic- facies was added in Unit-II |

Following members were present in the meeting-

MEMBERS


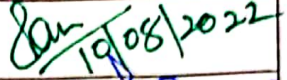
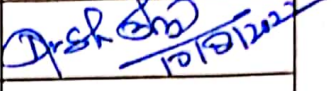
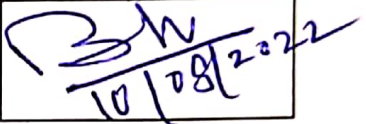
(A) Departmental

| S.N. | Name | Designation | Institute | Signature |
|------|-------------------------|--------------------------|--|---|
| 1 | Dr. Srikrishna Nautiyal | Asst. Prof. & Head | Pt.L.M.S. Campus, Rishikesh, SDSU Univ. |  |

(B) Director From Research Institute

| S.N. | Name | Designation | Institute | Signature |
|------|------------------|-------------|-----------------|-----------|
| 1 | Dr. Durgesh Pant | Director | UCOST, Dehradun | |

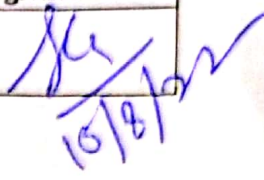
(C) Experts from other Institutions

| S.N. | Name & Designation | Category of Member | Institute | Signature |
|------|---------------------------------------|----------------------|---|---|
| 1 | Dr.D.C. Nainwal Prof. & Principal | Invited Principal | Govt. PG College, Doiwala |  10/08/22 |
| 2 | Dr. Renu Negi Prof. & Principal | Invited Principal | Govt. PG College, New Tehri |  19/08/2022 |
| 3 | Dr. Devesh Bhatt Prof. & Principal | Invited Principal | Govt. Degree College, Bedikhal |  10/08/2022 |
| 4 | Dr. V.K. Khanduri Prof. & Dean | VC Nominee | Horticulture University, Ranichauri, Tehri Garhwal | |
| 5 | Dr. A.A. Baurai Prof. & Director | VC Nominee | SRT Campus, Badshahithaul, Tehri Garhwal | |
| 6 | Dr. J.P. Bhatt Professor (Rtd.) | VC Nominee | Dept. of Zoology, HNB Garhwal Univ., Srinagar |  10/08/2022 |

BOARD OF STUDIES (BOS) IN GEOLOGY
Faculty of Science
Sri Dev Suman Uttarakhand University

MEMBERS

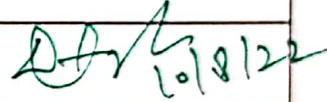
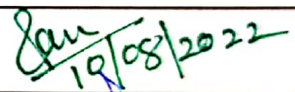

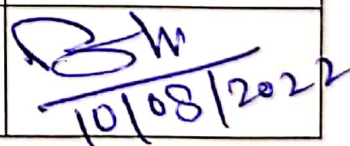
(A) Departmental

| S.N. | Name | Designation | Institute | Signature |
|------|-------------------------|--------------------|---|--|
| 1 | Dr. Srikrishna Nautiyal | Asst. Prof. & Head | Pt.L.M.S. Campus, Rishikesh, SDSU Univ. |  10/8/22 |

(B) Director From Research Institute

| S.N. | Name | Designation | Institute | Signature |
|------|------------------|-------------|-----------------|-----------|
| 1 | Dr. Durgesh Pant | Director | UCOST, Dehradun | |

(C) Experts from other Institutions

| S.N. | Name & Designation | Category of Member | Institute | Signature |
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| 1 | Dr.D.C. Nainwal <i>Prof. & Principal</i> | Invited Principal | Govt. PG College, Doiwala |  10/8/22 |
| 2 | Dr. Renu Negi <i>Prof. & Principal</i> | Invited Principal | Govt. PG College, New Tehri |  19/08/2022 |
| 3 | Dr. Devesh Bhatt <i>Prof. & Principal</i> | Invited Principal | Govt. Degree College, Bedikhal |  10/8/2022 |
| 4 | Dr. V.K. Khanduri <i>Prof. & Dean</i> | VC Nominee | Horticulture University, Ranichauri, Tehri Garhwal | |
| 5 | Dr. A.A. Baurai <i>Prof. & Director</i> | VC Nominee | SRT Campus, Badshahithaul, Tehri Garhwal | |
| 6 | Dr. J.P. Bhatt <i>Professor (Rtd.)</i> | VC Nominee | Dept. of Zoology, HNB Garhwal Univ., Srinagar |  10/08/2022 |

Curriculum Design Committee, Uttarakhand

| Sr.No. | Name & Designation |
|--------|--|
| 1. | Prof. N.K. Joshi Vice-Chancellor , Kumaun University Nainital Chairman |
| 2. | Prof. O.P.S. Negi Vice-Chancellor , Uttarakhand Open University Member |
| 3. | Prof. P. P. Dhyani Vice-Chancellor , Sri Dev Suman Uttarakhand University Member |
| 4. | Prof. N.S. Bhandari Vice-Chancellor, Soban Singh Jeena University Almora Member |
| 5. | Prof. Surekha Dangwal Vice-Chancellor, Doon University, Dehradun Member |
| 6. | Prof. M.S.M. Rawat Advisor, Rashtriya Uchchar Shiksha Abhiyan, Uttarakhand Member |
| 7. | Prof. K. D. Purohit Advisor, Rashtriya Uchchar Shiksha Abhiyan, Uttarakhand Member |

Expert Committee

| S.N. | Name | Designation | Department | Affiliation |
|------|-------------------------|---------------------|---|---|
| 1. | Dr. Pradeep Goswami | Professor & Head | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 2. | Dr. Santosh Kumar | Professor | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 3. | Dr. Rajeev Upadhya | Professor | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 4. | Dr. Srikrishna Nautiyal | Assistant Professor | Department of Geology | Pt. Lalit Mohan Sharma Campus Sri Dev Suman Uttarakhand University, Chamba, Tehri Garhwal |
| 5. | Dr. Manish Sanguri | Guest Faculty | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |

Syllabus Preparation Committee

| S.N. | Name | Designation | Department | Affiliation |
|------|---------------------|---------------------|---|-----------------------------|
| 1. | Dr. Pradeep Goswami | Professor & Head | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 2. | Dr. Santosh Kumar | Professor | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 3. | Dr. G. K. Sharma | Professor | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 4. | Dr. Rajeev Upadhyay | Professor | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 5. | Dr. Deepa Arya | Assistant Professor | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 6. | Dr. Ashok Kumar | Guest Faculty | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |
| 7. | Dr. Manish Sanguri | Guest Faculty | Center of Advanced Study, Department of Geology | Kumaun University, Nainital |

PROGRAMME PREREQUISITES

Any student who has passed intermediate Science with Mathematics/Biology group or equivalent examination can opt for geology in **Six Semester B.Sc. programme** (undergraduate level). He/she should have keen interest in understanding the earth forming processes through time and aptitude for geoscientific study and research.

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

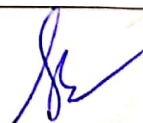
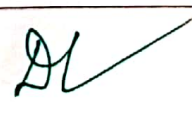
PROGRAMME INTRODUCTION

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

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

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

| List of Semester-wise Titles of the Papers in Geology (Ten Semester) | | | | | |
|--|------|-------------|---|----------------------|---------|
| Year | Sem. | Course Code | Paper Title | Theory/ Practical | Credits |
| CERTIFICATE COURSE IN SCIENCE | | | | | |
| FIRST YEAR | I | | Physical & Structural Geology | Theory | 04 |
| | | | Physical & Structural Geology + Field work | Practical | 02 |
| | II | | Elements of Mineralogy & Gemology | Theory | 04 |
| | | | Mineralogy & Gemology | Practical | 02 |
| DIPLOMA COURSE IN SCIENCE | | | | | |
| SECOND YEAR | III | | Petrology | Theory | 04 |
| | | | Petrology + Field work | Practical | 02 |
| | IV | | Palaeontology | Theory | 04 |
| | | | Practical (Palaeontology) | Practical | 02 |
| BACHELOR OF SCIENCE | | | | | |
| THIRD YEAR | V | | Economic Geology & Mineral Exploration | Theory | 04 |
| | | | Geohydrology & Environment Geology | Theory | 04 |
| | | | Economic & Exploration Geology + Field work | Practical | 02 |
| | VI | | Remote Sensing & Elementary Engineering Geology | Theory | 04 |
| | | | Stratigraphy | Theory | 04 |
| | | | Remote Sensing + Stratigraphy | Practical | 02 |
| BACHELOR (RESEARCH) OF SCIENCE | | | | | |
| FOURTH YEAR | VII | | Advanced Structural Geology | Theory | 04 |
| | | | Advanced Mineralogy | Theory | 04 |
| | | | Geochemistry & Geochronology | Theory | 04 |
| | | | Geological Mapping | Field Training | 04 |
| | | | Practical | Practical | 04 |
| | VIII | | Igneous Petrology | Theory | 04 |
| | | | Metamorphic Petrology | Theory | 04 |
| | | | Sedimentology | Theory | 04 |
| | | | Fuel Geology | Theory | 04 |
| | | | Practical | Practical | 04 |
| MASTER OF SCIENCE (GEOLOGY) | | | | | |
| FIFTH YEAR | IX | | Geodynamics | Theory | 04 |
| | | | Tectonic Geomorphology | Theory | 04 |
| | | | Micropalaeontology & Oceanography | Theory | 04 |
| | | | Field & Laboratory techniques in Geology | Field Training | 04 |
| | | | Practical | Practical | 04 |
| | X | | Applied Groundwater Hydrology | Theory | 04 |
| | | | Advanced Remote Sensing & GIS | Theory | 04 |
| | | | Project/Research Oriented Dissertation | Dissertation | 08 |
| | | | Practical | Practical | 04 |
| | | | | | |

COURSE STRUCTURE (Year wise Structure of X semesters)

CBCS pattern

| Year | Semester | Course type | Credits | Teaching hrs |
|--------|----------|---|---------|--------------|
| First | I | Physical & Structural Geology | 04 | 60 |
| | | Practical (Physical & Structural Geology + Field work) | 02 | 60 |
| | II | Elements of Mineralogy & Gemology | 04 | 60 |
| | | Practical (Mineralogy & Gemology) | 02 | 60 |
| Second | III | Petrology | 04 | 60 |
| | | Practical (Petrology + Field work) | 02 | 60 |
| | IV | Palaeontology | 04 | 60 |
| | | Practical (Palaeontology) | 02 | 60 |
| Third | V | Economic Geology & Mineral Exploration | 04 | 60 |
| | | Geohydrology & Environment Geology | 04 | 60 |
| | | Practical (Economic & Exploration Geology + Field work) | 02 | 60 |
| | VI | Remote Sensing & Elementary Engineering Geology | 04 | 60 |
| | | Stratigraphy | 04 | 60 |
| | | Practical (Remote Sensing + Stratigraphy) | 02 | 60 |
| Fourth | VII | Advanced Structural Geology | 04 | 60 |
| | | Advanced Mineralogy | 04 | 60 |
| | | Geochemistry & Geochronology | 04 | 60 |
| | | Geological Mapping (Field training) | 04 | 60 |
| | | Practical | 04 | 60 |
| | VIII | Igneous Petrology | 04 | 60 |
| | | Metamorphic Petrology | 04 | 60 |
| | | Sedimentology | 04 | 60 |
| | | Fuel Geology | 04 | 60 |
| | | Practical | 04 | 60 |
| Fifth | IX | Geodynamics | 04 | 60 |
| | | Tectonic Geomorphology | 04 | 60 |
| | | Micropalaeontology & Oceanography | 04 | 60 |
| | | Field & Laboratory techniques in Geology (Field training) | 04 | 60 |
| | | Practical | 04 | 60 |
| | X | Applied Groundwater Hydrology | 04 | 60 |
| | | Advanced Remote Sensing & GIS | 04 | 60 |
| | | Project/Research Oriented Dissertation | 08 | 120 |
| | | Practical | 04 | 60 |

Semester I
Paper: Physical & Structural Geology

| <p>Course outcome: After successful completion of this course students will understand the origin of solar system, and dynamics of earth's surface and interiors, plate tectonic processes, seismicity, and volcanism. They will be enhanced by the knowledge regarding formation of different landforms and the physical, chemical and biological processes operating upon the earth. After completing this course they will be able to recognize and interpret the geological structures formed as a result of deformation.</p> | | |
|--|---|----------------|
| Course type, paper & Credits, paper & credit | Content | Teaching hours |
| Theory Physical & Structural Geology (04) | Unit I: Introduction to geology and its scope, Earth and solar system: origin, size, shape, mass, density and its atmosphere. A brief account of various theories regarding the origin of the earth; Internal structure of the earth and its composition. Earth's gravity and magnetic fields, and thermal structure. Law of uniformitarianism. | 15 |
| | Unit II: Earth's internal and external processes: The rock cycle. Earthquakes: nature of seismic waves, their intensity and magnitude; Volcanoes: types, products and causes of volcanism. Weathering and its types; Erosion, transportation and deposition by rivers, wind, glaciers, and waves and underground water, and their related landforms, <i>land forms of India in nutshell</i> | 15 |
| | Unit III: Introduction to Structural Geology; basic concept of stress and strain. Elementary idea of bed, dip and strike; Outcrop, effects of various structures on outcrop. Clinometer/Brunton compass and its use. Elementary idea of types of deformation; Folds: nomenclature and types of folds. | 15 |
| | Unit IV: Faults: nomenclature, geometrical and genetic classifications, normal, thrust and slip faults; Definition, kinds and significance of joints and unconformity. | 15 |
| Practical (02) | Section A: Physical Geology: Study of important geomorphological models; Reading topographical maps of the Survey of India; Identification of geomorphic features. | 60 |
| | Section B: Structural Geology: Identification of different types of folds/faults from block models; Exercises on structural problems: preparation of cross section profile from a geological map. | |
| | Section C: Geological Field Training: Students will be required to carry out one week fieldwork in a suitable geological area to study the elementary aspects of field geology and submit a report thereon. | |

Suggested Reading:

- Arthur Holmes (1992). Principles of Physical Geology. Chapman and Hall, London.
- Miller (1949). An Introduction to Physical Geology. East West Press Ltd.
- Spencer, E.V. (1962). Basic concepts of Physical Geology. Oxford & IBH.
- Mahapatra, G.B. (1994). A text book of Physical geology. CBS Publishers.
- Billings, M.P. (1972). Structural Geology. Prentice Hall.
- Davis, G.R. (1984). Structural Geology of Rocks and Region. John Wiley
- Hills, E.S. (1963). Elements of Structural Geology. Farold and Sons, London.
- Singh, R. P. (1995). Structural Geology, A Practical Approach. Ganga Kaveri Publ., Varanasi.

Suggested Online Link:

- <https://www.futurelearn.com/courses/extinctions-past-present/19/steps/1312906>.
- <https://www.mooc-list.com/course/mountains-101-coursera>
- [https://www.mooc-list.com/course/origins-formation-universe-solar-system-earth-and-life coursera](https://www.mooc-list.com/course/origins-formation-universe-solar-system-earth-and-life-coursera)
- <https://www.mooc-list.com/course/science-solar-system-coursera>
- <https://www.mooc-list.com/course/planet-earth-and-you-coursera>
- <https://www.mooc-list.com/course/dynamic-earth-course-educators-coursera>
- <https://www.classcentral.com/course/swavam-structural-geology-14312>



Semester II

Paper: Elements of Mineralogy & Gemology

| <p>Course outcome: After completing this course, student will gain basic and fundamental knowledge about the various mineral groups with regard to their physical and optical properties along with an idea about crystal systems, their symmetry elements and notation systems. Apart from this, basic knowledge about the instruments such as physical tools and polarizing microscope etc. will also be imparted. Basic knowledge about gemstones will be given to train the students in recognizing and using the semiprecious and precious minerals and gemstones, which make them a professional in geology and newly emerging medicinal gemology field of therapy.</p> | | |
|--|--|----------------|
| Course type, paper & Credits | Content | Teaching hours |
| Theory Elements of Mineralogy & Gemology (04) | Unit I: Crystals and their characters: Crystal form, face, edge, solid angle; Interfacial angle and their measurements; Crystallographic axes and angles. Crystal parameters, Weiss and Miller system of notations. Symmetry elements and description of normal class of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic systems. Twinning and twin laws. | 15 |
| | Unit II: Definition and characters of mineral; Chemical composition and diagnostic physical properties of common rock forming minerals: quartz, feldspar, pyroxene, amphibole, garnet, olivine and mica families. | 15 |
| | Unit III: Polarizing microscope, its parts and functioning; Ordinary and polarized lights; Common optical properties of minerals observed under ordinary, polarized lights and crossed nicols. Optical properties of some common rock forming minerals (Quartz, Orthoclase, Microcline, Olivine, Augite, Hornblende, Muscovite, Biotite, Garnet). | 15 |
| | Unit IV: Definition and scope of Gemology. Basic qualities of a gem, Physical properties, Optical properties & optical effects in gemstones. Theory of gem cutting techniques, & application crystallography in Gemology. Instruments used in gem identification. Techniques, limitation and precautions of gem identification. | 15 |
| Practical (02) | Study of physical properties of minerals such as Olivine, Garnet, Muscovite, Biotite, Beryl, Tourmaline, Hornblende, Gypsum, and its varieties, Quartz and its varieties, Orthoclase, Microcline, Plagioclase, Chalcedony, Barite, Augite, Chalcedony, Agate, Jasper, Flint. Use of polarizing microscope; Study of optical properties of common rock forming minerals such as Olivine, Garnet, Muscovite, Biotite, Hornblende, Tourmaline, Augite, Quartz, orthoclase, Microcline, Plagioclase etc. | 60 |

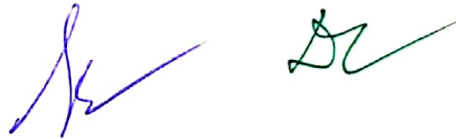



Suggested Reading:

- Berry, L.G., Mason, B. and Dietrich, R.V. (1982). Mineralogy. CBS Publ.
- Nesse, D.W. (1986). Optical Mineralogy. McGrawHill.
- Read, H.H. (1968). Rutley's Element of Mineralogy (Rev. Ed.). Thomas MurbyandCo.
- Berry and Mason (1961). Mineralogy. W.H. Freeman &Co.
- Sharma, R.S. and Sharma A. (2013). Crystallography and Mineralogy (Concepts and Methods). Geological Society of India, Bangalore.
- Hall, Cally (2000) Gemstones. Dorling Kindersley, London; New York.
- Liddicoat, Richard T. (1989) Handbook of Gem Identification. 12th ed., rev., Gemological Institute of America, Santa Monica, CA.
- Nassau, Kurt (1994) Gemstone Enhancement: History, Science and State of the Art. 2nd ed. Butterworth-Heinemann, London.
- Anderson, Basil W (1990) Gem Testing. Rev. by E. A. Jobbins. 10th ed., Butterworth, London.

Suggested Online Link:

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



Semester III

Paper Petrology

| <p>Course outcome: The prime aim of this course is to characterize, classify, and deduce the genesis of individual rock, and rocks in association making a rock suite or complex or succession. Students will characterize, identify and name different types of rocks in the field and in hand-specimens, and rock-thin sections, and finally they will propose the rock-forming processes (petrogenesis). The most common criteria are structure, texture, mineral assemblage and modes present in a particular rock that are examined at megascopic and microscopic levels.</p> | | |
|---|--|---------------------|
| Course type, paper & Credits | Content | Teaching hours |
| Theory Petrology (04) | Unit I: Introduction to igneous petrology; Magma: definition, composition, properties, types and origin; Plutonic, hypabyssal, and volcanic magma emplacement; Forms of igneous rocks; textures of igneous rocks. Reaction principle; Bowen's reaction series, Differentiation and Assimilation; Crystallization of uni-component and bi-component (mixed-crystals). Basic classification of igneous rocks; IUGS classification of igneous rocks. Detailed petrographic description of Granite, Granodiorite, Syenite, Diorite, Rhyolite and Basalt. | 15 |
| | Unit II: Introduction to metamorphic petrology; Process and products of metamorphism; Type of metamorphism. Factors, zones and grade of metamorphism; Textures, structures and classification of metamorphic rocks. Petrographic details of some important metamorphic rocks, such as slate, schists, gneiss, quartzite, and marble. | 15 <i>* Jais</i> |
| | Unit III: Introduction to sedimentary petrology; Processes of formation of sedimentary rocks. Clastic and non-clastic sedimentary rocks. Textures and structures of sedimentary rocks. Palaeocurrent and sediment dispersal. | 15 |
| | Unit IV: Concept of provenance and basins. Elementary knowledge about continental and oceanic sedimentary basins. Concept of sedimentary environments and facies. Petrographic details of important siliciclastic and carbonate rocks such as-conglomerate, breccia, sandstone, shale, and limestone. | 15 |
| Practical (02) | Section A: Petrology: Study of common igneous, metamorphic and sedimentary rocks in hand specimen and thin sections. Study of common structures in igneous, metamorphic and sedimentary rocks. | 60 |
| | Section B: Geological Field Training : Students will be required to carry out one week fieldwork in a suitable geological area to study the elementary aspects of field geology and submit a report thereon. | |




Suggested Reading:

- Bose, M.K. (1997). Igneous petrology. World press.
- Ehlers, W.G. and Blatt, H. (1987). Petrology, Igneous, Sedimentary and Metamorphic rocks, CBS Publishers.
- Friedman and Sanders, (1978). Principles of Sedimentology. John Wiley and sons.
- Mason, R. (1978). Petrology of Metamorphic Rocks. CBS Publ.
- Moorhouse, W.W. (1969). The study of rocks in thin sections. Harper and sons.
- Pettijohn, F.J. (1975). Sedimentary rocks, Harper & Bros. 3rd Ed.
- Prasad, C. (1980). A text book of Sedimentology.
- Sengupta, S. (1997). Introduction to Sedimentology. Oxford-IBH.
- Turner, F.J. and Verhoogen, J. (1960). Igneous & Metamorphic petrology. McGraw Hill Co.
- Turner, F.J. (1980). Metamorphic petrology. McGraw Hill.
- Tyrell, G. W. (1989). Principles of Petrology. Methuren and Co (Students ed.).
- Winkler, H.G.C. (1967). Petrogenesis of Metamorphic Rocks. Narosa Publ.
- Blatt, H. and Tracy, R.J. (1996). Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman & Co., New York

Suggested Online Link:

- <https://www.classcentral.com/course/swayam-petrology-14084>
- <https://www.mooc-list.com/course/myths-and-facts-about-rocks-iversity>.
- E- pathshala. <https://epgp.inflibnet.ac.in/>



Semester IV
Paper: Paleontology

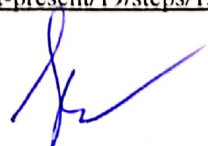
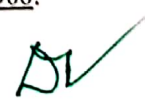
| Course outcome: This course intends to acquaint the students about origin and evolution of life through geological time and the major evolutionary breakthroughs, and to correlate the evolutionary history with other synchronous geological events. It would add to their knowledge regarding the basic concept of paleontology using mode and methods of fossil preservation and species identification, thereafter suggesting the organic evolutionary path and paleoenvironment. Also they will know the causes of major events of mass extinctions in geological past including the glaciations periods | | |
|--|---|----------------|
| Course type, paper & Credits | Content | Teaching hours |
| Theory Paleontology (04) | Unit I: Origin of life. Organic evolution- Macro and Micro evolution, Punctuated Equilibrium and Phyletic Gradualism. Taxonomy and Species concept. Taphonomy. Mass extinctions and their causes. Ediacaran. Gondwana fauna and flora and their significance. | 15 |
| | Unit II: Fossils, condition, modes of fossilization and its significance in geological time scale. Trace fossils and Ichno-fossils. Binomial nomenclature. Biozones-significance and correlation, Index fossils. | 15 |
| | Unit III: Invertebrate Paleontology- Morphology, classification, evolutionary trends, and geological distribution of Brachiopods, Lamellibranchs, Gastropods and Cephalopods, Trilobites, Graptolites, Echinoids and Corals. | 15 |
| | Unit IV: Vertebrate Paleontology- Origin of vertebrates and evolution of vertebrate. Evolutionary history of Equidae, Proboscidea and Hominidae. Origin, diversity and extinction of dinosaurs. | 15 |
| Practical (02) | Study of fossils showing various modes of preservation. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils. | 60 |

Suggested Reading:

- Raup, D. M., Stanley, S. M., Freeman, W. H. (1971). Principles of Paleontology.
- Clarkson, E. N. K. (2012). Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
- Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
- Shukla, A. C. and Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher.
- Moore, R.C. Lalliker, C.G. and Fischer, A.G. (1952). Text book of Invertebrate Palaeontology.
- Schrock, Twenhofel and Williams (1953). Principles of Invertebrate Palaeontology. CBS, Delhi Bilal U. Haq and A. Boersome, Introduction to Marine Micropalaeontology

Suggested Online Link:

- <https://www.futurelearn.com/courses/extinctions-past-present/19/steps/1312906>.



 

Semester V
Paper I: Economic Geology & Mineral Exploration

| Course outcome: The course is intended to impart basic knowledge about the occurrence and distribution of metallic and non-metallic ores and energy resources in India, and to understand ore-forming processes. The acquired knowledge of ore-formation indeed paved the way of developing methods of ore prospecting, exploration, mining, and beneficiation of economic deposits.. This course will surely help the students for opting carrier in the field of mineral prospection, exploration, and mining industry. | | |
|--|--|-------------------|
| Course type, paper & Credits | Content | Teaching hours |
| Theory Paper I Economic Geology & Mineral Exploration (04) | 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. Ore forming processes: magmatic, contact metasomatic, hydrothermal, sedimentary. | 15 |
| | Unit II: Study of important metallic (Cu, Pb, Zn Mn, Fe, Au, Al) and non-metallic (industrial) minerals (gypsum, magnesite, mica). Basic knowledge about the genesis of oil and natural gas, and coal. Metallogenic epochs and provinces. Distribution of iron, copper, zinc, lead, gold, diamond, uranium, bauxite, phospherite, magnesite, mica, coal, and oil and natural gas in India. | 15 |
| | Unit III: Mineral exploration: Surface and sub surface exploration methods including use of remote sensing techniques, Elementary idea of geological, geophysical and geo-botanical prospecting and mining methods. Drilling, sampling and assaying. | 15 |
| | Unit IV: Elementary knowledge of geological and geophysical prospecting. Gravity, electrical, magnetic airborne and seismic methods of exploration. Geo-botanical and geochemical methods of exploration. Elementary idea of mining and environmental considerations. | 15 |

Suggested Reading:

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

- McKinstry, H.E. (1962). Mining Geology. II Ed. Asia Publishing House.
- Clark, G.B. (1967). Elements of Mining. III Ed. John Wiley
- Arogynswami, R.P.N. (1996). Courses in Mining Geology. IV Ed. Oxford IBH.
- Umathi, Exploration Geology.

Suggested Online Link:

- <https://www.mooc-list.com/course/minerals-and-mining-business-edx>
- <https://www.classcentral.com/course/swayam-drilling-and-blasting-technology-58442>
- <https://www.classcentral.com/course/swayam-underground-mining-of-metalliferous-deposits-43673>

Paper II: Geohydrology & Environment Geology

| <p>Course outcome: This course has a direct implication on understanding and resolving the societal issues particularly dealing with groundwater and environment. The students will gain a better knowledge regarding groundwater occurring in the form of aquifers and surface waters, and the laws governing the recharge, storage, movement and exploitation. They will be enlightened as to how we the humans are part of our surrounding natural environment and how we should work for its preservation and sustainable development. This course will help making a responsible citizen and professional with regard to understanding our valuable land and water resources, and their utilization in more scientific and sustainable manner and further managing geohazards</p> | | |
|---|---|----------------|
| Course type, paper & Credits | Content | Teaching hours |
| <p>Theory Paper II Geohydrology & Environment Geology (04)</p> | <p>Unit I: Introduction and scope of hydrology. Hydrologic cycle and its components: precipitation, evapo-transpiration, run-off, infiltration and sub-surface movement of water. Vertical distribution of sub-surface water. Types of aquifers, aquifer parameters.</p> | 15 |
| | <p>Unit II: Aquifers and their types. Darcy's Law and its validity, Dupuit's assumptions, Base flow equation. Surface and sub-surface water interaction. Drinking water quality parameters: Physical and Chemical properties of water. Hydrological provinces in India.</p> | 15 |
| | <p>Unit III: Scope and aims of environmental geology. Biosphere and man. Geohazards: Earthquakes, volcanism, landslides, floods, flash floods, and snow avalanches. Concepts of geohazard management. Climatology and global environment- Coastal, riverine, desertic, tropical, cold and polar. Green-house effect and global warming.</p> | 15 |
| | <p>Unit IV: Elementary idea of soil types. Soil erosion and conservation. Preliminary idea of environmental implications of mining activities and their remedies.</p> | 15 |

| | | |
|-----------------|---|----|
| | Elementary concept of watershed management. Land reclamation. | |
| Practical 02 | Section A: Economic Geology & Mineral Exploration: Study of common ores in hand specimen. Study of copper, lead, zinc, iron, gold, phosphorite, magnesite, oil and gas, and coal deposits of India. Laboratory exercises in solving exploration related problems. | 60 |
| | Section B: Geohydrology: Estimation of hydrologic components, Assessment of different aquifer parameters, Plotting of hydrological provinces in India. | |

Suggested Reading:

- Valdiya, K.S. (2013). Environmental Geology 2nd Edition. McGraw Hill Education
- Todd, D.K. (1980). Groundwater Hydrology- John Wiley
- Davis, S.N. and De Wiest, R.J.M. (1966): Hydrogeology- John Wiley
- Freeze, R.A. and Cherry, J.A. (1979): Ground Water- Prentice Hall
- Fetter, C.W. (1990). Applied Hydrogeology- Merrill Publishing
- Ragnath, N.M. (1982): Ground Water- Wiley Eastern
- Karanth, K.R. (1987). Groundwater Assessment- Development and Management- Tata McGraw Hill
- Alley, W.M. (1993). Regional Ground Water Quality- VNR, New York

Suggested Online Link:

- <https://www.mooc-list.com/course/natural-resources-sustainable-development-edx>
- <https://www.mooc-list.com/course/extreme-geological-events-futurelearn>
- <https://www.mooc-list.com/course/history-ancient-environments-climate-and-life-edx>



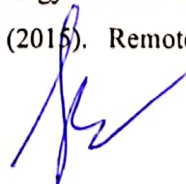

Semester VI

Paper I: Remote sensing & Elementary Engineering Geology

| <p>Course outcome: This course introduces recent technique of remote sensing that has wide application potential in several fields of surveying such as geological, geographical, agricultural, forestry etc. In the present programme, the students will know about the interpretation of aerial remote sensing and its application potential in geological investigations. The students will also be introduced to geological aspects that must be taken care of for any safe and stable geo-engineering activity such as construction, mining, and environmental conservation.</p> | | |
|--|--|----------------|
| Course type, paper & Credits | Content | Teaching hours |
| Theory Remote sensing & Elementary Engineering Geology (04) | Unit I: Definition and scope of remote sensing. EM energy and its interaction interactions with atmosphere and earth surface features. Film and digital aerial photography. Types of aerial photographs. Aerial photography mission and stereopair aerial photographs. Tilt in aerial photographs. Scale of aerial photographs. Relief distortions and vertical exaggeration in aerial photographs. Ortho photographs. | 15 |
| | Unit II: Aerial photo mosaics, their types and utility. Stereoscopic vision in aerial photographs. Pocket and Mirror Stereoscopes. Photo-technical and geotechnical elements of photo-interpretation. Application potential of aerial photographs in land cover, landform, rock type and structure recognition. | 15 |
| | Unit III: Engineering properties of rocks and Soils. Soil and Soil groups of India. Dams and their types. Geological conditions controlling the safety of dams. Causes of dam failure. Geological problem of reservoirs. Bridges and their types. Geological conditions controlling the safety of dams. | 15 |
| | Unit IV: Tunnels and their types. Geological conditions controlling the safety of tunnels. Seepage problem in tunnels and role of water table. Landslides: classification, causes and preventative measures. | 15 |

Suggested Reading:

- Valdiya, K.S. (2013). Environmental Geology 2nd Edition. McGraw Hill Education
- Krynine D.P. and Judd W.R. (1957). Principles of Engineering Geology & Geotechnics. McGraw-Hill Book
- Kesavulu, N.C. (2009). A text book of engineering geology. Macmillan P publishing India Ltd.
- Crozier. M.J. (1989). Landslides: causes, consequences and environment. Academic Press.
- Bell, F.G. (1983). Fundamentals of Engineering Geology. Butterworth and Co.
- Lillesand, T.M., Kiefer, R.W., and Chipman (2015). Remote Sensing and Image Interpretation. Wiley.




- Pandey, S.N. (1987). Principles and Application of Photogeology. Wiley Eastern, New Delhi.

Suggested Online Link:

- <https://www.classcentral.com/course/swayam-rock-mechanics-and-tunneling-43654>
- <https://www.classcentral.com/course/swayam-introduction-to-engineering-seismology-43605>
- <https://www.mooc-list.com/course/reservoir-geomechanics-edx>
- <https://www.mooc-list.com/course/geology-and-engineering-geology-gongchengdezhixue-edx>
- <https://www.classcentral.com/course/swayam-photogeology-remote-sensing-45165>

Paper II: Stratigraphy

| Course outcome: After completion of this course students will be able to understand fundamentals of stratigraphy and the geological time scale. They will now be able to correlate and understand about the various age group rocks occurring in India and the boundaries separating them. It will enable them to understand the evolution of terranes through time and space. | | |
|---|---|--------------|
| Course type, paper & Credits | Content | Teaching hrs |
| Theory Stratigraphy (04) | Unit I: Principle of stratigraphy; fundamentals of litho-, bio-, chrono-, and magneto-stratigraphy; Code of stratigraphic nomenclature; Concepts of palaeogeographic reconstructions. Geological Time Scale. Precambrian-Cambrian, Permian-Triassic, and Cretaceous-Tertiary boundaries | 15 |
| | Unit II: Study of following Precambrian succession: Dharwar, Aravalli, Cuddappa, Vindhyan and Delhi Supergroups; Precambrian-Cambrian successions of Uttarakhand; | 15 |
| | Unit III: Brief idea about Palaeozoic succession of northwestern Himalaya; Triassic of Spiti; Mesozoic type succession of Kutch and Rajasthan; Cretaceous of Tiruchirapalli | 15 |
| | Unit IV: Stratigraphy of the Indian Gondwana, and Deccan Trap. Paleogene-Neogene sequences of northwest Himalaya. | 15 |
| Practical (02) | Section A: Remote sensing: Studying stereopair aerial photographs and using stereoscopes for identifying the photo-technical and geotechnical elements of different landforms, and land use/ land cover classes. | 60 |
| | Section B: Stratigraphy: Preparation of litho-stratigraphic maps of India showing distribution of important geological formations and Gondwana flora. | |

Suggested Reading:

- Wadia, D. (1973). Geology of India. Mc Graw Hill Bookco.

- Krishnan, M.S. (1982). Geology of India and Burma, 6th Edition. CBS Publ.
- Ravindra Kumar (1985). Fundamentals of Historical Geology & Stratigraphy of India. Wiley Eastern.
- Valdiya K.S. (2010). The making of India, McMillan India Pvt Ltd.



Theory and Practical Examination Pattern

Theory (External) each theory paper carrying maximum marks 75 and shall consist of two sections A and B. Examination duration shall be 02 hours.

- a. Section A: Multiple choice questions (MCQ)/true and false/very very short answer type questions.
Section A will consist of 10 questions, each of one mark)
Total: 10X1= 10 Marks
- b. Section B: (Short answers type , 200 words)
Section B will consist of 08 questions, each of 7 marks in which 5 has to be answered.
Total: 7X5= 35 Marks
- c. Section C: (Long answers type, 500 words)
Section C will consist of 3 long answered questions, in which has to be answered, each of 15 marks.
Total: 2X15= 30 marks

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25 (Assignments 10 marks, written test/viva 10 marks and regularity 5 marks). The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

Practical The laboratory work of the students has to be evaluated periodically.

The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 10 marks for each semester shall be conducted during the semester. All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students.

In each semester practical examination of 40 marks has to be conducted by two examiners (External and internal) having duration of 4 hours. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri.

The breakup of marks for practical examination for each semester would be as follows:

| | |
|----------------------------|--------------------------|
| Practical exam: | 30 Marks (exercises) |
| Viva voce: | 05 Marks |
| Lab Record and collection: | 05 Marks |
| Sessional (Internal): | 10 Marks |
| Total: | 50 marks (each semester) |

Handwritten signatures and dates in blue and green ink, including a date 'Jan 10/08/2022' and various illegible signatures.