



SOMAIYA
VIDYAVIHAR

K J Somaiya College of Science And Commerce



K.J. SOMAIYA COLLEGE OF SCIENCE AND COMMERCE

AUTONOMOUS – Affiliated to University of Mumbai

Re-accredited “A’ Grade by NAAC

Vidyanagar, Vidyavihar, Mumbai 400077

Syllabus for M.Sc. Part 1

Program: M.Sc.

Course: Geology (Major and Minor)

Learning Outcomes based

Curriculum Framework (LOCF)

From the academic year 2023–2024

As Per NEP 2020

Structure of Syllabus - Semester VII (Theory)

Course Number	Course Title	Course Code	Credits	Hours	Periods (60 mins)/week	No. of Unit / Module	Lectures per Module
CC-1	Advanced Mineralogy and Crystal Optics	23PS1GECC1AMO	2	30	2	2	15
CC-2	Structural Geology and Tectonics	23PS1GECC2SGT	2	30	2	2	15
CC-3	Tectonic Geomorphology	23PS1GECC2TGM	2	30	2	2	15
CC-4	Igneous Petrology	23PS1GECC3IGP	2	30	2	2	15
DSE-1	Rock Mechanics and Rock Engineering	23PS1GEDSE1RME	2	30	2	2	15
DSE-2	Analytical Geochemistry	23PS1GEDSE2AGC	2	30	2	2	15
DSE-3	Volcanology	23PS1GEDSE3VCG	2	30	2	2	15



Structure of Syllabus - Semester VII (Practical)

Course Number	Course Title	Course Code	Credits	Hours	Periods (60 mins)/week
CP-1	Advanced Mineralogy and Crystal Optics Practical	23PS1GECC1P	1.5	45	3
CP-2	Structural Geology and Tectonics Practical	23PS1GECC2P	1.5	45	3
CP-3	Tectonic Geomorphology Practical	23PS1GECC3P	1.5	45	3
CP-4	Igneous Petrology Practical	23PS1GECC4P	1.5	45	3
DSEP-1	Rock Mechanics and Rock Engineering Practical	23PS1GEDSE1P	2	60	4
DSEP-2	Analytical Geochemistry Practical	23PS1GEDSE2P	2	60	4
DSEP-3	Volcanology Practical	23PS1GEDSE3P	2	60	4



Structure of Syllabus - Semester VIII (Theory)

Course Number	Course Title	Course Code	Credits	Hours	Periods (60 mins)/week	No. of Unit / Module	Lectures per Module
CC-1	Sedimentary Geology	23PS2GECC1SMG	2	30	2	2	15
CC-2	Metamorphic Petrology	23PS2GECC2MMP	2	30	2	2	15
CC-3	Mineral Exploration and Mineral Economics	23PS2GECC3MEE	2	30	2	2	15
CC-4	Paleontology	23PS2GECC4PAL	2	30	2	2	15
DSE-1	Applications of Paleontology	23PS2GEDSE1APL	2	30	2	2	15
DSE-2	Coal and Petroleum Geology	23PS2GEDSE2CPG	2	30	2	2	15
DSE-3	Stratigraphy of India	23PS2GEDSE3STI	2	30	2	2	15



Structure of Syllabus - Semester VIII (Practical)

Course Number	Course Title	Course Code	Credits	Hours	Periods (60 mins)
CP-1	Sedimentary Geology	23PS2GECC1P	1.5	45	3
CP-2	Metamorphic Petrology	23PS2GECC2P	1.5	45	3
CP-3	Mineral Exploration and Mineral Economics	23PS2GECC3P	1.5	45	3
CP-4	Paleontology	23PS2GECC4P	1.5	45	3
DSEP-1	Applications of Paleontology	23PS2GEDSE1P	2	60	4
DSEP-2	Coal and Petroleum Geology	23PS2GEDSE2P	2	60	4
DSEP-3	Stratigraphy of India	23PS2GEDSE3P	2	60	4

Semester I - Theory

Course Number	Course Code	Course Name	Number of Lectures
CC-1	23PS1GECC1AMO	Advanced Mineralogy and Crystal Optics	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Explain the various aspects of crystal chemistry
2. Understand the properties of light and its interaction with minerals
3. Understand the concept of Geothermobarometry and its applications
4. Understand the Composition of the Earth
5. Classify elements as per Goldschmidt's Classification

Module 1 - Elements of Mineral Chemistry and Crystal Optics	
Learning Objective	<ol style="list-style-type: none"> 1. Introduce a fundamental understanding of mineral composition and its occurrence in different rocks. 2. Understand microscopic techniques applicable to mineralogical and petrographic studies.
Learning Outcome	<ol style="list-style-type: none"> 1. Understand various aspects of crystal chemistry 2. Understanding the fundamental properties of light that are related to optical properties in minerals
1.1	Chemical elements, electronic configuration, Periodic Table Coordination of ions : Paulings Rule, Isostructuralism Polymorphism.
1.2	Optics of Isotropic minerals and optics of Anisotropic minerals Uniaxial and Biaxial crystals: optical Indicatrix, Interference figures, Optic sign determination

Module 2 - Geothermobarometry and Composition of the Earth	
Learning Objective	1. Introduce the Laws of Thermodynamics and their applications in understanding mineral assemblages. 2. Understand the composition of the earth and its evidence. 3. Understand Goldschmidt's Classification
Learning Outcome	1. Learn to use mineral assemblages to predict Temperature and pressure of formation using Geothermobarometry 2. Understand the Composition of the earth at various depths with evidences 3. Classify elements into various groups based on Goldschmidt's Classification
2.1	Introduction to Thermodynamics Phase diagrams: One component diagrams and Two Component diagrams
2.2	Chemical composition of the earth and its constituent reservoirs. Meteorite evidence, Atomic structure, Isomorphism, Polymorphism and Solid-Solution. Goldschmidt's classification of elements.

Recommended books for References

1. Nesse, W. D. (2012). Introduction to Mineralogy. United Kingdom: Oxford University Press.
2. Nesse, W. D. (2013). Introduction to Optical Mineralogy. United Kingdom: Oxford University Press.
3. Klein, C., Dutrow, B. (2008). The 23rd edition of the manual of mineral science: (after James D. Dana). India: Wiley.
4. Perkins, D. (2013). Mineralogy: Pearson New International Edition. United Kingdom: Pearson Education.
5. Dana, E. S. (2017). A Text-Book of Mineralogy: With an Extended Treatise on Crystallography and Physical Mineralogy (Classic Reprint). United States: FB&C Limited.
6. Gribble, C. (2012). Rutley's Elements of Mineralogy. Netherlands: Springer Netherlands.



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K J Somaiya College of Science And Commerce



M.Sc. Part 1 Syllabus

Department: Geology

7. Phillips, F. C. (1971). Introduction to Crystallography. United Kingdom: John Wiley & Sons Canada, Limited.
8. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill



Question Paper Template

M. Sc. (Geology) SEMESTER VII

Core Course- I

COURSE TITLE: Advanced Mineralogy and Crystal Optics

COURSE CODE: 23PS1GECC1AMO [CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
CC-2	23PS1GECC2SGT	Structural Geology and Tectonics	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Determine strain in rocks using the Mohr diagram.
2. Understand the behaviour of rocks under various stress conditions.
3. Familiarise the deformation mechanism of rocks at various scales.
4. Understand the Mechanics of rock fracturing
5. Interpret Geological structures such as folds, faults, Joints, shear zones and Lineations

Module 1 - Introduction to rock mechanics and rheology	
Learning Objective	<ol style="list-style-type: none"> 1. Familiarise the concept of Stress, strain and Mohr Diagram 2. Learn the behaviour of rocks under several stress conditions 3. Familiarise deformation mechanism and rock fracturing mechanisms
Learning Outcome	<ol style="list-style-type: none"> 1. Determine the strain in rocks using Mohr Diagram 2. Interpret stress and strain diagrams 3. Understand different rock fracturing criterion
1.1	Concept of Stress and Strain: 2D stress and strain analysis; different types of strain ellipses and their geological significance; Mohr diagrams and their use; concept of stress-strain compatibility; Behaviour of rocks under stress: elastic, plastic, viscous and visco-elastic responses and their geological significance.
1.2	Deformation mechanism in grain scale: dislocation and diffusion creep, strain hardening and softening mechanism, lattice preferred orientation. Mechanics of rock fracturing: fracture initiation and propagation; Coluomb's criterion and Griffith's theory.

Module 2 - Analysis of geological structures	
Learning Objective	1. Understand the diverse geological regimes creating several geological structures. 2. Understand the importance of continental crustal evolution
Learning Outcome	1. Determine the deformation regime of strained rocks 2. Analyse shear zone structures to understand continental evolution
2.1	Ductile regime: A. Fold - Morphological classification of folding. Mechanical aspects of folding: buckling, bending, flexural slip and flow folding. Mechanics of single-layer and multi-layer folds. Fold interference and superposed folds.
2.2	B. Foliation and Lineation - Different types of planar and linear structures in a deformed rock, Kinematic significance of foliation and lineation. Importance of cleavage-bedding intersection in a folded terrain.
2.3	Brittle regime: Faulting - Mechanics of faulting: Anderson's theory and limitations. Geometry of strike-slip, thrust and normal faults with natural example; Fault reactivation and its significance.
2.4	Joints - Importance of tectonic, Columnar and release joints, Joints with relation to fold and faults.
2.5	Shear zones - Geometry and kinematics: Analysis of strain in shear zone, kinematic significance of different shear zone structures, shear sense indicators, Large scale shear zones and their importance in continental crustal evolution



Recommended books for References

1. Bayly, B. (1991). *Mechanics in Structural Geology*. Germany: Springer New York.
2. Reynolds, S. J., Davis, G. H. (1996). *Structural geology of rocks and regions*. United Kingdom: Wiley.
3. Ghosh, S. K. (1993). *Structural Geology: Fundamentals and Modern Developments*. South Korea: Elsevier Science & Technology Books.
4. Means, W. (2012). *Stress and Strain: Basic Concepts of Continuum Mechanics for Geologists*. United States: Springer New York.
5. Leyshon, P. R., Lisle, R. J. (2004). *Stereographic projection techniques for geologists and civil engineers*. Spain: Cambridge University Press.
6. Passchier, C., Trouw, R. (2013). *Microtectonics*. Germany: Springer Berlin Heidelberg.
7. Ramsay, J. G. (1967). *Folding and fracturing of rocks*. Mc Graw Hill Book Company, 568.
8. Bhattacharya, A. (2022). *Structural Geology*. Switzerland: Springer International Publishing.
9. Twiss, R. J., Moores, E. M. (2007). *Structural geology*. United Kingdom: W. H. Freeman.



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M.Sc. (Geology) SEMESTER VII

Core Course- II

COURSE TITLE: Structural Geology and Tectonics

COURSE CODE: 23PS1GECC2SGT [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
CC-3	23PS1GECC2TGM	Tectonic Geomorphology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Understand models of landscape development
2. Interpret geomorphic markers
3. Understand geomorphic expressions and earthquake cycle
4. Familiarise geomorphology at various timescales

Module 1 - Introducing Tectonic Geomorphology	
Learning Objective	<ol style="list-style-type: none"> 1. Familiarise Landscape evolution models 2. Interpret Geomorphic markers 3. Understand Earthquake cycle and geomorphic expressions
Learning Outcome	<ol style="list-style-type: none"> 1. Analyse Landscape and its evolution 2. Use Geomorphic markers for landscape interpretation 3. Interpret Folds and Faults using Geomorphic Expressions
1.1	Active Tectonics and models of Landscape development; Geomorphic Markers: Planar and Linear and commonly encountered problems with markers;
1.2	Establishing Time in Landscapes: Dating methods, Earthquake Cycle, Geomorphic Expression of Faults, folds.

Module 2 - Geomorphology in Timescales

Learning Objective	1. Understand deformation and Paleoseismology 2. understand Landscape response
Learning Outcome	1. Model Landscape evolution and its outcomes 2. Understand Paleoseismology
2.1	Near and Far field techniques in Short term deformation, Paleoseismology, Rates of uplift, erosion and denudation, Holocene deformation and landscape response
2.2	Deformation and Geology at intermediate time scales, Tectonic Geomorphology at late cenozoic timescales, Numerical modelling of landscape evolution.

Recommended books for References

1. Anderson, R. S., Burbank, D. W. (2011). Tectonic Geomorphology. Germany: Wiley.
2. Kale, V. S. (2023). Processes, Products and Cycles of Tectonic Geomorphology. United States: Elsevier Science.
3. Summerfield, M. A. (2014). Global Geomorphology. United Kingdom: Taylor & Francis.
4. Ollier, C. (1981). Tectonics and landforms. Hong Kong: Longman.
5. Sugden, D. E., Schumm, S. A., Chorley, R. J. (2019). Geomorphology. United Kingdom: Taylor & Francis.
6. Selby, M. J. (1985). Earth's changing surface: an introduction to geomorphology. United Kingdom: Clarendon Press.



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M.Sc. (Geology) SEMESTER VII

Core Course- III

COURSE TITLE: Tectonic Geomorphology

COURSE CODE: 23PS1GECC2TGM [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
CC-4	23PS1GECC3IGP	Igneous Petrology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Classify rocks as per IUGS system
2. Understand the evolution of magmas and its relationship with textures
3. Understand Phase diagrams
4. Interpret Major and Trace element geochemical analysis and variation diagrams
5. Understand Ultramafic, Mafic and felsic Igneous Rocks
6. Familiarise with Large Igneous Provinces in India

Module 1 - Classification and Evolution of Magmas

Learning Objective	<ol style="list-style-type: none"> 1. Classify Igneous Rocks as per IUGS 2. Learn the Properties of Magma and magmatic rocks
Learning Outcome	<ol style="list-style-type: none"> 1. Classify rocks based on modal composition 2. Understand the properties of Magma 3. Understand magmatic evolution 4. Interpret Binary and Ternary phase diagrams
1.1	Classification of igneous rocks. IUGS classification. Textures and structures of igneous rocks. Origin and evolution of magmas. Viscosity, temperature and pressure relationships in magmas, nucleation and growth of minerals in magmatic rocks, development of igneous textures; magmatic evolution (differentiation, assimilation, mixing and mingling); Binary and Ternary Systems;

Module 2 - Types of Igneous Rocks and Petrogenesis	
Learning Objective	1. Understand variation diagrams 2. Learn the different types of Ultramafic, Mafic, Felsic rocks 3. Learn the Large Igneous Provinces of India
Learning Outcome	1. Interpret Variation diagrams and trace element data 2. Understand the various types of Rocks with various compositions 3. Understand Hotspots and Large Igneous Provinces of India
2.1	Representation of chemical analysis of igneous rocks. Major and Trace element systematics in igneous rocks. Silica/alumina saturation, variation diagrams, their applications and limitations.
2.2	Ultramafic and layered rocks,,Kimberlites and their origin.Lamprophyres and their petrography and origin. nature and origin. Granites and their origin, I-, S-, A- type granites. Pegmatites, their nature, occurrence and petrogenesis.Alkaline rocks and their origin. Anorthosites and their petrogenesis.Carbonatites, Petrography and their petrogenesis. Mantle metasomatism, hotspot magmatism and large igneous provinces of India.

Recommended books for References

- 1.Cox, K.G., Bell, J.D., Pankhurst, R.J., 1993. The Interpretation of Igneous Rocks, Chapman and Hall, London
- 2.McBirney, A.R., 1993. Igneous Petrology, Jones & Bartlett Publishers, Boston
- 3.Philpotts, A.R., Ague, J.J., 2009. Principles of Igneous and Metamorphic Petrology, Cambridge University Press, New York
- 4.Best, M.G., 2003. Igneous and Metamorphic Petrology, Blackwell Publishing
- 5.Wilson, M., 2007. Igneous Petrogenesis – A Global Tectonic Approach, Springer, Dordrecht
- 6.Gill, R., 2010. Igneous Rocks and Processes: A Practical Guide, Wiley-Blackwell, Oxford
- 7.Winter, J.D., 2014. Principles of Igneous and Metamorphic Petrology, PHI Learning Private Limited



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M.Sc. (Geology) SEMESTER VII

Core Course- IV

COURSE TITLE: Igneous Petrology

COURSE CODE: 23PS1GECC3IGP [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
DSE-1	23PS1GEDSE1RME	Rock Mechanics and Rock Engineering	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Understand Stress and Strain
2. Familiarise with the theories of Rock failure
3. Determine the strength of rocks
4. Prepare ground improvement methods for various conditions

Module 1 - Concept of Stress, Strain and Failure of Rocks	
Learning Objective	1. Understand Stress-Strain relation and its implications to Rock failure
Learning Outcome	1. Analyse Stress and Strain. 2. Understand rock failure and behaviour of jointed rock mass
1.1	Analysis of stress, Analysis of strain, Constitutive relations, Parameters influencing strength / stress-strain behavior. Failure Criteria for Rock and Rock Mass
1.2	Classical theories of rock failure: Coulomb's criterion, Mohr's criterion, Griffith's theory, Empirical failure criteria. Behaviour of jointed rock mass.

Module 2 - Rock Mass Testing, Engineering Properties and Ground Improvement	
Learning Objective	1. Familiarise with various Rock Strength Testing methods 2. Learn the Engineering Properties of Rocks 3. Understand ground improvement techniques
Learning Outcome	1. Evaluate the Strength of rocks 2. Understand Engineering properties of rocks and its uses 3. Suggest ground improvement methods
2.1	Strength and Deformability of Rock Mass In situ shear tests; Evaluation of shear strength; In situ bearing strength test; In situ deformability tests- Plate Loading Test, Plate Jacking Test and Borehole Jack Tests
2.2	Engineering properties of intact rock – physico-mechanical, Overview of requirements, methods and analysis of engineering-geological investigation methods, Rock mass classification methods and their applications, Soil classification methods and their applications
2.3	Ground improvement; grouting, fore polling, pre-reinforcement, shotcreteing and others

Recommended books for References

1. Cook, N. G. W., Jaeger, J. C. (1979). Fundamentals of rock mechanics. Netherlands: Springer Netherlands.
2. Verma, A. K., Debasis, D. (2016). Fundamentals and Applications of Rock Mechanics. India: Prentice Hall India Pvt., Limited.
3. Harrison, J. P., Hudson, J. A. (2000). Engineering Rock Mechanics: An Introduction to the Principles. Netherlands: Elsevier Science.
4. Hencher, S. (2015). Practical Rock Mechanics. United Kingdom: CRC Press.
5. Goodman, R. E. (1989). Introduction to rock mechanics. United Kingdom: Wiley.
6. Aydan, Ö. (2020). Rock Mechanics and Rock Engineering. Netherlands: CRC Press.
7. Cosgrove, J. W., Hudson, J. A. (2016). Structural Geology And Rock Engineering. Singapore: World Scientific Publishing Company.



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M.Sc. (Geology) SEMESTER VII

Department Specific Elective - I

COURSE TITLE: Rock Mechanics and Rock Engineering

COURSE CODE: 23PS1GEDSE1RME [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
DSE-2	23PS1GEDSE2AGC	Analytical Geochemistry	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Understand the important chemical and geological parameters and instrumentation techniques used in geochemistry
2. Understand Chemical diversity in igneous rocks
3. Apply radiogenic isotope signatures to trace the source of minerals, rocks and, to date magmatic and metamorphic events.

Module 1 - Composition and classification of magmatic rocks

1.1	Analytical principles and procedures: XRF, ICP-MS, EPMA and SEM-EDS, sampling, analyses, geo-standards, accuracy and precision, mineral and glass compositions, major, minor and trace elements and relative abundances, oxidation states and volatile, FeO, Fe ₂ O ₃ and Total Fe, Mg #, mole conversions, mineral formulae calculations, chemical compositions and variation diagrams
1.2	Classification of magmatic rocks based on whole-rock composition, Chemical discriminant of rock types.



Module 2 - Application of isotope geochemistry in Igneous petrogenesis

2.1

Stable and radiogenic isotopes, mass fractionation, radiogenic decay, isotopes as petrogenetic indicators, K-Ar system, isochron technique, Rb-Sr, U-Pb-Th and Sm-Nd systems, model ages, interpretation of chronological data, isotope reservoirs. Introduction to isoplot software.

Recommended books for References

1. Wilson, M. (1989). Igneous Petrogenesis. London Unwin Hyman.
2. Ragland, P. C. (1989). Basic Analytical Petrology. United Kingdom: Oxford University Press.
3. Ague, J. J., Philpotts, A. R. (2022). Principles of Igneous and Metamorphic Petrology. Singapore: Cambridge University Press.
4. Winter, J. D. (2001). An Introduction to Igneous and Metamorphic Petrology. United Kingdom: Prentice Hall.
5. Best, M. G. (2013). Igneous and Metamorphic Petrology. Wiley Blackwell
6. White, W. M. (2015). Isotope Geochemistry. United Kingdom: Wiley.
7. Faure, G. and Mensing, T. M. (2009) Isotope principles and Applications.
8. Rollinson, H. R. (2014). Using Geochemical Data: Evaluation, Presentation, Interpretation. United Kingdom: Taylor & Francis.



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M.Sc. (Geology) SEMESTER VII

Department Specific Elective - II

COURSE TITLE: Analytical Geochemistry

COURSE CODE: 23PS1GEDSE2AGC [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
DSE-3	23PS1GEDSE3VCG	Volcanology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Volcanism and Deposits

1.1	Introduction/ Historical Background, Magmas and Melting, Global Volcanism: Mid-ocean ridges, oceanic islands, : Continental Volcanoes and Island Arcs, Volcanic Edifices and Deposits, Explosive Eruptions, Pyroclastic Falls and Flow Deposits, Surges; Lahars, Magma & Water
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Module 2 - Hazards and Case Studies

2.1	Volcanic Hazards, Volcanic Hazard Assessment & Management/OPEN, Benefits of Volcanoes, Case Histories: : Iceland, Japan, Mid-ocean ridges, Mt. St. Helens, Hawaii, ,Extraterrestrial Volcanism
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Recommended books for References

1. Schmincke, H. (2012). *Volcanism*. Germany: Springer Berlin Heidelberg.
2. Wilson, L., Parfitt, L. (2009). *Fundamentals of Physical Volcanology*. Germany: Wiley.
3. Wright, J. V., Giordano, G., Cas, R. (2023). *Volcanology: Processes, Deposits, Geology and Resources*. Switzerland: Springer International Publishing.
4. Acocella, V. (2021). *Volcano-Tectonic Processes*. Germany: Springer International Publishing.
5. Jerram, D. (2011). *Introducing Volcanology: A Guide to Hot Rocks*. United Kingdom: Dunedin Academic Press.
6. de la Cruz-Reyna, S., Lockwood, J. P., Hazlett, R. W. (2022). *Volcanoes: Global Perspectives*. United Kingdom: Wiley.

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M.Sc. (Geology) SEMESTER VII

Department Specific Elective- III

COURSE TITLE: Volcanology

COURSE CODE: 23PS1GEDSE3VCG [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100



Semester VII - Practical

Course Number	Course Code	Course Name
CP-1	23PS1GECC1P	Advanced Mineralogy and Crystal Optics Practicals

1	Microscopic identification of Rock forming minerals
2	Hand Specimen Identification of Rock forming minerals
3	Mineral Formula Calculation
4	XRD Calculations



Course Number	Course Code	Course Name
CP-2	23PS1GECC2P	Structural Geology and Tectonics Practical

1	Analyses and interpretation of geological maps
2	Stereographic analysis of structural data; Use of specialized softwares, e.g. GEOrient
3	Stereographic techniques: Significance of contour diagrams: orientation analyses of foliation and lineation data for regional structural geometry.
4	Structural problems related to borehole data.
5	Subsurface structures using Borehole data



Course Number	Course Code	Course Name
CP-3	23PS1GECC3P	Tectonic Geomorphology Practical

1	Hillslope Sediment Transport
2	Basin Morphometry
3	Hypsometric Analysis
4	Assessment of Active Tectonics
5	Fault plain Geometry
6	Slope-Area Analysis and River Terraces
7	Paleoseismology and Field Neotectonics Method
8	Control of tectonics
9	Rate of Subsidence



Course Number	Course Code	Course Name
CP-4	23PS1GECC4P	Igneous Petrology Practical

1	Handspecimen Identification of Igneous Rocks
2	Microscopic Identification of Igneous Rocks
3	Igneous Rock Classification based on TAS, IUGS, CIPW norm



Course Number	Course Code	Course Name
DSEP-1	23PS1GEDSE1P	Rock Mechanics and Rock Engineering

1	Determination of modulus of elasticity, Poisson's ratio and compressive strength of rock
2	Determination of tensile strength of rock and tri-axial strength of rock
3	Determination of shear strength of rock
4	Determination of Atterberg's limits of soil
5	Slope Stability analysis
6	RMR and RQD



Course Number	Course Code	Course Name
DSEP-2	23PS1GEDSE2P	Analytical Geochemistry Practical

1	Whole rock analysis of igneous rocks using XRF
2	Norm calculations and application of GEOSOFTWARE.
3	MELT programme
4	Ar40-Ar39 age calculations using the ArArCALC software.
5	Model age calculations
6	Use of Isoplot software with special emphasis on U-Pb concordia, Sm-Nd and Lu-Hf technique
7	Mineral formulae calculations



Course Number	Course Code	Course Name
DSEP-3	23PS1GEDSE3P	Volcanology Practical

1	Handspecimen Identification of Volcanic Rocks
2	Microscopic Identification of Volcanic Rocks
3	Identification of Volcanic rock textures.

Semester VIII - Theory

Course Number	Course Code	Course Name	Number of Lectures
CC-1	23PS2GECC1SMG	Sedimentary Geology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Sedimentary petrology	
1.1	Genesis and classification of major sedimentary rocks: conglomerate, shale, sandstone carbonate and siliceous rocks;
1.2	Diagenesis of sandstones, carbonates and evaporites. Important Sedimentary structures.

Module 2 - Sedimentary Environments and Facies	
2.1	Facies Modelling; Marine Environments: Continental Shelf, Continental Slope, Continental Rise; Non Marine Environments: Glacial, Aeolian, Lacustrine, Fluvial Mixed Environments: Barrier Island, Tidal Flats; Deltaic Environment
2.2	Sedimentary Basins, Geosynclinal Concept, Plate Tectonics Concept, Plate movement and Basin Formation.



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M.Sc. Part 1 Syllabus

Department: Geology

Recommended books for References

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
5. Lewis, D.W. and McConchie, D., (1984) Practical sedimentology Wiley Blackwell



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M.Sc. (Geology) SEMESTER VIII

Core Course- I

COURSE TITLE: Sedimentary Geology

COURSE CODE: 23PS2GECC1SMG [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
CC-2	23PS2GECC2MMP	Metamorphic Petrology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Types and factors of metamorphism

1.1	Definition and limits of metamorphism, significance of metamorphic studies, factors controlling metamorphism, metamorphic texture, tectonic context of metamorphic transformation.
1.2	Rocks as a chemical system, intensive and extensive variable, Gibbs phase rule, Phase diagrams including pseudo component diagram (ACF, AFM etc), continuous and discontinuous reaction, Clayperon equation.

Module 2 - Metamorphic Zones, isograds and facies

2.1	Metamorphic zones and isograds, progressive metamorphism of any two bulk chemical compositions (pelitic, quartzfeldspathic, mafic and calcareous),
2.2	Metamorphic facies, Schreinemakers rules, Mineral formula calculation, geothermobarometry, migmatites, Metamorphic field gradient and P-T-t paths



Recommended books for References

1. Bucher, K. and Grapes, R (2010). Petrogenesis of Metamorphic Rocks, Springer.
2. Best, M.G. (2003). Igneous and Metamorphic Petrology, Blackwell Science.
3. Vernon, R. H. and Clarke, G.L. (2008). Principles of Metamorphic Petrology, Cambridge University Press.
4. Winter, J.D. (2001). An Introduction to Igneous and Metamorphic Petrology, Prentice Hall.
5. Yardley, B.W.D (1997). An Introduction to Metamorphic Petrology, Longman Earth Science Series.
6. Spear, F.S. (1995). Metamorphic Phase Equilibria and Pressure-Temperature-Time paths, Mineralogical Society of America Monograph.

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M.Sc. (Geology) SEMESTER VIII

Core Course- II

COURSE TITLE: Metamorphic Petrology

COURSE CODE: 23PS2GECC2MMP [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100



Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
CC-3	23PS2GECC3MEE	Mineral Exploration and Mineral Economics	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Mineral Exploration	
1.1	Principles and concepts of mineral exploration, methods of Prospecting and Exploration. Different Stages of mineral Exploration. Sampling and Subsurface exploration. Reserve Estimation: Cut-off grade concepts and applications, Reserve Estimation– principles, practices and different conventional methods
1.2	Principles of Geochemical Exploration, Primary and secondary dispersions of elements; Determination of background, and geochemical anomalies; Pathfinder and target elements for geochemical exploration. Methods of geochemical explorations, Procedures for geochemical sampling; Interpretation of geochemical surveys.

Module 2 - Mineral Economics	
2.1	Classification of mineral resources with special reference to UNFC and JORC schemes. IBM Guidelines, Mineral markets, Import-Export policies and International Trade. Demand analysis of minerals, Royalty and Taxes. India's status in mineral production. International and national mineral policies. Mines and Mineral policies. Mines and Minerals (Development and Regulation) act. Marine and mineral resources and International Land Sea Convention
2.2	Economic evaluation of mineral deposit. Methods of mineral conservation and substitution

Recommended books for References

1. Reedman, J. (2011). Techniques in Mineral Exploration. Netherlands: Springer Netherlands.
2. Peters, W. C. (1978). Exploration and Mining Geology. United Kingdom: Wiley.
3. Haldar, S. K. (2018). Mineral Exploration: Principles and Applications. Netherlands: Elsevier Science.
4. Moon, C., G. Whateley, M. K., & Evans, A. M. (Eds.). (2009). Introduction to Mineral Exploration. Wiley-Blackwell.
5. Gandhi, S. M., Sarkar, B. C. (2016). Essentials of Mineral Exploration and Evaluation. Netherlands: Elsevier Science.
6. Sinha, R. K. (2019). Mineral Economics. India: CBS Publishers & Distributors.
7. Chatterjee, K. K. (2010). Lectures and Thoughts on Mineral Economics. United States: Nova Science Publishers.
8. Jawadand, S., Randive, K. (2020). Mineral Economics: An Indian Perspective. United States: Nova Science Publishers, Incorporated.
9. Sarkar, S. C., Deb, M. (2017). Minerals and Allied Natural Resources and Their Sustainable Development: Principles, Perspectives with Emphasis on the Indian Scenario. Singapore: Springer Nature Singapore.



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M.Sc. (Geology) SEMESTER VIII

Core Course- III

COURSE TITLE: Mineral Exploration and Mineral Economics

COURSE CODE: 23PS2GECC3MEE [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
CC-4	23PS2GECC4PAL	Paleontology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Invertebrate Paleontology

1.1	Study of important invertebrate groups (Bivalvia, cephalopods, Brachiopoda, Graptolites, Trilobites) and their biostratigraphic significance
1.2	Significance of ammonites in Mesozoic biostratigraphy and their palaeobiogeographic implications Functional adaptation in trilobites and ammonoids.

Module 2 - Paleobotany

2.1	Introduction to Palaeobotany; Definition, conditions and different modes of preservation of plant fossils, fossil record of plants through time;
2.2	Record of plant fossils in India with reference to Gondwana Flora and Deccan Inter-trappean flora



Recommended books for References

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. (2014). Vertebrate Palaeontology, fourth edition
4. Shukla, A. C., & Misra, S.P. (1982). Essentials of Palaeobotany.
5. Stewart, W.N. & Rothwell, G.W. (2018). Palaeobotany and the Evolution of Plants
6. Armstrong, H.A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing
7. Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
8. Briggs, D.E.G. & Crowther, P.R. (2003). Palaeobiology II.
9. Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition.

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M.Sc. (Geology) SEMESTER VIII

Core Course- IV

COURSE TITLE: Paleontology

COURSE CODE: 23PS2GECC4PAL [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
DSE-1	23PS2GEDSE1APL	Applications of Paleontology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Applications of Paleontology

1.1	Application of fossils in Stratigraphy; Biozones, index fossils, correlation; Role of fossils in sequence stratigraphy; Fossils and palaeoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers
1.2	Paleoecology – fossils as a window to the evolution of ecosystems. Introduction to Ichnology; utility of ichnofossils in interpreting sedimentary environments.

Module 2 - Applications of micropaleontology

2.1	Introduction to micropaleontology Record of microfossils from Phanerozoic rocks of India Collection, preparation and preservation of microfossils .
2.2	Introduction to micropaleontology with reference to ostracods, foraminifera, Radiolaria, and conodonts , environmental significance of Pollens and Spores



Recommended books for References

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. (2014). Vertebrate Palaeontology, fourth edition
4. Shukla, A. C., & Misra, S.P. (1982). Essentials of Palaeobotany.
5. Stewart, W.N. & Rothwell, G.W. (2018). Palaeobotany and the Evolution of Plants
6. Armstrong, H.A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing
7. Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
8. Briggs, D.E.G. & Crowther, P.R. (2003). Palaeobiology II.
9. Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition.



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M.Sc. (Geology) SEMESTER VIII

Department Specific Elective - I

COURSE TITLE: Applications of Paleontology

COURSE CODE: 23PS2GEDSE1APL [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
DSE-2	23PS2GEDSE2CPG	Coal and Petroleum Geology	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Identify the basic processes involved within the Earth
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Coal Geology

1.1	Origin, mode of Occurrence of Coal, Prospecting for Coal Physical and Chemical constituents of Coal, Utilization of Coal Classification and Structural Features of Coal Seams.
1.2	Sampling of coal in Mines and in the Laboratory; Methods of Coal mining Study of Indian Coals with reference to Geology, grade of coal, economic reserves and future prospects.

Module 2 - Petroleum Geology

2.1	Physical and Chemical properties of Petroleum, Petroleum Traps and Reservoirs Migration accumulation and Geophysical Prospecting of Petroleum.
2.2	Study of potential sedimentary basins and oil fields of India, India's position as regards to Petroleum and Natural Gas and future prospects



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M.Sc. Part 1 Syllabus

Department: Geology

Recommended books for References

1. Diessel, C. F. (2012). Coal-Bearing Depositional Systems. Germany: Springer Berlin Heidelberg.
2. Thomas, L. (2020). Coal Geology. United Kingdom: Wiley.
3. Rogers, R. E. (1994). Coalbed methane : principles and practice. United States: PTR Prentice Hall.
4. Thomas, L. (1992). Handbook of practical coal geology. United Kingdom: Wiley.
5. Sonnenberg, S. A., Selley, R. C. (2022). Elements of Petroleum Geology. Netherlands: Elsevier Science.
6. Tissot, B., Welte, D. (2013). Petroleum Formation and Occurrence. Germany: Springer Berlin Heidelberg.
7. Chapman, R. (2000). Petroleum Geology. Netherlands: Elsevier Science.

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M.Sc. (Geology) SEMESTER VIII

Department Specific Elective - II

COURSE TITLE: Coal and Petroleum Geology

COURSE CODE: 23PS2GEDSE2CPG [CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Department: Geology

Course Number	Course Code	Course Name	Number of Lectures
DSE-3	23PS2GEDSE3STI	Stratigraphy of India	15 L / Module

Course Learning Outcome:

After the successful completion of the Course, the learner will be able to:

1. Describe evolution of co
2. List various methods for calculation of the age of the Earth
3. Understand the basics of plate tectonics and mantle convection
4. Comprehend interactivity between the hydrosphere, atmosphere, biosphere and lithosphere
5. Understand Ocean and atmospheric circulation
6. Explain the process of soil formation and soil types

Module 1 - Precambrian Craton

1.1	Geological evolution of Archean craton Dharwar, Bastar, Singhbhum, Aravalli and Bundelkhand
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Module 2 - Basins of India

2.1	Spatio-temporal distribution of proterozoic basins in India.
2.2	Geology of Kashmir, Spiti, Gondwana, Kutch, Narmada and Trichinopoly basins.



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M.Sc. Part 1 Syllabus

Department: Geology

Recommended books for References

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010). The making of India, Macmillan India Pvt. Ltd.
5. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
6. <https://www.dghindia.gov.in/index.php/page?pagelid=67&name=Indian%20Geology>

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M.Sc. (Geology) SEMESTER VIII

Department Specific Elective - III

COURSE TITLE: Stratigraphy of India

COURSE CODE: 23PS2GEDSE3STI [CREDITS - 02]

Module	Remebering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	11	8	5	3	3		30
II	13	9	3	3	2		30
Total Marks per Objective	24	17	8	6	5		60
% Weightage	40	28	13	10	9		100

Semester VIII - Practical

Course Number	Course Code	Course Name
CP-1	23PS2GECC1P	Sedimentary Petrology Practical

1	Study of important sedimentary rocks in hand-specimens
2	Particle size distribution and statistical analysis
3	Palaeocurrent analysis
4	Petrography of selected clastic and non-clastic rocks through thin sections with emphasis on diagenetic features.
5	Study of important sedimentary structures.



Course Number	Course Code	Course Name
CP-2	23PS2GECC2P	Metamorphic Petrology Practical

1	Identification of metamorphic rocks and textures under microscope in different rock compositions of different metamorphic grade
2	Special metamorphic textures: Foliation (I phyllite schist, gneiss), mineral layering, Pressure Shadow, Pre, Syn, Post Kinematic porphyroblast, Granoblastis texture, Crenulation Cleavage, Sympletitic texture, Corona texture
3	Schrienemakers Method, ternary Diagram-ACF, AKF, A(K)FM



Course Number	Course Code	Course Name
CP-3	23PS2GECC3P	Mineral Exploration and Mineral Economics Practical

1	Reserve Estimation using Thiessen polygon
2	Reserve Estimation using Cross Section for Bedded Deposit
3	Reserve Estimation using Longitudinal - Vertical Section for Inclined Deposits
4	Cut-off Grade Decisions Based on Current Market Prices
5	Geochemical Anomaly Mapping
6	Making Mineral Reserve isopach maps



Course Number	Course Code	Course Name
CP-4	23PS2GECC4P	Paleontology Practical

1	Study of fossils showing various modes of preservation.,
2	Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate fossils.- Bivalves, Cephalopods, Trilobites, Graptolites, Brachiopods,
3	Study of Gondwana plant fossils
4	Problems on fossil group and fossil assemblage, range chart problems
5	location of important fossils and formations on the map of India.



Course Number	Course Code	Course Name
DSEP-1	23PS2GEDSE1P	Applications of Paleontology Practical

1	Problems on biozone
2	Problem on corelation of strata and index fossils
3	Fossils and paleoenvironmental analysis
4	Identification of plant fossils and role in paleogeography
5	Micropaleontology

Course Number	Course Code	Course Name
DSEP-2	23PS2GEDSE2P	Coal and Petroleum Geology Practical

1	Physical Properties of Coal
2	Classification of Coal Lithotypes in Hand specimen
3	Seam Formation Curve
4	Coal Reserve Estimation
5	Structural Problems in Coal Basins
6	Proximate Analysis of Coal
7	Source Rock Potential using Rock eval Pyrolysis
8	Well Log Analysis
9	Seismic Data Analysis
10	drawing oil/water contact from borehole data.
11	Preparation of structure contour and isopach maps of reservoir facies
12	Hydrocarbon Reserve Estimation



Course Number	Course Code	Course Name
DSEP-3	23PS2GEDSE3P	Stratigraphy Practical

1	Study of geological map of India and identification of major stratigraphic units
2	Study of rocks in hand specimens from known Indian stratigraphic horizons
3	Study of common fossil characteristics of a particular stratigraphic horizon.
4	Interpretation of various stratigraphic logs and their correlation
5	International Stratigraphic Nomenclature code