

VIDYASAGAR UNIVERSITY

Midnapore, West Bengal



PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE (HONOURS) MAJOR IN GEOLOGY

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

**Curriculum & Credit Framework for Undergraduate Programmes
(CCFUP), 2023 & NEP, 2020**

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS) MAJOR IN GEOLOGY
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks				
								CA	ESE	TOTAL		
B.Sc. (Hons.)	2 nd	III	SEMESTER-III									
			Major-3	GELHMJ03	T: Structural Geology; P: Practical			4	3-0-1	15	60	75
			Major-4	GELHMJ04	T: Igneous Petrology; P: Practical			4	3-0-1	15	60	75
			SEC	GELSEC03	P: Field Work II-Geological Mapping and Structural Geology			3	0-0-3	10	40	50
			AEC	AEC03	Communicative English -2 (<i>common for all programmes</i>)			2	2-0-0	10	40	50
			MDC	MDC03	Multidisciplinary Course -3 (<i>to be chosen from the list</i>)			3	3-0-0	10	40	50
			Minor-3 (Disc.-I)	GELMIN03	T: Introduction to Petrology; P: Practical			4	3-0-1	15	60	75
		Semester-III Total					20				375	
		IV	SEMESTER-IV									
			Major-5	GELHMJ05	T: Elements of Geochemistry; P: Practical			4	3-0-1	15	60	75
			Major-6	GELTHMJ06	T: Sedimentology; P: Practical			4	3-0-1	15	60	75
			Major-7	GELHMJ07	T: Paleontology; P: Practical			4	3-0-1	15	60	75
			AEC	AEC04	MIL-2 (<i>common for all programmes</i>)			2	2-0-0	10	40	50
			Minor-4 (Disc.-II)	GELMNI04	T: Introduction to Mineralogy; P: Practical			4	3-0-1	15	60	75
			Summer Intern.	INT	Internship/ Apprenticeship - activities to be decided by the Colleges following the guidelines to be given later			4	0-0-4	-	-	50
		Semester-IV Total					22				400	
		TOTAL of YEAR-2					42				775	

MJ = Major, MI = Minor Course, SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language

MAJOR (MJ)

MJ-3: Structural Geology

Credits 04

MJ-3T: Structural Geology (Theory)

Full Marks: 75

Course contents:

Unit 1: Basic structural elements

1. Diastrophic and non- diastrophic structures
2. Structural elements: planar and linear structures, concept of strike and dip, trend and plunge, rake/pitch
3. Application of primary sedimentary and igneous structure in structural geology. Unconformity and its types; recognition of Unconformity
4. Concept of scale of observation of structures
5. Topographic maps. Outcrop patterns of different structures

Unit 2: Stress and strain in rocks

1. Concept of rock deformation: Concept of Stress. Basic idea of Shear zone
2. Concept of Strain: Homogeneous and inhomogeneous strain, Rotational and irrotational strain in rocks,
3. Strain ellipsoids of different types and their geological significance.
4. Flinn and Ramsay's diagram
5. Concept of Rock deformation: Brittle and ductile deformation.

Unit 3: Folds

1. Fold morphology
2. Geometric and genetic classification of folds, Ramsay's classification of Fold.
3. Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding

Unit 4: 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

Unit 5: Fractures and faults

1. Fracture, Geometric and genetic classification of faults. Effects of faulting on the outcrops. Joints and classification of Joints.
2. Geologic/geomorphic criteria for recognition of faults and fault plane solutions

Suggested Readings:

1. Davis, G. R. (1984) Structural Geology of Rocks and Region.
2. John Wiley Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall. Park, R. G. (2004)
3. Foundations of Structural Geology. Chapman & Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
6. Lahee F. H. (1962) Field Geology. McGraw Hill

MJ-3P: Structural Geology (Practical)**Credits 01****List of Practical:**

1. Basic idea of topographic maps, Topographic sheets of various scales
2. Interpretation of topographic maps
3. Interpretation of Geological maps with unconformity, fault, fold and igneous bodies. Construction of structural cross section
4. Stereographic projections of planes and lines
5. True dip and apparent dip problems, 3-point problems, fold problems, fault problems and their solutions through stereographic projection methods

MJ-4: Igneous Petrology**Credits 04 (Full Marks: 75)****MJ-4T: Igneous Petrology****Credits 03****Course contents:****Unit 1: Introduction to Igneous petrology**

1. Modes of magma formation in the crust and upper mantle
2. Physical properties of magma - temperature, viscosity, density and volatile content
3. Modes of emplacement of igneous rocks: volcanic, hypabyssal, plutonic

Unit 2: Forms of Igneous rock bodies

1. Mode of occurrence of Igneous rocks
2. Forms of igneous rocks

Unit 3: Texture and microstructure of Igneous rocks

1. Crystallinity, granularity, shapes and mutual relations of grains; nucleation and growth of igneous minerals
2. Description of the following textures and microstructures with their occurrence in different rocks - panidiomorphic, hypidiomorphic, allotriomorphic, porphyritic, vitrophyric, poikilitic, ophitic, sub-ophitic, intergranular, intersertal, pilotaxitic, trachytic, graphic, granophyric, rapakivi, orbicular, corona, perthitic, myrmekitic, variolitic, speherulitic & spinifex
3. Binary and Ternary Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic magmas
4. Magma generation in crust and mantle, their emplacement and evolution

Unit 4: Classification of igneous rocks

1. Bases of classification of igneous rocks: mineralogical, textural, chemical, chemicomineralogical and associational; Norm and mode; Standard classification schemes – Niggli, Wells & Wells and IUGS. TAS diagram for volcanic rocks
2. Composition and texture of important igneous rocks: Granitoids, Pegmatite, Syenite, Monzonite, Diorite, Norite, Gabbro, Anthrothosite, Dolerite, Pyroxenites, Peridotite, Lamprophyres, Carbonatite, Rhyolite, Andesite, Dacite, Basalt, Komatiite

Unit 5: Phase Diagrams

Phase Rule and its application to eutectic, peritectic and solid solution system: Phase equilibria in the following binary and ternary systems, and their petrogenetic significance: diopside – anorthite, forsterite – silica, albite – anorthite, albite – orthoclase, diopside – albite – anorthite, forsterite – diopside – silica and nepheline - kalsilite – silica.

Unit 6: Petrogenesis of Igneous rocks

1. Magma generation in crust and mantle, their emplacement and evolution
2. Petrogenesis of Felsic and Mafic igneous rocks: Granitoids, Basalt, Gabbros, Anorthosite, Komatiites, Alkaline rocks, Kimberlites

Unit 7: Magmatism in different tectonic settings

1. Magmatism in the oceanic domains (MORB, OIB)
2. Magmatism along the subduction zones: Island arcs and continental arcs
3. Magmatism along continental rifts

MJ-4P: Igneous Petrology (Practical)

Credits 01

List of Practical

1. Study of important igneous rocks in hand specimens and thin sections: granite, granodiorite, diorite, syenite, nepheline syenite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite, dacite
2. Norm calculation. Visual estimation of modes from thin sections
3. Plotting of mode in IUGS classification of plutonic rocks (Streckeisen diagram)

Suggested Readings:

1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. Myron G. Best (2001). Igneous and Metamorphic Petrology,
6. K. G. Cox, J. D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
7. Bose M.K. (1997). Igneous Petrology.
8. Frost B. R. and Frost C. D (2014). Essentials of Igneous and Metamorphic Petrology. Cambridge University Press.

MJ-5: Elements of Geochemistry**Credits 04 (Full Marks: 75)****MJ-5T: Elements of Geochemistry****Credits 03****Course contents:**

Unit 1: Basic Concepts-Introduction to properties of elements: The periodic table. Chemical bonding, states of matter and atomic environment of elements. Geochemical classification of elements: Clarke of concentration, Clarke of abundance, Goldschmidt's Rule; Behaviour of elements during magmatic crystallization.

Unit 2: Layered Structure of Earth and Geochemistry: Chemical Composition of the Earth as three-layer structures. Composition of crust, mantle and core.

Unit 3: Element Transport: Advection and diffusion Chromatography. Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations. Elements of marine chemistry. Mineral reactions- diagenesis and hydrothermal reactions.

Unit 4: Geochemistry of Solid Earth: Geochemical variability of magma and its products. Melting processes

Unit 5: The atmosphere: structure and composition of atmosphere and its evolution. Formation and destruction of ozone layer, Ozone hole.

Unit 6: Isotope Geology: Isotopic and elemental fractionation. Radiogenic and stable isotopes in Earth materials.

Unit 7: Geochemical behavior of elements: Geochemical behavior of selected elements- Si, Al, K, Na, Ca, Fe, Mg, Ti.

Unit 8: Geochemical cycle: Geochemical cycles of Oxygen, Nitrogen, Carbon and Sulphur.

MJ-5P: Elements of Geochemistry (Practical)**Credits 01****List of Practical*****Geochemical variation diagrams and its interpretations:***

a. Bivariate and trivariate plots to delineate the control of different compositional variables:

- i. Harker variation diagram
- ii. AFM diagram
- iii. MgO diagram

b. Chemical variation diagrams based on major elements:

- i. Alkali-lime index
- ii. Iron enrichment index
- iii. Aluminium saturation index

- iv. Alkalinity index diagrams

Suggested Readings:

1. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
2. Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.
3. Walther, J. V. (2009). Essentials of geochemistry. Jones & Bartlett Publishers.
4. Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
5. Faure, Gunter and Teresa M. Mensing (2004). Isotopes Principles and Applications, Wiley India Pvt. Ltd

MJ-6: Sedimentology

Credits 04 (Full Marks: 75)

MJ-6T: Sedimentology

Credits 03

Course contents:

Unit 1: Introduction to Sedimentology: Scope of sedimentology, origin of sediments, classification of sedimentary rocks based on composition and texture.

Unit 2: Granulometry: Textural parameters of clastic sediments Grain size: concept of size and scale; particle shape and fabric; sedimentary textures. grain size analyses and environmental connotations.

Unit 3: Basic Hydraulics and Sedimentary Structures: sediment transport mechanism Fluid flow: flow rheology, fluid gravity flow, sediment gravity flow, flow regime, laminar and turbulent flow, particle entrainment in fluid flow. Mass flow: types and products. Sedimentary structure: primary and penecontemporaneous deformation structures, biogenic structures. Paleocurrent analysis: data acquisition, methodology, different palaeocurrent patterns.

Unit 4: Sedimentary rocks Siliciclastic rocks: components and classification(s) of sandstones, conglomerates, mudrocks. General introduction to carbonate rocks, BIF, chert; Components and classifications of limestone, dolomite and dolomitisation.

Unit 5: Sedimentary environments and their characteristics: Aeolian, Fluvial, Glacial, Lacustrine.

Unit 6: Diagenesis Concepts of diagenesis Stages of diagenesis: diagenetic changes in sand and carbonate deposits, lithification.

MJ-6P: Sedimentology (Practical)

Credits 01

List of Practical

1. Identification of sedimentary structures

2. Particle size distribution and statistical analysis
3. Paleocurrent analysis
4. Petrographic study of clastic and non-clastic rocks through hand specimens and thin sections

Suggested Readings:

1. Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.
3. Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
4. Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell

MJ-7: Paleontology

Credits 04 (Full Marks: 75)

MJ-7T: Paleontology

Credits 03

Course contents:

Unit 1: Fossilization and fossil record

1. Fossilization: definition of fossil, fossilization processes and modes of preservation, exceptional preservation
2. Taphonomy: definition, different types of taphonomic filters

Unit 2: Taxonomy and Systematics

1. Taxonomy: concept of taxonomy and taxonomic hierarchy
2. Biological and morphological species concept

Unit 3: Evolution and History of Life

1. Theory of organic Evolution: theory, concept of adaptation and variation, Natural Selection. Precambrian – doubtful organic traces of life during the Precambrian, Ediacaran fauna
2. Paleozoic – Cambrian Explosion of life. Episodes of mass extinction
3. Plants: Appearance of angiosperma and gymnosperma
4. Appearance of fish, amphibia, reptiles, birds, mammals and humans
5. Mass extinction: five major extinction episodes and their causes; effect of extinction

Unit 4: Invertebrates and Vertebrates

1. Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance
2. Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications. Functional adaptation in trilobites and ammonoids
3. Origin of vertebrates and major steps in vertebrate evolution
4. Mesozoic reptiles with special reference to origin, diversity and extinction of dinosaurs
5. Evolution of horse and intercontinental migrations
6. Human evolution

Unit 5: Introduction to Paleobotany, Gondwana Flora Introduction to Ichnology.

1. Introduction to Paleobotany, Gondwana Flora, Plants as indicator of past climate
2. Ichnology and its application in paleoecology

Unit 6: Application of fossils in Stratigraphy

1. Definitions: Biozones, index fossils, stratigraphic correlation, examples - significance of ammonites in Mesozoic paleobiostratigraphy
2. Application of fossils in Paleoenvironmental analysis
3. Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers. Paleoenvironmental analysis.

MJ-7P: Sedimentology (Practical)**Credits 01****List of Practical**

1. Study of fossils with various modes of preservation
2. Study of systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils
3. Study of functional morphological characters of different groups (Bivalvia, Gastropods, Brachiopoda, Echinodermata, Ammonoidea, Gondwana flora, vertebrates)
4. Identification of feeding habits from vertebrate (horse, elephants, Sus) teeth
5. Hard part morphology and identification of common Brachiopoda, Anthozoa, Trilobita, Echinoidea, Gastropoda. Identification of Gondwana flora

Suggested Readings:

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Benton, M. J., Harper, D. A. T. (2010). Introduction to Paleobiology and the Fossil Record , Wiley-Blackwell.
5. Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher

MINOR (MI)

MI – 3: Introduction to Petrology

Credits 04 (Full Marks: 75)

MI – 3T: Introduction to Petrology

Credits 03

Course contents:

Igneous Petrology

Unit-I: Magma: definition, composition, types and origin; Forms of igneous rocks; textures and structures of igneous rocks.

Unit-II: Reaction principle; Differentiation and Assimilation; Crystallization of unicomponent and bicomponent (mix-crystals); Bowen's reaction series.

Unit-III: Mineralogical and chemical classification of igneous rocks.

Unit-IV: Detailed petrographic description of Granite, Granodiorite, Rhyolite, Syenite, Diorite, Basalt, Gabbro.

Sedimentary Petrology

Unit-V: Processes of formation of sedimentary rocks; Classification, textures and structures of sedimentary rocks;

Unit-VI: Petrographic details of important siliciclastic and carbonate rocks such as conglomerate, breccia, sandstone, greywacke, shale, limestones.

Metamorphic Petrology

Unit-VII: Process and controlling factors of metamorphism; Type of metamorphism. Facies, zones and grade of metamorphism; Textures, structures and classification of metamorphic rocks.

Unit-VIII: Petrographic details of some important metamorphic rocks such as - slate, schists, gneiss, quartzite, marble.

MI – 3P: Introduction to Petrology (Practical)

Credits 03

1. Igneous Petrology:
Identification of rocks: On the basis of their physical properties in hand specimen; and optical properties in thin sections.
2. Sedimentary and metamorphic Petrology:
Identification of sedimentary and metamorphic rocks both in hand specimen and thin sections.

Suggested Readings:

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

MI-4: Introduction to Mineralogy

Credits 04 (Full Marks: 75)

MI-4: Introduction to Mineralogy

Credits 03

Course contents:

UNIT-I: Crystals and their characters:

UNIT-II: Crystal form, face, edge, solid angle; Interfacial angle and their measurements; Crystallographic axes and angles.

UNIT-III: Symmetry elements and description of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems.

UNIT-IV: Introduction to Mineralogy, Definition and characters of mineral;

UNIT- V: Classification of Minerals

UNIT-VI: Common physical properties of minerals; Chemical composition and diagnostic physical properties of minerals such as: Quartz, Orthoclase, Microcline, Hypersthene, Hornblende, Garnet, Muscovite, Biotite, Chlorite, Olivine, Epidote, Calcite.

MI-4: Introduction to Mineralogy (Practical)

Credits 01

Course Outline:

1. **Crystallography:** Study of symmetry elements of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems..
2. **Mineralogy:** Study of physical properties of minerals mentioned in theory course.

3. Study of functional morphological characters of different groups (Bivalvia, Gastropods, Brachiopoda, Echinodermata, Ammonoidea, Gondwana flora, vertebrates)
4. Identification of feeding habits from vertebrate (horse, elephants, Sus) teeth
5. Hard part morphology and identification of common Brachiopoda, Anthozoa, Trilobita, Echinoidea, Gastropoda. Identification of Gondwana flora

Reference Books:

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Benton, M. J., Harper, D. A. T. (2010). Introduction to Paleobiology and the Fossil Record , Wiley-Blackwell.
5. Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher

SKILL ENHANCEMENT COURSE (SEC)

SEC 3: Field Work II-Geological Mapping and Structural Geology

Credits 03

SEC3P: Field Work II-Geological Mapping and Structural Geology

Full Marks: 50

Course Outline:

Field Geology: Stratigraphy and structure related field

1. Preparation of a Geological map of a small area with folded/faulted beds.
2. Interrelation between different structural elements and their interpretations

OR

Field Geology: Stratigraphy Sedimentology - related field

1. Field training in a sedimentary basin. Documentation of stratigraphic details in the field.
2. Collection of sedimentological, and stratigraphical and paleontological details and their representation.

INTERNSHIP/APPRENTICESHIP (INT)

Credit-04 Marks: 50

(120 hours, 8 weeks)

Guideline for Internship/Apprenticeship

Compulsory training to each student for at least 120 hours duration in a reputed industry/ corporate house/laboratory of academic/ research institute and report preparation and PPT presentation.

Colleges will assign coordinators who will be supervising the students. Students will have to complete the total 120 hours within the entire second year of their course.

A certificate from the visiting institution will be attached in the report.