

**FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY
UNDER NEP 2020**

DEPARTMENT OF GEOLOGY
VINOBA BHAVE UNIVERSITY
HAZARIBAG – 825301



2025

**FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN
GEOLOGY
(BASED ON NEP2020 SYLLABUS)**

**FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY
UNDER NEP 2020**

**DEPARTMENT OF GEOLOGY
VINOBABHAVEUNIVERSITY,HAZARIBAG
FOUR YEAR UNDERGRADUATE PROGRAMME
NEP2020 SYLLABUS**

Firstyear–UndergraduateCertificate

Marks Distribution Pattern

For Major Courses/Associated Courses/Elective Courses:

Theory	: End Semester Examination	: 60 Marks
	Internal Examination	: 10 (written) + 5 (Day-to-day assessment)
Practical	: End Semester Examination	: 25 Marks
	Internal Examination	: 0

For Advanced Major Courses/Research Methodology/Research Proposal-Planning & Techniques:

End Semester Examination	: 75 Marks
Internal Examination	: 20 (Written) + 5 (Day-to-day assessment)

EndSemesterExamination(ESE60marks)

There will be two group of questions.

Group A will be of very short answer type (consisting Five objective types excluding multiple choice questions) of 1 mark and two short answer type of 5 marks each.

GroupAwill becompulsory.

Group B will contain 5 long answer type questions of 15 marks each in which 3 have to be attempted.

EndSemesterExamination(ESE75marks)

There will be two groups of question.

Group A will be of very short answer type (consisting Five objective types excluding multiple choice questions) of 1 mark and two short answer type of 5 marks each.

Group A will be compulsory.

Group B will contain 7 long answer type questions of 15 marks each in which 4 have to be attempted.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

MAJOR(MJ)

Semester-I

PhysicalGeology–3Credits–75Marks–**MJ-1/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

CourseLearning Objectives:

The study of this paper strengthens students' knowledge with respect to understanding the essentials of the structural dynamics of the earth.

Coursecontent:

MJ – 1:PhysicalGeology

Physical Geology and its relation with other branches of geology; Scope & importance of geology. Study of atmosphere and hydrosphere, pedosphere and biosphere. Radioactivity and age of the earth; Brief idea about Geological Time Scale. an elementary idea of seismic waves and interior of the earth. Origin of the earth. Earth in the solar System-Size, Shape, Mass, Density, Rotational and revolution parameter.

Brief idea about plate tectonics, concept of isostasy, sea floor spreading, continental drift. origin and significance of mid-oceanic ridges and trenches; Earthquake and Volcanism.

A detailed account of the geological work of natural agencies- groundwater, rivers, glaciers, ocean and wind. Weathering and erosion. Drainage pattern and its significance. Mitigation of environmental hazards- Earthquakes, volcanism, floods, landslides.

MJ-1/VUG-GEL(Practical)- 1 credit [25 Marks]

1. Study of Toposheet & contour maps.
2. Identification of drainage pattern in a topographic map.
3. Geological field excursion in areas relevant to course study.
4. Practical Record & Viva-voce.

Suggested Readings and Tools:

1. Grotzinger and Jordan, (2019). Understanding Earth. Eighth Edition. W.H. Freeman
2. Arthur Holmes, (1992) Principles of Physical Geology. Chapman and Hall, London.
3. Charles C. Plummer, Diane H. Carlson, Lisa Hammersley 2016. Physical Geology, 15th Edition McGraw-Hill Education.
4. Frederick K. Lutgens, Edward J. Tarbuck, Dennis G. Tasa 2016 -Essentials of Geology, 13th Edition. Pearson Publications.
5. Miller, (1949) An Introduction to Physical Geology. East West Press Ltd.
6. Emiliani, C. (1992) Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Semester–II

Mineralogy and Optical Mineralogy–3Credits–75Marks MJ- 2/VUG-GEL
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

Studying the basics of mineralogy and optical mineralogy helps in understanding and building the overall knowledge in Geology. The course deals with the study of minerals, their chemistry and identification in hand specimen as well as under polarizing microscope. Further, it also introduces students to the study of minerals and rocks using transmitted and reflected light microscopy. The students will be able to identify common rock-forming minerals in hand specimens as well as in thin sections.

Course content:

MJ-2: Mineralogy & Optical Mineralogy

Mineralogy

Mineral- definition and classification; Isomorphism, Polymorphism, Solid solution and exsolution; Silicate Structures; Mineralogy of common rock-forming minerals; Chemical classes of minerals. Physical and chemical properties of minerals. Examples and economic uses of the minerals.

Optical Mineralogy

Nature of light. Polarization of light. Uniaxial and biaxial minerals. Phenomenon of double refraction. Nicol prism – its construction and function. Construction and function of petrological microscope. Optical properties of minerals - relief, colour and pleochroism, interference colours, birefringence, extinction and extinction angle, optic sign of uniaxial and biaxial minerals.

MJ-2/VUG-GEL (Practical)–25ESE [1 Credit]

1. Study of physical properties of minerals in hand specimen.
2. Use of polarizing microscope; Study of optical properties of important rock forming minerals.
3. Determination of length fast and length slow characters of minerals; Scheme of pleochroism, extinction.
4. Geological fieldwork related to course studies in a suitable geological terrain.

Suggested Readings and Tools:

1. Dexter Perkins. Mineralogy. PHI Learning Private Ltd., New Delhi, 2012.
2. Dana, E.S. and Ford, W.E., (Reprints 2002) A text book of Mineralogy.
3. Berry, L.G., Mason, B. and Dietrich, R.V., (1982) Mineralogy. CBS Publ.
4. Read, H.H., (1968) Rutley's Element of Mineralogy (Rev. Ed.). Thomas Murby and Co.
5. C. Klein & B. Dutrow. Manual of Mineral Science. CBS Publishers & Distributors Pvt.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Ltd., New Delhi, 2012.

6. W. D. Nesse. Introduction to Optical Mineralogy. Oxford University Press, 2004
7. Kerr, P.F., (1995) Optical Mineralogy 5th Ed. McGraw Hill, New York.
8. Deer, Howie and Zussman (1996) Introduction to Rock Forming Minerals, Pearson
9. Wahlstrom E.E. (1971) Optical crystallography, John Wiley and sons.

Second Year – Undergraduate Diploma

Semester – III

Crystallography – 3 Credits – 75 Marks – MJ-3/VUG-GEL
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

The aim of this course is to develop in the learner, the ability to understand and identify various minerals along with their characteristic crystallographic properties, as this forms one of the fundamental requirements in the identification of mineral resources.

MJ-3: Crystallography

Elementary ideas about crystal structure. Crystalline and amorphous substances. Crystal structures: faces, edges, solid angles and interfacial angles. Unit cells and lattices in two dimensions and three dimensions, Bravais lattices. Ionic radii, coordination number, packing, Pauling's rules, substitutions. Crystallographic axes and axial angles. Crystallographic forms. Symmetry elements- plane, axis, centre and rotary inversion axis of symmetry. Parameter, indices and symbol. Laws of crystallography. Symmetry elements and common forms of normal classes of seven crystal system.

MJ-3/VUG-GEL (Practical) – 25 ESE [1 Credit]

1. Study of crystal models representing forms of seven normal classes of symmetry.
2. Clinographic projection of important crystal forms.
3. Stereographic projection of important crystal forms/models.
4. Practical record and viva-voce.

Suggested Readings and Tools:

1. Dana, E.S. and Ford, W.E., (Reprints 2002) A text book of Mineralogy.
2. Cornelis Klein and Barbara Dutrow (2007). The manual of Mineral Science, Wiley Publication
3. Ram S. Sharma and Anurag Sharma (2013) Crystallography and Mineralogy - Concepts and Methods. Text Book Series, Geological Society of India, Bangalore
4. Flint, Y., (1975) Essential of crystallography, Mir Publishers.
5. Phillips, F.C., (1963) An introduction to crystallography. Wiley, New York.
6. Wahlstrom E.E. (1971) Optical crystallography, John Wiley and sons.
7. R.N. Hota (2012) Practical approach to Mineralogy and Crystallography, CBS Publications &

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Distributions.

Structural Geology–3Credits–75Marks–**MJ-4/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

CourseLearningObjectives:

The course deals with geological structures resulting from the action of tectonic forcing. The student will gain knowledge of the geometry of the rock structures, understand the mechanism of the evolution of rock structures and its application in the field. The course is designed for the students to understand the geometry and mechanics of the various geological structures that result through the deformative processes operative within the earth. The students learn the skills of identifying different structure and measurements using Brunton compass. This is a fundamental to geological mapping.

MJ-4:StructuralGeology

Topographic and structural maps. Stress and strain in rocks, Strain ellipses of different types and their geological significance. Planar and linear structures; Concept of dip and strike; Outcrop patterns of different structures. Folds, fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding. Faults geometric and genetic classification of faults. Effects of faulting on the outcrops. Geologic/geomorphic criteria for recognition of faults.

Foliation and lineation, description and origin of foliations: axial plane cleavage and its tectonic significance. Description and origin of lineation and relationship with the major structures. Unconformity & its types. Joints: Its classification and importance.

MJ-4/VUG-GEL(Practical)–25ESE [1 credit]

1. Basic idea of topographic contours
2. Drawing of geological cross-section of important maps and interpretation.
3. Structural problems related to dip and strike.
4. Determination of dip, strike, plunge, etc. through stereonet.
5. Geological field work around Hazaribagh district for studying structural features.
6. Record & Viva-voce.

Suggested Readings and Tools:

1. Ramsay, J.G. (1967) Folding and fracturing of rocks. McGraw-Hill, New York
2. Ragan, D.M. 2009. Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practicals)
3. Billings, M.P., (1972) Structural Geology. Prentice Hall.
4. Davis, G.R., (1984) Structural Geology of Rocks and Region. John Wiley
5. Park, R.G. 2004. Foundations of Structural Geology. Chapman & Hall.
6. Pollard, D.D. 2005. Fundamental of Structural Geology. Cambridge University Press.
7. Hills, E.S., (1963) Elements of Structural Geology. Farrol and Sons, London.
8. Structural Geology (2010)–Hakon Fossien, Cambridge.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Semester – IV

Igneous Petrology–3Credits–75Marks–**MJ-5/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

On completion of this course the students will understand the processes involved in the formation of igneous rocks, their textures, structures, classifications and their importance. Petrology is the science of rocks. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types. Students learn to identify, describe and classify rocks using hand specimens. The students will also acquire skills to identify the minerals and interpret the textures of the igneous rocks. Generate and utilize the petrography data acquired for the better understanding about the mineral deposit and to extract the information understanding of magma generation and finally interpret geochemistry of rocks.

Course content:

MJ-5: Igneous Petrology

Magma- its nature and composition. Form and structure of igneous rocks. Texture of igneous rocks. Classification of igneous rocks. Bowen's reaction series and its significance. Magmatic differentiation and assimilation.

Concept of Phase diagrams; Crystallization of unicomponent and bicomponent (immiscible and solid solution) magma. Magmatism in the oceanic domains (MORB, OIB), Magmatism along the plate margins (Island arcs/continental arcs); Petrographic notes on granite, granodiorite, diorite, rhyolite, trachyte, syenite, gabbro, basalt, dolerite, anorthosite, dunite and pyroxenite.

IKS component in this course: Ancient monuments carved in the Basaltic terrain of India.

MJ-5/VUG-GEL(Practical)–25ESE [1 credit]

1. Megascopic study of important igneous rocks in hand specimen.
2. Microscopic study of common igneous rocks in thin section.
3. Practical record and viva-voce.

Suggested Readings and Tools:

1. G.W. Tyrrell, (Reprint 1926). The Principles of Petrology. AITBS publishers and distributors- Delhi
2. Frost, B.R. and Frost, C.D. 2019, Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
1. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
2. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
3. Bose M.K. (1997). Igneous Petrology. The world press private limited, Calcutta.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

4. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
 5. Ehlers, WG, and Blatt, H, (1987). Petrology - Igneous, Sedimentary and Metamorphic rocks, CBS Publishers.
 6. Turner F.J and Verhoogen J. (1960) Igneous and Metamorphic Petrology, McGraw-Hill.
 7. Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg.
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Metamorphic Petrology–3Credits–75Marks–**MJ-6/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

The students will learn how to identify metamorphic rocks in hand specimen and in thin section along with their structures and textures. The study of metamorphic rocks encompasses the chemical and physical transformations that takes place in response to changing pressure, temperature, and chemical environments in the Earth's interior. In this course, different petrogenetic processes involving mineral reactions will be explored using equilibrium thermodynamics. The thermodynamic principles related to metamorphic petrology will then be applied to a number of orogenic events in time and space to derive the different pressure-temperature conditions during orogenesis.

Coursecontent:

MJ-6: Metamorphic Petrology

Metamorphism - definition, agents and types. Metasomatism Texture and structure of metamorphic rocks. Basic concepts of zone, grade and facies. ACF, AKF, AFM diagrams; Prograde, retrograde and polymetamorphism; Thermal metamorphism of calcareous rocks. Progressive regional metamorphism of argillaceous rocks. Tectonic setting of metamorphic rocks, paired metamorphic belts, concept of P-T-t path.

Petrographic notes on slate, phyllite, schist, gneiss, quartzite, marble, amphibolite, khondalite and charnockite.

MJ-6/VUG-GEL(Practical)–25ESE [1 credit]

1. Identificationofcommon metamorphicrocksinhandspecimen.
2. Identificationofcommon metamorphicrocksundermicroscope.
3. Plottingof Minerals inACF, AKF and AFM Diagram.
4. Geologicalfieldwork inanigneousandmetamorphicterrain.
5. Practicalrecord&viva-voce.

Suggested Readings and Tools:

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
 2. Best, M.G., 2003. Igneous and Metamorphic Petrology, Blackwell.
 3. Frost, B.R. and Frost, C.D. 2019, Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
 4. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
 5. Yardley, Bruce, and Clare Warren. (2021). An introduction to metamorphic petrology. Cambridge University Press.
 6. Winkler, H.G.C., (1967) Petrogenesis of Metamorphic Rocks. Narosa Publication.
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Sedimentary Petrology–3Credits–75Marks–**MJ-7/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

Students will recognize how sediments become sedimentary rocks, how porosity forms and evolves. They will be able to identify primary sedimentary structure and their depositional environments, texture of rocks and understanding the economic deposit formed by sedimentary processes. Students learn to identify, describe and classify rocks using hand specimens. The students will also acquire skills to determine and interpret diagenetic evolution of ancient sedimentary rocks.

Course content:

MJ-7: Sedimentary Petrology

Formation of sedimentary rocks – weathering, erosion, lithification and diagenesis. Classification of sedimentary rocks – clastic and non-clastic rocks. Classification of sandstone and limestone. Structures of sedimentary rocks and their significance. Determination of top and bottom of sedimentary beds. Textures of sedimentary rocks. Concept of sedimentary environment and facies. Basin and Palaeocurrent analysis. Concept of Provenance-mobility of oxides, stability of minerals and significance of light and heavy minerals.

MJ-7/VUG-GEL(Practical)–25ESE [1 credit]

1. Petrography of clastic and non-clastic rocks through hand specimens and thin section.
2. Exercises on Sedimentary structures and their palaeoenvironmental significance.
3. Exercises based on vertical sedimentary sequences of different terrestrial, coastal and marine environments
4. Geological field work in a sedimentary terrain.
5. Data collection & Palaeocurrent analysis.
6. Practical record and viva-voce.

Suggested Readings and Tools:

1. Sengupta S.M. (2007) Introduction to Sedimentology (2nd Edition), CBS Publishers and Distributors, New Delhi.
2. Sam Boggs, Jr., 2009. Petrology of Sedimentary Rocks, Cambridge University Press; 600p.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

3. Pettijohn, F.J., (2005). Sedimentary rocks. Third edition. CBS publishers and distributors pvt ltd.
 4. Greensmith J. (1989) Petrology of the Sedimentary rocks (7th Edition), CBS Publishers, New Delhi.
 5. H. Blatt, G. Middleton and R. Murray (1980) Origin of sedimentary rocks, Princeton Hall.
 6. Maurice E. Tucker, 2006, Sedimentary Petrology, Blackwell Publishing, 262p.
 7. Gary Nichols, 2009. Sedimentology and Stratigraphy Second Edition. Wiley Blackwell.
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Third year – Bachelor's Degree

Semester – V

Geochemistry – 3 Credits – 75 Marks – MJ-8/VUG-GEL
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

A geochemistry course generally aims to equip students with the knowledge and skills to understand the distribution, behavior, and processes involving chemical elements within the Earth and other planetary bodies. This includes understanding geochemical reactions, interactions between Earth's reservoirs, and the application of geochemical principles to various geological and environmental problems. A crucial skill is the ability to interpret and evaluate geochemical data, including understanding the limitations of different analytical methods and developing a critical approach to data analysis. Students learn about various analytical techniques used in geochemistry to determine elemental and isotopic compositions of geological materials.

Course content:

MJ-8: Geochemistry

Introduction to Geochemistry: properties of elements - periodic table, chemical bonding, states of matter and atomic environment of elements, geochemical classification of elements, the concept of elemental fractionation. Universe – nature, age and composition. Solar system – nature and origin. Meteorites: cosmic abundance of the elements. Structure and composition of the Earth. Application of geochemical data in igneous rock classification and variation diagrams, igneous and sedimentary processes – using major and trace elements. using geochemical data.

Stable and radioactive isotopes. Radioactive decay, Half-life, dating by radioactive nuclides – C-14, Uranium-lead method and Potassium-argon method, geochemical cycle. Use of oxygen and carbon isotopes in geological processes.

MJ-8/VUG-GEL (Practical) – 25 ESE [1 credit]

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

1. Types of geochemical data analysis and interpretation of common geochemical plots.
2. Geochemical variation diagrams and its interpretations
3. Practical record & viva-voce.

Suggested Readings and Tools:

1. Brian Mason and C.B. Moore (1982). Principles of Geochemistry. John Wiley & Sons; 4th Edition
 2. Mason, B (1986). Principles of Geochemistry. 3rd Edition, Wiley New York
 3. Walther John, V., 2009 Essentials of geochemistry, student edition. Jones and Bartlett Publishers.
 4. Albarede, F, 2003. An introduction to geochemistry. Cambridge University Press.
 5. Kula C. Misra 2012. Introduction to Geochemistry: Principles and applications. 1st Edition. Wiley-Blackwell.
 6. Rollinson, H.R., 1993. Using geochemical data: Evaluation, Presentation, and Interpretation. Longman.
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Stratigraphy–3Credits–75Marks–**MJ-9/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

A course in stratigraphy aims to equip students with the knowledge and skills to understand the principles of rock layering and their relationship to geological time. Key learning objectives include identifying and interpreting sedimentary rocks and their depositional environments, understanding stratigraphic principles like superposition and correlation, and using fossils and other tools to reconstruct Earth's history. Students will also learn about the geological timescale, different stratigraphic units, and the significance of stratigraphy in resource geoscience and other applications.

Course content:

MJ-9: Stratigraphy

Principles of stratigraphy. Fundamentals of litho-, bio- and chrono-stratigraphy and stratigraphic correlation. Geological time scale. Classification, lithological characteristics, fossil contents and economic importance of the geological sequences of India. Precambrian of Singhbhum, Dharwar and Bastar craton. Proterozoic basins of India – Cuddapah and Vindhyan Supergroup. Gondwana sequence of India with special reference to coal bearing formations, Palaeozoic of Himalaya, Mesozoic rocks of India – Triassic of Spiti, Jurassic of Kuttch, Cretaceous of Trichinapally and their equivalents in India. Deccan Traps. Cenozoic - Tertiary and Quaternary geology of India. Siwalik Supergroup. Concept of sequence stratigraphy.

MJ-9/VUG-GEL (Practical)–25ESE [1 credit]

1. Geological formations on the map of India.
2. Preparation and Correlation of the lithologs, biostratigraphic correlation and their interpretations.
3. Identification of rocks of different geological formations.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

4. Geological field work in an important stratigraphic section.
5. Practical record & viva-voce.

Suggested Readings and Tools:

1. Boggs, S., Jr. (1987) Principles of Sedimentology and Stratigraphy, Meril Publishing.
 2. Dasgupta, A. 2010, Phanerozoic Stratigraphy of India, World Press, Kolkata.
 3. Wadia, D., (1973) Geology of India. McGraw Hill Book Co.
 4. Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological Society of India, Bangalore.
 5. Krishnan, M.S., (1982) Geology of India and Burma, 6th Edition. CBS Publ.
 6. Ravindra Kumar (2018) Fundamentals of Historical Geology and Stratigraphy of India, New age Publications.
 7. Weller J.M. (1960), Stratigraphic Principles and Practice, Harper.
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Palaeontology–3Credits–75Marks–**MJ-10/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

A palaeontology course aims to equip students with the knowledge and skills to understand Earth's past life and geological history. Key objectives include learning about fossil preservation, the diversity and evolution of past life, and the principles of stratigraphy and dating. Students will also develop practical skills in fossil identification, analysis, and interpretation, as well as the ability to communicate their findings effectively.

Course content:

MJ-10: Palaeontology

Introduction to Palaeontology. Life through time. Mode of preservation and types of fossils and its application. Classification, morphology and geological history of the following: Brachiopoda, Palecypoda, Gastropoda and Trilobita and Cephalopods. A brief study of Gondwana flora and siwalik vertebrates. Evolution of horse. Human evolution. Introduction to micropalaeontology, types of microfossils and their applications in palaeoclimatic studies and hydrocarbon exploration.

MJ-10/VUG-GEL (Practical)–25ESE [1 credit]

1. Study of morphological characters of about 30 genera pertaining to trilobite, brachiopods, pelecypods, gastropods, cephalopods and plant fossils.
2. Geological field work in a nearby Gondwana section for studying the Gondwana fossil records.
3. Practical record & viva-voce.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Suggested Readings and Tools:

1. Raup, D.M.&Stanley, S.M., W.H. Freeman, 1985. Principles of Palaeontology. W.H. Freeman & company.
 2. Clarkson, E.N.K., 2012 Invertebrate palaeontology and evolution 4th Edition by Blackwell
 3. Armstrong, H.A., and Brasier, M.D., 2005. Microfossils. Blackwell
 4. MorleyDavies(2008)AnIntroductiontoPalaeontology
 5. MichaelBenton,(2005)VertebratePalaeontology,BlackwellPublishing
 6. RaymondEnay(2012)PalaeontologyofInvertebrates,Springer-Verlag.
 7. PeterDoyle,UnderstandingFossils:AnIntroductiontoInvertebratePalaeontology.
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Photogeology–3Credits–75Marks–**MJ-11/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

Students will learn the fundamental concepts of photogeology, including image acquisition, scale, resolution, stereoscopy, relief displacement, and distortion. Photogeology courses aim to equip students with the skills to extract geological information from aerial and satellite imagery. This involves understanding the principles of photogeology, using stereoscopes to view images in 3D, and interpreting landforms, rock types, and subsurface structures. The ultimate goal is to obtain geological data with minimal fieldwork, potentially even data that would be difficult or impossible to gather through ground surveys alone.

Coursecontent:

MJ-11: Photogeology

Elementary idea of photo geology. Types and acquisition of aerial photographs. Types of aerial cameras and flight planning. Human eye and stereoscopic vision, depth perception. Stereoscopes - their types, construction and function. Geometric characteristics of aerial photographs. Scale of the photographs, stereoscopic parallax and relief displacement. Elements of aerial photo interpretation. Identification of igneous, sedimentary and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

MJ-11/VUG-GEL(Practical)–25ESE [1 credit]

1. Interpretationofaerial photographs.
2. Determinationofscaleofthephotosandimages.
3. Heightmeasurementusingparallaxbar.
4. Practical record & viva-voce.

Suggested Readings and Tools:

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

1. Sinha, S.K., 2015. Fundamental of Remote Sensing & GIS. Anshuman Publication.
2. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & Sons. Inc.
3. Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer-Verlag.
4. Lillesand, T.M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.
5. Richards, J.A. and Jia, X., 1999. Remote Sensing Digital Image Analysis, Springer-Verlag

Semester – VI

Hydrogeology–3Credits–75Marks–**MJ-12/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

A hydrogeology course aims to provide students with a comprehensive understanding of groundwater, including its occurrence, movement, and interaction with the surrounding environment. Key learning objectives include understanding the hydrological cycle, aquifer properties, and methods for groundwater investigation and management. Students will also learn to assess and address groundwater contamination and develop sustainable management strategies.

Course content:

MJ-12: Hydrogeology

Introduction and basic concepts of hydrogeology and its scope; Hydrological cycle. precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of subsurface water. Types of aquifer, aquifer parameters, porosity, permeability, specific yield, specific retention, transmissivity, storativity, anisotropy and heterogeneity of aquifers.

Groundwater flow: Darcy's law & its validity. Intrinsic permeability and hydraulic conductivity. Groundwater flow rates and flow direction. Laminar and turbulent groundwater flow. Surface-based groundwater exploration methods. Groundwater chemistry-physical and chemical properties of water and water quality, Seawater intrusion in coastal aquifers. Groundwater level fluctuations, Rainwater harvesting and artificial recharge of groundwater

MJ-12/VUG-GEL (Practical)–25ESE [1 credit]

1. Hydrological properties of different rock types.
2. Preparation and interpretation of water level contour maps and depth to water level

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

- maps.
3. Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.
 4. Plotting of Groundwater provinces of India on the map of India.
 5. Practical record & viva-voce.

Suggested Readings and Tools:

1. Todd, D.K. and Mays, L.W. (2004). Groundwater Hydrology, John Wiley & Sons.
 2. Karanth, K.R. (1987) Hydrogeology. Tata McGraw-Hill Publishing Company.
 3. Raghunath, H.M. (1987) Groundwater, New Age International
 4. Davis, S.N. and Dewiest R.J.M. (1966) Hydrogeology, John Wiley & Sons.
 5. Freeze, R.A. and Cherry, J.A. (1979) Groundwater, Prentice Hall.
 6. Hiscock, K.M. (2005) Hydrogeology: Principles and Practice, Blackwell Publishing.
 7. Kresic, N. (1997) Hydrogeology and Groundwater Modeling, Lewis Publishers.
 8. Brassington, R. (2017) Field Hydrogeology, Wiley Blackwell.
 9. Hudak, P.F. (1999) Principles of Hydrogeology, Lewis Publishers.
 10. Das Subhajyoti (2011) Groundwater Resources of India. National Book Trust. 1st Edition, 248 p.
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Economic Geology–3Credits–75Marks–**MJ-13/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

The primary objective of the course of Economic Geology is to introduce fundamental aspects of origin, mode of occurrences and the distribution of ore deposits to the students. Students will learn identification of ores in hand specimen as well as the process of formation of ores.

Course content:

MJ-13: Economic Geology

Definition of ore, ore minerals, gangue minerals, tenor of ore, mineral reserves and mineral resources. Critical minerals and their importance. Processes of formation of mineral deposits with special reference to Magmatic concentration, Hydrothermal processes, Supergene sulphide enrichment, weathering enrichment and Mechanical concentration. Formation of oceanic ferromanganese nodules.

Study of physical properties, chemical composition and uses of following minerals: Galena, Sphalerite, Chromite, Graphite, Asbestos, Kyanite, Sillimanite, Cassiterite, Chalcopyrite, Hematite, Beryl, Barite, Uraninite, Monazite, Corundum; Elementary idea regarding origin and uses of Coal (and CBM) and petroleum, their distribution in India.

MJ-13/VUG-GEL (Practical)–25ESE [1 credit]

1. Identification and uses of important Ores and Industrial minerals in hand specimen.
2. Plotting of important ore deposits, Coal and Petroliferous basins on the map of India.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

3. Reserve calculation of ores.
4. Identification of Coal samples.
5. Geological field work in an area of economic mineral deposit.
6. Practical record and viva-voce

Suggested Readings and Tools:

1. Bateman, A.M. and Jensen, M.L. 1990. Economic Mineral Deposits. John Wiley.
 2. Krishnaswamy, S. 1979: India's Minerals Resources, Oxford and IBH Publ.
 3. Sharma, N.L. and Ram, K.V.S. 1972: Introduction to India's Economic Minerals, Dhanbad Publ.
 4. Prasad, U. 2019. Economic Geology: Economic Mineral Deposits. CBS 2nd edition.
 5. Gokhale, K.V.G.K. and Rao, T.C. 1978. Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
 6. Evans, A.M. 1993. Ore Geology and Industrial minerals. Wiley.
 7. Sarkar, S.C. and Gupta, A. 2014 'Crustal Evolution and Metallogeny in India' Cambridge Publications.
 8. Guilbert, J.M. and Park Jr., C.F. 1986. The Geology of Ore deposits. Freeman & Co.
 9. Laurence Robb. 2005. Introduction to ore forming processes. Wiley.
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Environmental and Mathematical Geology–3Credits–75Marks–**MJ-14/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

Students will learn the basic fundamentals of earth science as applied to the interaction between human activity and the natural environment. The course "Environmental and Mathematical Geology" typically aims to equip students with a strong foundation in geological principles, mathematical applications in geoscience, and the ability to analyze environmental issues from a geological perspective. Learning objectives include understanding geological processes, applying mathematical and statistical methods to analyze geological data, and developing skills in environmental problem-solving domain.

Course content:

MJ-14: Environmental and Mathematical Geology

Environmental Geology

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Definition, Concept, Scope and Importance of Environment Geology; General idea about components and composition of different environmental domains such as atmosphere, hydrosphere and biosphere; Types of environmental pollution; Introduction to weather and climate; Past-climates in the earth history; Concept and origin of monsoon; Elements of natural hazards.

Processes of soil formation, types of soil, soil degradation and mitigation. Environmental changes due to the influence of geological events. volcanoes, earthquakes, floods and anthropogenic activities. Environmental degradation due to mining and related activities and remedies. Water and air pollution.

Mathematical Geology

Application of statistics, trigonometry, algebra and calculus in Geological sciences.

MJ-14/VUG-GEL(Practical)–25ESE [1 credit]

1. Sampling, measurement and interpretation of data on water and air quality.
2. Study of soil profile and physical characteristics of soil.
3. Exercises based on different statistical analysis such as measures of central tendency, measures of dispersion, skewness and kurtosis.
4. Geological field work in an area to study the environmental impact assessment related to natural and anthropogenic activities.
5. Practical record & viva-voce.

Suggested Readings and Tools:

1. Valdiya, K.S., 1987. Environmental Geology-Indian Context. Tata McGraw Hill New Delhi.
2. De, A.K., 2022. Environmental chemistry. New Age International Private Limited.
3. Subramaniam, V., 2001: Textbook in Environmental Science-Narosa International
4. Keller, E.A., 2000. Environmental Geology. Shales E. Merrill Publishing Co., Columbus, Ohio.
5. Montgomery, C., 1984. Environmental Geology. John Wiley and Sons, London.
6. Sharma J.P., 2017. Environmental Studies, Laxmi Publications (P) Ltd, New Delhi
7. Bell, F.G., 1999: Geological Hazards-Routledge, London
8. Patwardhan, A.M., 1999. The Dynamic Earth System-Prentice Hall
9. Smith, K., 1992. Environmental Hazards-Routledge, London
10. Bryant, E., 1985. Natural Hazards-Cambridge University Press
11. John C Davis, 2002. Statistics and Data analysis in Geology. John Wiley & Sons Inc; 3rd edition.

Engineering Geology–3Credits–75Marks–MJ-15/VUG-GEL
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Course Learning Objectives:

Students will understand the engineering properties of rocks and their use as construction material. Detailed study of various geological and geotechnical investigations for various civil engineering projects. To understand the impact of Geological activities on the environment.

Course content:

MJ-15: Engineering Geology

Engineering properties of rocks, laboratory testing of rocks – uniaxial compressive strength, tensile strength, shear strength, Mohr's diagram: mass movement- classification and causes". Dam – its type, geotechnical consideration, selection of sites, forces acting on a dam. Reservoirs – geological investigation, silting of reservoirs. Tunnel – geological investigations in tunneling. Case histories related to Indian Civil Engineering projects.

MJ-15/VUG-GEL(Practical)–25ESE [1 credit]

1. Geological maps to demarcate and evaluate the suitability of sites for engineering projects such as Tunnels, Dams and Reservoir construction.
2. Determining engineering properties of rocks.
3. Geological field visit in an area of civil engineering project.
4. Practical record & viva-voce.

Suggested Readings and Tools:

1. Gokhale, K.V.G. (2006) Principles of engineering geology, CBS publications.
2. Bell, F.G. (2007). Engineering Geology. Butterworth-Heinemann.
3. Blyth, F.G.H. and M.H. de Freitas (1984) Geology for Engineers, Butterworth-Heinemann Title
4. Kryniene, D. and Judd, W.R. (2005) Principles of Engineering Geology and Geotechniques, CBS Publishers & Distributors.
5. Singh, B and Goel, R.K. (2011)-Engineering Rock Mass Classification: Tunneling, Foundations, and Landslides-Elsevier.
6. Ries, H. and T.L. Watson, (1949) Elements of Engineering Geology, New York, John Wiley & Sons, Inc.
7. Kryniene, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGraw Hill.
8. Johnson, R.B. and DeGraf, J.V. 1988. Principles of Engineering Geology, John Wiley
9. Goodman, R.E., 1993. Engineering Geology: Rock in engineering constructions. John Wiley & Sons, N. Y.
10. Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.). Taylor and Francis.
11. Bell: F.G., 2006. Basic Environmental and Engineering Geology. Whittles Publishing.

Fourth year – Bachelor's Degree with Hons.

Semester - VII

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Research Methodology–4Credits–100Marks–**MJ-16/VUG-GEL**
[(ESE-75) + (SIE -20) + (D to D-5)]

EndSemesterExamination(ESE75marks)

Course Learning Objectives:

A research methodology course in geology aims to equip students with the skills to conduct independent scientific research. This includes understanding the fundamentals of research, developing research plans, applying statistical tools and computer applications, and effectively communicating research findings. Students will also learn to identify research problems, formulate hypotheses, and critically evaluate existing literature.

Coursecontent:

MJ-16: Research Methodology

Planning Research: Research problem; Techniques involved in defining a problem; Techniques involved in solving a problem. Review of literature: Sources of Literature: Journals, Books, use of e- resources – Science direct (Elsevier, Springer Link, Scopus, Web of Science, Google scholar, ShodhSindhu, Shodh Ganga. (INFLIBNET, JSTOR)Techniques of Review Writing and Referencing Styles (AIP/APA), Plagiarism and Academic Integrity: Use of Plagiarism Detection Tools (Turnitin, URKUND).Ethical issues in conducting research and paper writing.

Identification of geological research problem, formulating a plan. Quantitative methods of research in Geology: Methods of data collection – experimental data, field data, data from secondary sources. Using statistical methods for the treatment of various data: Correlation, Regression, Test of significance. Hardware and software, Operating system, M.S. Office. Development of skills in scientific writing, data entry, graph plotting. Data analysis – Use of software like MS Excel/ MATLAB/Mathematica/SPSS etc. Principles and application of analytical techniques in Geology: XRF, XRD, SEM, Spectrophotometer, Flame photometer, AAS, ICP-OES, ICP-MS, EPMA.

Suggested Readings and Tools:

1. Research Methodology and Techniques in Geology by Panna Lal. Anmol Publishers.
2. Handbook of Research Methodology – A Compendium for Scholars & Researchers by Dr. Shanti Bhushan Mishra & Dr. ShashiAlok. Educreation Publishing.
3. Kothari, C. R., 2008: Research Methodology-Methods and Techniques, New Age International, 2nd Ed. (New Delhi).
4. Kumar, R., 2005: Research Methodology: A step-by-step guide for beginners, SAGE Publications.
5. Rollinson, H.R., 1993. Using geochemical data: Evaluation, Presentation, and Interpretation. Longman.
6. Mishra, R. P., 1980: Research Methodology, Handbook Concept Publishing Company, New Delhi.
7. Khandpur, R. S., 2015: Handbook of Analytical Instruments, McGraw Hill Education; 3rd Ed.
8. Duane, C. Hanselman and Bruce, L. Littlefield., 2011: Mastering MATLAB.

Fuel Geology–3Credits–75Marks–**MJ-17/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

Fuel geology courses generally aim to provide a comprehensive understanding of the geological processes involved in the formation and occurrence of fossil fuels, particularly Coal and petroleum. Students will learn about the petroleum system, including source rocks, reservoir rocks, traps, and seals, as well as the geological factors influencing hydrocarbon exploration, production, and reservoir management. Student will also learn about other sources of energy such as nuclear energy, Coal Bed Methane (CBM), Gas Hydrate, Oil shale. They will also be introduced to various other potential alternative (renewable) energy sources such as geothermal energy, solar, wind, wave, tidal, biofuel/biodiesel, etc.

Coursecontent:

MJ-17: Fuel Geology

Coal: Definition and origin of Coal, Condition of formation of coal. Basic classification of coal: ASTM and Indian classification. Fundamentals of Coal Petrology – Introduction to lithotypes, microlithotypes and macerals in coal. Proximate and Ultimate analysis. Correlation of coal seams. Industrial utilization of coal. Coal liquefaction. Coal deposits of India.

Petroleum: Origin of petroleum; Chemical composition and physical properties of crudes in nature, Petroleum system, source rock, reservoir rocks, primary and secondary migration. Classification of reservoir rocks – clastic and chemical. Hydrocarbon traps: structural, stratigraphic and combination. Cap rocks – definition and general properties. Well logging. Petroliferous basins of India.

Nuclear Fuel: Geochemistry of U and Th, geochemical abundance of radioactivity in crustal rocks, important minerals, types of U and Th deposits, nuclear raw material resources of India, usage of nuclear energy.

Coal Bed Methane (CBM), Gas Hydrate. Oil Shale – a brief overview. Renewable Energy: geothermal energy, solar, wind, wave, tidal, biofuel/biodiesel, etc.

MJ-17/VUG-GEL(Practical)–25ESE [1 credit]

1. Petrographic study of coals.
2. Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks). Reserve estimation of coal.
3. Calculation of formation-pressures. Estimation of oil and gas reserves.
4. Interpretation of well-logs and VSP data.
5. Practical record & viva-voce.

Suggested Readings and Tools:

1. Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.
2. Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

3. Boyle, R.W., 1982: Geochemical Prospecting for Thorium and Uranium Deposits-Elsevier
 4. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa PublishingHouse.
 5. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
 6. Chandra, D., Singh, R.M. and Singh, M.P., 2000: Textbook of Coal (Indian Context)-TaraBook Agency, Varanasi.
 7. Dahlkamp, F.J., 1993: Uranium Ore Deposits-Springer Verlag
 8. Durrance, E.M., 1986: Radioactivity in Geology. Principles and Application-EllisHoorwood
 9. Holson, G.D. and Tiratsoo, E.N., 1985: Introduction to Petroleum Geology-Gulf Publ.Houston, Texas
 10. Singh, M.P., (Ed.), 1998: Coal and Organic Petrology-Hindustan Publ. Corp., New Delhi
 11. Stach, E., Mackowsky, M.T.H., Taylor, G.H., Chandra, D., Teichmuller, M. andTeichmuller, R., 1982: Stach's Text Book of Coal Petrology-GebruderBorntraeger,Stuttgart
 12. Tissot, B.P. and Welte, D.H., 1984: Petroleum Formation and Occurrence-Springer Verlag
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Mining Geology & Ore Dressing–3Credits–75Marks–**MJ-18/VUG-GEL**
[(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

The learning objectives for a Mining Geology and Ore Dressing course typically include understanding ore genesis, geological exploration techniques, various mining methods, and mineral processing principles. Students will also learn about the geological factors influencing ore deposit formation, the different types of ore deposits, and the environmental and safety aspects of mining operations.

Coursecontent:

MJ-18: Mining Geology & Ore Dressing

Mining

Shaft, Hanging and footwall, Adit, Drive, Crosscut, Raise, Winze, Chute, Open cast Mining, Basic idea of Dragline, Power Shovel, Scrapers.Underground Mining- Open stopes (Grophering, Breast stoping, Open Under hand stoping, Underground gloryhole,RoomandPiller),SupportedStopes(OverhandStopingMethodwith supports, timbered stopes), Filled Stopes (Cut and Fill method, Horizontal-cut and fill stopes, Baltic dry wall method, Cross-cut method, Inclined-cut Method), Shrinkage stopes.

Ore Dressing

Mineral Beneficiation(Ore Dressing)- Preparation of the mineral samples for dressing, crushing, screening, grinding, sizing, concentration, storage. Gravity Separation, Heavy MediaSeparation, Jigging, Tabling, MagneticSeparation, ElectrostaticSeparation, Floatation Collector, Frothers, Modifiers, Agglomeration. Biometallurgy and Biomining.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

MJ-18/VUG-GEL(Practical)–25ESE [1 credit]

1. Mine Design and planning.
2. Concentration Methods: Applying various techniques to separate valuable minerals from the gangue based on their physical and chemical properties, including: Gravity separation, Magnetic separation, Froth flotation, Electrostatic separation.
3. Mineral processing economics: reserve estimation and evaluating the economic feasibility of different ore dressing processes and optimizing for grade and recovery.
4. Geological field work in the Mining zones.
5. Practical record & viva-voce.

Suggested Readings and Tools:

1. Arogyaswamy R.N.P.(1973) Courses in Mining Geology, Oxford and IBH Publishers Co. Ltd., 916 pages
2. Sinha R.K. and Sharma N.L.(1989) Mineral Economics, Oxford and IBH Publishers Co. Ltd, 4th Edition, 410 pages
3. McKinstry H.E.(1980) Mining Geology, Prentice Hill Inc., 667 pages.
4. Babu S.K. and Sinha D.K.(1988) Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi
5. Sharma J.P.(2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi, Indian Bureau of Mines publications
6. Krieter, V.M. (2004) Geological prospecting and exploration, University Press of Pacific.
7. Dobrin, M.B.(1960) Geophysical prospecting, McGraw Hill.

Semester– VIII

Mineral Exploration–3Credits–75Marks–MJ-19/VUG-GEL
[(ESE-60) + (SIE -10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

Mineral exploration courses aim to equip students with the knowledge and skills to identify, assess, and potentially develop economically viable mineral deposits. This involves understanding geological principles, applying various exploration techniques, and evaluating the feasibility of mining operations. Key objectives include resource estimation, economic viability assessment, understanding geological settings, and exploration targeting.

Course content:

MJ-19: Mineral Exploration

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Concept of mineral exploration; Resource reserve definitions, Principles of mineral exploration, Prospecting and exploration - conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, Geochemical exploration - nature of samples, anomaly, strength of anomaly and controlling factors, coefficient of aqueous migration. Introduction to geophysical methods of exploration. Evaluation of sampling data. Mean, mode, median, standard deviation and variance, symmetrical and non-symmetrical variation, krigging, evaluation of assay values and determination of one sided cut-off grade. Core and non-core drilling, planning of bore holes and location of boreholes on ground. Core-logging. Reserve Estimation and errors.

MJ-19/VUG-GEL(Practical)–25ESE [1 credit]

1. Identification of anomaly.
2. Problems on reserve estimation.
3. Bore hole problems related to mineral exploration.
4. Geological field work in an area of mineral exploration.
5. Practical record & viva-voce.

Suggested Readings and Tools:

1. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
 2. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.
 3. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.
 4. Haldar, S.K., 2013. Mineral Exploration – Principles and Applications. Elsevier Publication.
 5. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
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Remote Sensing and GIS–3Credits–75Marks–MJ-20/VUG-GEL [(ESE-60) + (SIE -10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

A course on Remote Sensing and GIS aims to equip students with the knowledge and skills to understand, analyze, and apply spatial data using satellite imagery and Geographic Information Systems (GIS). Key objectives include understanding remote sensing principles, GIS components and data models, spatial analysis techniques, and practical applications in various fields like environmental management, urban planning, and disaster mitigation.

Coursecontent:

MJ-20: Remote Sensing and GIS

Concept in remote sensing. General idea of electromagnetic spectrum, signature of common

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

natural objects. Radiation laws. Interaction of EMR with the earth's surface and with the atmosphere. Platform and sensors. Multi-spectral scanners. Resolution of sensor- Spatial, Spectral, Radiometric and Temporal. Satellites and their characteristics. Microwave remote sensing. Digital image processing technique. Application of remote sensing in geology, mineral exploration, groundwater and hydrocarbon exploration.

Principles of Geographic information System(GSI), data structure, data acquisition, retrieval, overlay operation and application of GSI. Concept of GPS. Application in earth science system.

MJ-20/VUG-GEL(Practical)–25ESE [1 credit]

1. Aerialphoto/imageinterpretation,identificationofsedimentary,igneousand metamorphic rocks.
2. Identificationofstructuralfeaturesinaerialphoto/ satelliteimagery.
3. Identificationofgeomorphicfeaturesinaerialphoto/satelliteimagery.
4. GIS Application: Georeferencing of toposheet/satellite imagery; creation of vector data (point, line and polygon), adding an attribute, spatial analysis, Map generation using open source GIS software, Practical record & viva-voce.

Suggested Readings and Tools:

1. MillerVictorC.MillerCalvinF.(1961)Photogeology(InternationalSeries in the Earth Sciences.McGraw-Hill Book Company, Inc.
 2. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons. Inc.
 3. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory & Practice, Springer Wien New York.
 4. Richards, J.A. and Jia, X., 1999. Remote Sensing Digital Image Analysis, Springer-Verlag.
 5. Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.
 6. DruryS.A,AGuidetoRemoteSensing-InterpretingImagesofEarth,OxfordScience Publications, Oxford. (1990)
 7. Sabins,F.F.Jr.,(1978)RemoteSensingPrinciplesandInterpretation,Freeman, Sanfrancisco.
 8. Gary L. Prost Remote Sensing for Geologists - A Guide to Image interpretation, Gordon andBreach Science Publishers, The Netherlands. 1997.
 9. Sinha, S.K., 2015. FundamentalofRemote Sensing&GIS. Anshuman Publication.
 10. Ramasamy, SM. (1999) Trends in Geological Remote Sensing - Rawat Publishers, Jaipur
 11. Jensen John R. (2000), Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
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FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

RESEARCH COURSES (For Hons. with Research)

Semester- VII

Research Proposal – Planning & Techniques—4Credits—100Marks—RC-1/VUG-GEL
[(ESE-50) + (SIE -20) + (D to D-5) + Term paper -25 marks]

EndSemesterExamination(ESE75marks)

Course Learning Objectives:

The learning objectives for a Research Proposal course in Geology typically focus on equipping students with the skills to identify, plan, and execute research projects in the field. This includes developing the ability to formulate research questions, conduct literature reviews, choose appropriate methodologies, and effectively communicate research findings.

Coursecontent:

RC-1: Research Proposal – Planning & Techniques

Research proposal and concepts; Developing research proposal in the frontier areas of geosciences. Proposal structure and methodology. Review of literature; Different reference pattern; Report writing. Proposal presentation and evaluation. Research approach and identifying gap areas from literature review; use of digital library, online resources; problem formulation and statement of research objectives; developing bibliography; ethical issues in conducting research and paper writing; concepts on plagiarism; ISSN and ISBN numbers; impact factors and citation index of research articles and assessing the quality of research articles. Carrying out field-based projects, survey analyses and Internship. Planning, Budgeting and Timeline.

Geological field work, mapping, sample preparation, analytical techniques and data analysis.

Suggested Readings and Tools:

1. Survey Methodology by Robert, M. B, et al., 2009, Wiley, New Jersey.
2. Research Design: Qualitative, Quantitative and Mixed Methods Approaches by John, W. C., 2011, Sage Publications, Thousand Oaks.
3. Principles of Writing Research Papers by Lester, James, D. and Lester Jr. J. D., 2007, Longman, New York.
4. Harris, D., 2019: Literature Review and Research Design (A guide to effective research practice)
5. How to Write and Publish a Scientific Paper, Robert A. Day and Barbara Gastel, Cambridge University Press, 8th ed., 2016.
6. Beall, J. 2012. Predatory publishers are corrupting open access. Nature 489 (7415), 179.
7. Otrel-Cass, K., Andrée, M., & Ryu, M. (2020). Ethics in Contemporary Science Education Research. In Examining Ethics in Contemporary Science Education Research (pp. 1-11). Springer, Cham.
8. Resnik, D.B. 2008. What is ethics in research and why is it important. University of Arizona Program in Research Integrity Education Monthly Newsletter, 8(8), August 1.
9. Chaddah, P. 2018. Ethics in Competitive Research. Pothi.com
10. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Semester- VIII

**Research Internship/Field Work/Project/Dissertation/Thesis–8Credits–200Marks–
RC-2/VUG-GEL**

EndSemesterExamination(200 Marks)

Course Learning Objectives:

Research internships, field work, projects, dissertations, and theses share several core learning objectives. These include developing research skills, enhancing problem-solving abilities, improving communication and presentation skills, fostering ethical research practices, and building professional competencies. Ultimately, these experiences aim to cultivate a research mindset and prepare students for future academic or professional endeavors.

Coursecontent:

RC-2: Research Internship/Field Work/Project/Dissertation/Thesis

Students will complete an 8-credit course involving a research internship and the preparation of a Project/dissertation/thesis. This course will include laboratory work, practicums, field projects, survey analyses, or internship- based projects. Students must submit a comprehensive research report and defend their project/dissertation/ thesis.

The evaluation will consider the following:

- a) Project dissertation design
- b) Methodology and content depth
- c) Participation in an internship programme with a reputed organization
- d) Application of research techniques in data collection
- e) Data Analysis
- f) Report presentation
- g) Presentation style
- h) Results and discussion
- i) Future scope
- j) References

Marks distribution may be as follows or adjusted as appropriate:

- | | | |
|------|--------------------------------|------------------|
| i. | Assessment of Project synopsis | :50marks |
| ii. | Assessment of Project Report | :100marks |
| iii. | Viva –voce | : 50marks |

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

ADVANCED MAJOR COURSES (For Hons.)

Semester- VII

Mineralogy and Geochemistry–4Credits–100Marks–AMJ-1/VUG-GEL
[(ESE-75) + (SIE -20) + (D to D-5)]

EndSemesterExamination(ESE75marks)

Course Learning Objectives:

Students will understand the foundational principles of mineralogy and geochemistry as essential components of Earth sciences. Explore the chemical and structural properties of minerals and their formation processes. Apply geochemical principles to interpret Earth processes, geochemical abundance distribution of elements/isotopes, origin and evolution of rocks.

Course content:

AMJ-1: Mineralogy and Geochemistry

P-T stability, properties, paragenesis and occurrence of the following mineral groups: Olivine, garnet, pyroxene, amphibole, mica, clay, quartz, zeolite, feldspar & feldspathoid, kyanite, sillimanite, epidote, chlorite.

X-ray crystallography and Bragg's law. X-ray investigations of rock-forming minerals.

Geochemistry of igneous rocks. Distribution coefficients and its application with numerical examples. Trace elements geochemistry and its application in Petrogenesis and as tectonic discriminants, Concept box model and mixing, and its applications. Geochemistry of weathering transportation and deposition. Application of Geochemistry in mineral exploration and in solving environmental problems. Radioactivity, Decay of radioactive atoms and growth of radiogenic atoms. Application of radioactivity in geochronology and in understanding geological processes. Stable isotope geochemistry, Introduction to cosmogenic isotope geochemistry.

Suggested Readings and Tools:

1. Dickin'.A P., 1995, Radiogenic Isotope Geology, Cambridge University Press.
2. Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.
3. Henderson, P., 1982. Inorganic Geochemistry, Pergamon Press, Oxford.
4. Krauskopf, K.B., 1979 Introduction to Geochemistry. McGraw Hill.
5. Mason, B. 1982 *Principles of Isotope Geology*, J. Wiley & Sons.
6. W.M. White. 2020. Geochemistry. 2nd Edition. Wiley-Blackwell.
7. Kula C. Misra 2012. Introduction to Geochemistry: Principles and applications. 1st Edition. Wiley-Blackwell.
8. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
9. Yardley, Bruce, and Clare Warren. (2021). An introduction to metamorphic petrology. Cambridge University Press.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Semester- VIII

Plate Tectonics, Igneous & Metamorphic Petrology and Geomorphology–4Credits–
100Marks–AMJ-2/VUG-GEL [(ESE-75) + (SIE -20) + (D to D-5)]

EndSemesterExamination(ESE75marks)

Course Learning Objectives:

The course will help students understand the fundamental principles of plate tectonic theory, including lithospheric plates, types of plate boundaries, and driving forces. Analyze palaeomagnetic data to reconstruct past plate motions and continental configurations. Identify igneous and metamorphic rocks and to understand the processes, reactions, and mineral assemblages formed under varying pressure–temperature conditions. To understand the distribution of different rock types at different plate tectonic settings. To understand how plate tectonic shape the earth surface. Understand key surface processes—weathering, erosion, transport, and deposition—that shape Earth’s landforms.

Coursecontent:

AMJ-2: Plate Tectonics, Igneous& Metamorphic Petrology and Geomorphology

Plate tectonics –types of plate boundaries, causes of plate motion, relation of plate tectonics with seismicity, volcanism and diastrophism. Palaeomagnetism. Tectonics of Precambrian orogenic belts of India. Structure and tectonics of Himalaya. Pattern of dipping strata- rule of V’s.

Study of the following three component systems of petrological interest:

Diopside – Albite –Anorthite; Diopside – Forsterite – Silica; Diopside – Forsterite – Anorthite. Modern classification of igneous rocks. Large Igneous Provinces.

Detail studies on Metamorphic zones, grades and facies. Mineral assemblages and important reactions in different facies, zone and grade. Paired metamorphic belts. Petrogenesis of charnockite and eclogite.

Concept of geomorphic cycle and its interpretation. Land forms in relation to lithology and structure. Morphometric analysis. Fluvial land forms, drainage pattern and its significance. Karst topography. Study of geomorphic feature of Chotanagpur plateau. Application of geomorphology in mineral prospecting, civil engineering and environmental studies.

Suggested Readings and Tools:

1. Condie K.C. 2013, Plate Tectonics & Crustal Evolution.
2. Condie, K.C. 2016, Earth as an Evolving Planetary System. Elsevier, Amsterdam. ISBN: 978-0-12-803689-1
3. Moores, E and Twiss. R.J., 1995. Tectonics. Freeman.
4. Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

5. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
6. Best, M.G., 2003. Igneous and Metamorphic Petrology, Blackwell.
7. Hugget; 2016. Fundamentals of Geomorphology by Taylor and Francis.
8. Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology. Orient Longman Ltd.
9. Thornbury, W.D. 2002. Principles of Geomorphology. CBS Publ. New Delhi.

Sedimentology, Palaeontology, Marine Geology and Stratigraphy–4Credits–100Marks–
AMJ-3/VUG-GEL [(ESE-75) + (SIE -20) + (D to D-5)]

EndSemesterExamination(ESE75marks)

Course Learning Objectives:

The learning objectives for this paper includes understanding the origin, transport, and deposition of sediments in various environments. Analyze sedimentary facies and interpret depositional environments (fluvial, deltaic, marine, aeolian). Analyze fossil assemblages to reconstruct past biodiversity, paleoecology, and paleoclimate. Understand the structure and composition of the ocean floor and continental margins. Explore oceanic resources (e.g., manganese nodules, hydrocarbons) and their environmental implications. Grasp the principles of stratigraphic correlation, lithostratigraphy, biostratigraphy, and chronostratigraphy. Interpret stratigraphic sequences and unconformities to reconstruct geological history.

Coursecontent:

AMJ-3: Sedimentology, Palaeontology, Marine Geology and Stratigraphy

Sedimentary Texture, Concept of grain size and grade, graphical representation of grain size and statistical parameters. Provenance. Palaeocurrent analysis, Walther's law of facies. Bouma sequence. Sequence stratigraphy with reference to Indian section.

Methods and techniques in Palaeontology. Evidence of life in Precambrian time. Causes of mass extinction. Morphology, geological records and applications of Foraminifera, Ostracoda, Chitinozoa, Acritarch and Pollen spores in palaeoclimatic studies.

Morphological and tectonic domains of ocean floor. Relief of the ocean floor. Temperature, salinity and density of oceans. Ocean circulation: thermohaline and surface circulation, upwelling, Ekman spiral. Ocean deposits – transportation and deposition of marine sediments. Marine mineral resources and their controlling factors.

Pc-C, P/T and K/T (K/Pg) boundary problems of India, Magnetostratigraphy-General principles, magnetic polarity time scales, magnetic-chron, application of Magnetostratigraphy, chemostratigraphy and seismic stratigraphy

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Suggested Readings and Tools:

1. Boggs, S., Jr. (1987) Principles of Sedimentology and Stratigraphy, Meril Publishing.
 2. Maurice E. Tucker, 2006, Sedimentary Petrology, Blackwell Publishing, 262p.
 3. Dasgupta, A. 2010, Phanerozoic Stratigraphy of India, World Press, Kolkata.
 4. Wadia, D., (1973) Geology of India. McGraw Hill Book Co.
 5. Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological Society of India, Bangalore.
 6. Brian, J. S., Barbara, W.M., 2010. The Blue Planet: An Introduction to Earth System Science, 3rd Edition, Wiley.
 7. Dronkers J. (2005) Dynamics of coastal systems, World Scientific
 8. Kennet, J. (1982) Marine Geology and Geophysics.
 9. Seibold E., Berger W.H. 1996. The Sea Floor: An Introduction to Marine Geology, Springer.
 10. Nittrouer, C.A., Austin, J. A., Field M.E., Kravitz J. H., Syvitski J.P.M., Wiberg P.L. (2007) Continental margin, sedimentation from sediment transport to sequence stratigraphy, Wiley Blackwell.
 11. Prothero and Schwab, 2004, Sedimentary Geology, Freeman and Co. New York, 557p
 12. Gary Nichols, 2009. Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
 13. Armstrong, H.A., and Brasier, M.D., 2005. Microfossils. Blackwell
 14. Morley Davies (2008) An Introduction to Palaeontology
 15. Michael Benton, (2005) Vertebrate Palaeontology, Blackwell Publishing
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FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

ASSOCIATED CORE AND ELECTIVE (MINOR) COURSES

Associated Core Course Semester-I/II

Physical Geology, Crystallography, Optical & Descriptive Mineralogy–3Credits–
75Marks–AC-1 or AC-2 /VUG-GEL [(ESE-60) + (SIE-10) + (D to D-5)]

EndSemesterExamination(ESE60marks)

Course Learning Objectives:

The learning objectives for Physical Geology, Crystallography, and Optical and Descriptive Mineralogy involve understanding the Earth's processes, the structure of minerals, and how to identify them using various properties. Students will learn to identify minerals based on physical and optical characteristics, understand crystal structures and symmetry, and relate these concepts to geological processes.

AC-1 or AC-2:Physical Geology, Crystallography, Optical & Descriptive Mineralogy

Physical Geology

The nature and scope of geology; Origin of the Earth; Age of the Earth; An elementary idea of seismic waves and interior of the Earth; Concept of plate tectonics. Geological work of river and wind.

Crystallography

Elementary ideas about crystal structure; Crystal: faces, edges, solid angles and interfacial angles; Crystallographic axes and axial angles; Elements of Crystal Symmetry. Parameter, indices and symbol. Laws of crystallography; Isometric System.

Optical Mineralogy

Nature of light; Polarization of light; Isotropic and anisotropic substances (minerals); Phenomenon of double refraction; Nicol prism – its construction; Construction and function of petrological microscope. Optical properties of olivine, pyroxene, hornblende, quartz, orthoclase, plagioclase, biotite, muscovite.

Descriptive Mineralogy

Mineral - definition; Physical properties of minerals; Structure and classification of silicates; Chemical composition and diagnostic physical properties of the primary rock forming minerals.

AC-1 or AC-2 /VUG-GEL(Practical)–25ESE [1 Credit]

1. Crystaldrawingofcube,octahedron,dodecahedron
2. Identificationofrockformingmineralsinhandandundermicroscope.
3. Practical recordandviva-voce.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

Suggested Readings and Tools:

1. Grotzinger and Jordan, (2019). Understanding Earth. Eighth Edition. W.H. Freeman
2. Mahapatra, G.B., (1994) A text book of Physical Geology. CBS Publishers.
3. Rutleys Elements of Mineralogy, CBS Publication.
4. Dexter Perkins. Mineralogy. PHI Learning Private Ltd., New Delhi, 2012.
5. Dana, E.S. and Ford, W.E., (2002) A text book of Mineralogy (Reprints).
6. Berry, L.G., Mason, B. and Dietrich, R.V., (1982) Mineralogy. CBS Publ.
7. W. D. Nesse. Introduction to Optical Mineralogy. Oxford University Press, 2004

Elective Course-I **Semester-III/IV**

Structural Geology and Petrology–3Credits–75Marks–ELC-1 or ELC-2/VUG-GEL
[(ESE-60) + (SIE-10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

A course in Structural Geology and Petrology typically aims to equip students with the knowledge and skills to understand the deformation of rocks and the composition and origin of rocks. This includes understanding rock structures, their formation, and the processes that create them, as well as the characteristics and origins of different rock types.

ELC-1 or ELC-2: Structural Geology and Petrology

Structural Geology

Understanding dip and strike. Construction and uses of Clinometer and Brunton compass. Understanding tectonic forces. Elementary idea and nomenclature of Folds, Faults, Unconformity and Joints.

Petrology

Igneous Rocks –Magma and Bowen's Reaction Series. Definition and classification of igneous rocks; Forms of igneous bodies; Brief petrographic description of common igneous rocks such as – granite, gabbro, dolerite, basalt, rhyolite. Sedimentary rocks – texture and structure; Brief Petrographic descriptions of common sedimentary rocks such as – conglomerate, breccia, sandstone, limestone and shale. Metamorphic rocks – definition, types and its agents; Textures of metamorphic rocks; Brief Petrographic descriptions of common metamorphic rocks – slate, phyllite, schist, gneiss, marble and quartzite.

ELC-1 or ELC-2/VUG-GEL (Practical)–25ESE [1 Credit]

1. Study of simple geological maps involving simple dip, fold, fault and unconformity,

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

- drawing of geological sections and detailed geological description.
2. Identification of igneous, sedimentary and metamorphic rocks in hand specimen.
 3. Practical record and viva-voce

Suggested Readings and Tools:

1. Grotzinger and Jordan, (2019). Understanding Earth. Eighth Edition. W.H. Freeman
2. Davis, G.R. (1984) Structural Geology of Rocks and Region. John Wiley
3. Billings, M.P. (1987) Structural Geology, 4th edition, Prentice-Hall.
4. Park, R.G. (2004) Foundations of Structural Geology. Chapman & Hall.
5. G.W. Tyrrell, (Reprint 1926). The Principles of Petrology. AITBS publishers and distributors- Delhi

Elective Course-II **Semester-V/VI**

Engineering Geology, Stratigraphy and Palaeontology–3Credits–75Marks–
ELC-3 or ELC-4/VUG-GEL [(ESE-60) + (SIE-10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

The course learning objectives for Engineering Geology, Stratigraphy, and Palaeontology typically focus on equipping students with a comprehensive understanding of Earth's processes, history, and materials. This includes understanding geological hazards, rock formations, and the evolution of life through time. Students should be able to apply this knowledge to various practical applications, including civil engineering projects, resource management, and environmental impact assessments.

ELC-3 or ELC-4: Engineering Geology, Stratigraphy and Palaeontology

Engineering Geology

Engineering properties of rock; Geological, geotechnical and environmental considerations for Dams and Reservoirs. Tunnels and Tunneling Methods. Landslides; Causes, Factors and corrective/preventive measures. Earthquakes; causes, role of Engineering geologists in planning, design and construction of major structural features.

Stratigraphy

Stratigraphy: Principles of stratigraphy. Geological time scale. A brief account of the important geological formation of India viz. Precambrian of Jharkhand, Gondwana Supergroup of Jharkhand and Vindhyan Supergroup; Stratigraphy of Himalayas.

Palaeontology

Palaeontology: Definition and its scope; Fossils definition, their mode of preservation and uses. Evolution of life through time, mass extinction, and human evolution.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

ELC-3 or ELC-4/VUG-GEL(Practical)–25ESE [1 Credit]

1. Determining engineering properties of rocks.
2. Identification of important fossils.
3. Practical record and viva-voce.

Suggested Readings and Tools:

1. Gokhale, K.V.G. (2006) Principles of engineering geology, CBS publications.
 2. Grotzinger and Jordan, (2019). Understanding Earth. Eighth Edition. W.H. Freeman.
 3. Bell, F.G. (2007). Engineering Geology. Butterworth-Heineman.
 4. Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
 5. Shrock, R.R. and Twenhoffel, W.H. (1952): Principles of Invertebrate Paleontology, CBS Publ.
 6. Woods, H. (1985): Palaeontology Invertebrate, CBS Publ.
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Elective Course-III **Semester–VII/VIII**

Economic Geology and Hydrogeology–3Credits–75Marks–ELC-5 or ELC-6/VUG-GEL [(ESE-60) + (SIE-10) + (D to D-5)]

End Semester Examination (ESE 60 marks)

Course Learning Objectives:

The primary objective of the course of Economic Geology is to introduce fundamental aspects of origin, mode of occurrences and the distribution of ore deposits to the students. The course provides the essential and basic concepts of groundwater flow and their retention in rocks.

ELC-5 or ELC-6: Economic Geology and Hydrogeology

Economic Geology

Definition of ore, ore minerals, gangue minerals, tenor of ore; processes of formation of mineral deposits – magmatic concentration and placer deposits; Mode of occurrence and distribution of metallic and non-metallic mineral deposits – Iron, Copper, Coal deposits of Jharkhand; Physical properties of chalcopyrite, pyrite, galena and hematite.

Hydrogeology

Occurrence and vertical distribution of groundwater; Hydrological cycle; Water bearing properties of rocks - Porosity and permeability, Specific yield, specific retention and storage coefficient. Aquifers and their types.

ELC-5 or ELC-6/VUG-GEL(Practical)–25ESE [1 Credit]

1. Megascopic identification of ore minerals.
2. Plotting of important ore deposits in the map of India.
3. Study of hydrological properties of different rock types.

FOUR YEAR COURSE STRUCTURE OF UNDERGRADUATE PROGRAMME IN GEOLOGY UNDER NEP 2020

4. Plotting of Groundwater provinces of India on the map of India.
5. Practical record and viva-voce.

Suggested Readings and Tools:

1. Bateman, A.M. and Jensen, M.L. 1990. Economic Mineral Deposits. John Wiley.
 2. Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.
 3. Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals, Dhanbad Publ.
 4. Prasad, U. (2019). Economic Geology: Economic Mineral Deposits. CBS 2nd edition.
 5. Todd, D.K. and Mays, L.W. (2004). Groundwater Hydrology, John Wiley & Sons.
 6. Karanth, K.R. (1987) Hydrogeology. Tata McGraw-Hill Publishing Company.
 7. Raghunath, H.M. (1987) Groundwater, New Age International
 8. Davis, S.N. and Dewiest R.J.M. (1966) Hydrogeology, John Wiley & Sons.
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