

SHIVAJI UNIVERSITY, KOLHAPUR.



***** B+
Accredited By NAAC

Syllabus For Master of Science in Geology

(Subject to the modifications to be made from time to time)

Syllabus to be implemented from June -2011 onwards.

Syllabus For Master of Science in Geology

A)BASIC INFORMATION

ORDINANCE AND REGULATIONS:-as applicable to Post-Graduate Degree / Program

1. TITLE : Subject Geology
Optional under the Faculty of Science

2. YEAR OF IMPLEMENTATION: Revised Syllabus will be implemented from June 2011 onwards.

3. PREAMBLE:-

The revised syllabus includes the foundation, core and applied components of the course/paper. The student should get into the prime objectives and expected level of study with required outcome in terms of basic and advance knowledge at examination level.

4. GENERAL OBJECTIVES OF THE COURSE/ PAPER/:

The course is structured with a view to impart basic as well as advance knowledge of the subject to the students in the light of the present day scenario in earth science.

5. DURATION

- The course shall be a full time course.
- The duration of course shall be of Two years / 4 Semesters.

6. PATTERN:-

Pattern of Examination will be Semester.

7. FEE STRUCTURE: - (As applicable to self supporting course)

- i) **Entrance Examination Fee:** As per Shivaji University norms (Not refundable)
- ii) **Course Fee-** Fees will be applicable as per University rules/norms.

8. IMPLEMENTATION OF FEE STRUCTURE:-

In case of revision of fee structure, this revision will be implemented in phase wise manner.

9. ELIGIBILITY FOR ADMISSION:-

As per eligibility criteria prescribed for each course and the merit list in the qualifying examination.

10. INTAKE CAPACITY / NUMBER OF STUDENTS:- 14

11. MEDIUM OF INSTRUCTION:

The medium of instruction shall be English.

12. STRUCTURE OF COURSE**FIRST YEAR: Semester I and II****Semester I**

Sr. No.	Paper No.	Subjects	Marks
1.	Paper I	Mineralogy, Optics, and Crystallography	100
2.	Paper II	Igneous Petrology	100
3.	Paper III	Metamorphic Petrology	100
4.	Paper IV	Sedimentary Petrology	100
5	Practical I	Related to Paper I and II	100
6	Practical II	Related to Paper III and IV	100
Semester I Total: 4 Papers and 2 Practicals			600

Semester II

Sr. No.	Paper No.	Subjects	Marks
1	Paper V	Structural Geology and Geotectonics	100
2	Paper VI	Stratigraphy and Palaeontology	100
3	Paper VII	Economic Geology	100
4	Paper VIII	Remote Sensing and Geomorphology	100
5	Practical III	Related to Paper V and VI	100
6	Practical IV	Related to Paper VII and VIII	100
Semester II Total: 4 Papers and 2 Practicals			600

Total Marks of First Year (Semester I = 600, Semester II = 600)	1200
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SECOND YEAR – Semester III and IV

Semester III

Sr. No.	Paper No.	Subjects	Marks
1.	Paper IX	Hydrogeology	100
2.	Paper X	Geophysics and Exploration Methods	100
3.	Paper XI	Geochemistry	100
4.	Paper XII	One of the following Optional Papers: (a) Gemology and Industrial Mineralogy (b) Mining Geology (c) Marine Geology (d) Geoinformatics	100
5.	Practical V	Related to Paper IX and X	100
6.	Practical VI	Related to Paper XI and XII	100
Semester III Total : 4 Papers and 2 Practicals			600

Semester IV

Sr. No.	Paper No.	Subjects	Marks
1	Paper XIII	Engineering Geology and Geotechniques	100
2	Paper XIV	Natural Resource Management	100
3	Paper XV	Environmental Geology	100
4	Paper XVI	Dissertation	100
5	Practical VII	Related to Paper XIII and XIV	100
6	Practical VIII	Related to Paper XV and XVI	100
Semester IV Total – 4 Papers and 2 Practicals			600

Total Marks of Second Year (Semester III = 600, Semester IV = 600)	1200
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13. SCHEME OF TEACHING

The Scheme of teaching common for all semesters:

Sr. No.	Lectures / Periods per week	Teaching periods per week
1	4 Theory papers \times 4 periods	16
2	2 Practicals \times 6 periods	12
	Total	28

4 Lectures of 60 minutes duration per Theory paper per week.

Total 40 Lecture periods of 60 minutes per Theory paper of 100 marks per Semester.

6 Clock hours per Practical per week.

Total 15 Practical turns amounting to total 90 clock hours per Practical per Semester.

14. SCHEME OF EXAMINATION

Theory and Practical examination shall be conducted at the end of each Semester.

Question Paper will be set in the view of the / in accordance with the entire syllabus of the semester and preferably covering each unit of syllabus.

Theory Examination

There will be 4 theory papers of 3 hours duration and 100 marks each.

Practical Examination

The Practical Examination of 200 marks will be conducted on 2 days. On each day there will be a practical examination 100 marks and six hours duration.

In each practical of 100 marks, 80 marks are assigned to the performance at the time of practical examination and 20 marks are assigned as follows:

- i) Journal – 5 marks
- ii) Viva – 5 marks
- iii) Fieldwork Report and Collection of specimens – 10 marks.

The evaluation of the performance of the students in theory and practical papers shall be made on the basis of four semester examinations of 600 marks each.

15. NATURE OF THEORY QUESTION PAPER AND SCHEME OF MARKING

Each theory paper will consist of 7 questions of 20 marks each, out of which 5 questions are to be solved (total amounting to maximum 100 marks) as detailed below:

Q. No. 1: Compulsory: This will be Objective Type involving Multiple Choice Questions / One line answers / Definitions / Reasoning etc.

Question Numbers 2, 3 and 4: Long Answer Type Descriptive questions:
Any two of the three given questions are to be solved

Question Numbers 5, 6 and 7: Short Answer Type Descriptive questions with Internal Options: Any two of the three given questions are to be solved.

16. STANDARD OF PASSING:-

As Prescribed under rules & regulation for each degree / programme.

17. EQUIVALENCE IN ACCORDANCE WITH TITLES AND CONTENTS OF PAPERS- (FOR REVISED SYLLABUS w. e. f. June 2011)

Semester I

Sr.No.	Paper / Practical No.	Title of Old Paper	Title of New Paper
1.	Paper I	Mineralogy, Optics, and Crystallography	Mineralogy, Optics, and Crystallography
2.	Paper II	Igneous Petrology	Igneous Petrology
3.	Paper III	Metamorphic Petrology	Metamorphic Petrology
4.	Paper IV	Sedimentary Petrology	Sedimentary Petrology
5.	Practical I	Related to Paper I and II	Related to Paper I and II
6.	Practical II	Related to Paper III and IV	Related to Paper III and IV

Semester II

Sr.No.	Paper / Practical No.	Title of Old Paper	Title of New Paper
1.	Paper V	Structural Geology and Geotectonics	Structural Geology and Geotectonics
2.	Paper VI	Stratigraphy and Palaeontology	Stratigraphy and Palaeontology
3.	Paper VII	Economic Geology	Economic Geology
4.	Paper VIII	Remote Sensing and Geomorphology	Remote Sensing and Geomorphology
5.	Practical III	Related to Paper V and VI	Related to Paper V and VI
6.	Practical IV	Related to Paper VII and VIII	Related to Paper VII and VIII

18. LIBRARY :

Paper wise List of Books is given in the detailed syllabus.

19. LABORATORY INSTRUMENTS AND FIELD EQUIPMENTS

1. Petrological Microscopes – One microscope per pair of students.
2. Ore Microscopes.
3. Thin sections of Rocks and Minerals relevant to syllabus.

4. Polished sections of Ore Minerals.
5. Crystal Models of 32 classes and twins.
6. Refractometer.
7. Palaeontological (Binocular) Microscope.
8. Slides of Micropalaeontology.
9. Aerial Photographs and Satellite Imageries.
10. Mirror Stereoscopes with Parallax Bar.
11. Toposheets.
12. Rock Cutting, Grinding and Polishing Machines for making Thin Sections of Rocks and Minerals, and Polished Sections of Ore Minerals.
13. Sieve Set and Sieve Shaker for Sediment Analysis.
14. Flame Photometer –1 No.
15. Spectrophotometer – 1 No.
16. Sets of Glassware for Chemical Analyses as per requirements
17. Set of Surveying Equipments.
18. Computers, printer and related geological software.
19. GPS and other Field Equipments.

I) GENERAL SAFETY RULES FOR SCIENCE-LABORATORY WORK

There is no substitute for safety

1. Any injury no matter how small, it must be reported to teacher immediately.
2. a) In case any chemical enters your eyes go immediately to eye- wash facility and flush your eyes and face with large amount of water.
b) For acid or phenol split, do not use water instead put some bicarbonate.
3. In case of fire, immediately switch off all gas connections in the laboratory and pour sand on the source of fire or cover it with asbestos or cement sheet.
4. While leaving laboratory, make sure that gas, water taps and electricity are switched off.
5. Remove your lab coat. Gloves and clean your hands before leaving laboratory.
6. Make your workplace clean before leaving the laboratory.
7. Keep your hands away from your face, while working in laboratory.
8. Know what to do in case of emergency - e.g.
(a) know the place of fire extinguisher and first aid box and the ways to use them.
(b) Remember important phone numbers
9. Don't use cell phones in the laboratory except in case of emergency.

II) DO's

1. Keep your belongings at the place allotted for the same.
2. Maintain separate record book for each subject.

3. Wear lab coat/apron, shoes in the laboratory especially while handling chemicals.
4. Handle the laboratory equipments, glassware and chemical with great care.
5. Work at the place allotted to you or specially used for certain operations.
6. Maintain silence, order, cleanliness and discipline in the laboratory.
7. Keep the working table clean.
8. Use only required quantities of material and apparatus of essential size.
9. Perform the test in their proper order.
10. Know the location of eye wash fountain and water shower.
11. Minimize your exposure to organic solvents.
12. The Metal like sodium should be kept under kerosene or liquid paraffin layer in a vessel with a cork stopper.
13. Sodium metal should be cut on dry filter paper. The cut off pieces of sodium should be immediately collected in a vessel containing kerosene or liquid paraffin.
14. Always pour acid into water when diluting and stir slightly.
15. All operations involving poisonous flammable gases and vapors should be carried out in the flame chamber (with exhaust facility)
16. Ladies should wear clothes appropriate to laboratory work, apron is essential.

III) DON'Ts

1. Don't enter the laboratory without permission of the authority or attendant.
2. Don't work alone in the laboratory.
3. Don't leave the glasswares unwashed.
4. Don't take apparatus, chemicals out of lab.
5. Don't leave any substance in a vessel or bottle without label.
6. Don't weigh the reagent directly on the balance pan.
7. Don't throw the cut off pieces of sodium metal in sink or water. Transfer it immediately in its container.
8. Don't take sodium metal with hands. Use forceps.
9. Don't panic and run in case of fire, use the fire extinguishers or sand buckets.
10. Don't breathe the vapours of organic solvents.
11. Don't pour any unused reagent back in its stock bottle.
12. Don't eat or drink any food in laboratory.
13. Don't distill to dryness.
14. Don't exchange stoppers of flasks and bottles containing different reagents.

15. Don't leave reagent bottle lying on the table.
16. Don't disturb the order of reagent bottles in which they are placed.
17. Don't bring reagent on your working table from the general shelf.
18. Don't throw burning matchstick into dustbin.
19. Don't leave the laboratory without permission of the authority or attendant.

IV) LAB SAFETY PRECAUTIONS / MEASURES IN GEOCHEMISTRY LABORATORY

Part I : Personal Precautions

1. All personnel must wear safety goggles at all times
2. Must wear the Lab Aprons/Lab Jacket and proper shoes.
3. Except in emergency, over-hurried activities are forbidden.
4. Fume cupboard must be used whenever necessary.
5. Eating, Drinking and Smoking in the laboratories strictly forbidden.

Part II : Learn to make use of Safety and Emergency Equipments

1. First aid kits
2. Sand bucket
3. Fire extinguishers (dry chemical and carbon dioxide extinguishers)
4. Chemical Storage cabinet with proper ventilation
5. Material Safety Data sheets.
6. Management of Local exhaust systems and Fume hoods.
7. Sign in register if using instruments.

V) FIELDWORK CARE AND SAFETY FOR GEOLOGY STUDENTS

1. Follow the tour schedule and instructions of teachers.
 2. Wear proper clothes, field shoes and cap during fieldwork.
 3. Carry the necessary field equipments carefully e.g. Sack, Clinometer / Brunton compass, Hammer, Field diary, Map, Writing and labeling material, Drinking water, Eatables, Mobile phone, whistle, first aid kit.
 4. Do not enter into unknown or restricted areas without a field guide.
 5. Keep rapport with local people. They can be of great help.
 6. Take proper care while collecting samples. Place the samples in thick plastic bags, stick labels bearing names or numbers on them and make a note in the field diary.
 7. Check your belongings and field equipments before leaving a field spot or location.
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M. Sc. Part – I: Geology
B) Detailed Revised Syllabus

(To be implemented from June 2011)

Semester I

Paper I: Mineralogy, Optics and Crystallography

Paper II: Igneous Petrology

Paper III: Metamorphic Petrology

Paper IV: Sedimentary Petrology

Practical I: Related to Paper I and II

Practical II: Related to Paper III and IV

Paper I: Mineralogy, Optics and Crystallography

Theory

Unit I

Atomic structure, Bonding in minerals, Mineral stability, Ionic radii, Co-ordination polyhedra, Pauling's rule, Ionic substitution, Solid solution, Isomorphism, Polymorphism, Pseudomorphism, Silicate structures. Fluid inclusions-formation, composition and importance. Partitioning of elements between melt and silicates

Unit II

Systematic study of the following common rock forming mineral groups with reference to their structure, chemical composition, physical-optical properties and paragenesis: Olivine, Pyroxene, Amphibole, Mica, Feldspar, Silica, Spinel.

Unit III

Systematic study of the following common rock forming mineral groups with reference to their structure, chemical composition, physical-optical properties and paragenesis: Garnet, Epidote, Feldspathoid, Alumino-silicates, Zeolites and Carbonates.

Unit IV

Properties of light, interference of light waves, Concept of plane polarized and cross polarized light, Petrological microscope, Behavior of light under petrological microscope, Optical properties of minerals, Measurement of Refractive Index.

Unit V

Conoscopic light, Accessory plates, Concept of uniaxial and biaxial indicatrix, Interference figure, Determination of optic sign of uniaxial and biaxial minerals, Optic orientation in different crystallographic systems, Measurement of birefringence, Universal stage.

Unit VI

Space lattice, Unit cell and space group / point group, 32 classes of symmetry,

Unit VII

Goniometry, Crystal projections- spherical, stereographic and goniometric, Twinning, Irregularities and imperfections of crystals.

Unit VIII

Analytical methods in mineralogy - Introduction to Multiple differential thermal analysis, Electron microscope analysis, Scanning and transmission electron microscopy, Electron-Probe Micro-Analysis (EPMA), Cathodoluminescence, thermoluminescence and X ray diffraction method.

Practical

Mineralogy

Megascopic and microscopic study of major rock forming minerals with emphasis on distinguishing features.

Calculation of mineral formula of the following- olivine, pyroxene, amphibole, and garnet. Determination of anorthite content of plagioclase by optical properties.

Sample preparation and obtaining XRD pattern, Indexing an XRD pattern, Calculation of 2θ and d spacing values.

Optics

Study of interference figures, optic axis, optic sign, and flash figure of uniaxial and biaxial minerals.

Scheme of pleochroism,

Determination of birefringence with the help of Michael Levy chart, quartz wedge and Berek compensator.

Determination of Refractive Index of uniaxial and biaxial minerals using various methods.

Crystallography

Construction of stereograms and gnomonograms. Stereographic projection of class 4/m, 32/m, 2/m.

Measurement of interfacial angles and determination of axial ratios of Normal class of Orthorhombic, Tetragonal and Monoclinic systems.

Study of twin crystals.

Reference Books

1. Textbook of Mineralogy: E. S. Dana.
2. Elements of Mineralogy: Berry Masson.
3. An Introduction to Rock Forming Minerals: W. A. Deer, R. A. Howie and J. Zussman.
4. Rock Forming Minerals, Volumes 1 to 5: W. A. Deer, R. A. Howie and J. Zussman; Longman
5. Optical Mineralogy: Paul F. Kerr.
6. Optical Crystallography: E. E. Wahlstrom.
7. Optical Mineralogy: U. M. Revell, Phillips and Dana, T. Griffien; CBS Edition.
8. A practical Introduction to Optical Mineralogy: C. D. Gribble, A. J. Hall.
9. An Introduction to Crystallography: Phillips
10. Minerals and Rocks: Exercises in Crystallography, Mineralogy, and Hand Specimens: Corneis Klein
11. Manual of Mineralogy: Klein, C. and Hurlbut, Jr. CS. 1993; John Wiley.

12. Gemstones Enchanting Gifts of Nature: Dr.Karant Geological Society of India, Bangalore, Publication.
13. Crystals and their structure: Cracknell .
14. Modern Mineralogy: Frye Keith.

Paper II: Igneous Petrology

Theory

Unit I

Magma definition, composition and source, Magma generation in the mantle, Magmatism and Plate Tectonics, Physical properties of magma- geothermal gradient, heat source, Present day igneous activity. Use of rare earth elements in determining the source of magma.

Unit II

Textures and structures of igneous rocks, Classification of igneous rocks and their tectonic significance. Norms-CIPW and Niggli values, Zavaritskii number, TAS diagram. IUGS classification of plutonic and volcanic igneous rocks: QAPF diagram, classification of Mafic and UltraMafic igneous rocks, Potassic igneous rocks, melilitic rocks, lamprophyres and carbonatites. ?

Unit III

Crystallisation of magma, Magmatic differentiation, and Assimilation, Role of volatiles, Variation diagrams and differentiation indices (Harker's diagram, mg number etc.) and their significance.

Unit IV

Phase equilibrium of single, binary, ternary and quaternary silicate system, Study of binary and ternary systems: Albite-Anorthite system, Forsterite-Silica system, Feldspathoid-silica system, Diopside-Albite-Anorthite system, Diopside-Forsterite-Silica system. Orthoclase – Albite system, its relevance to petrogenesis. Formation of perthite.

Unit V

Introduction to mantle processes, Continental and oceanic mantle lithosphere, MORB and depleted mantle, Evolution of depleted mantle.

Unit VI

OIB and Enriched mantle, Evolution of Enriched mantle- metasomatic processes, Island arc basalts, Concept of hot-spots, Mantle plumes- theory and structure, Re-Os isotope systematics, Trace elements characterization of mantle domains.

Unit VII

Petrogenetic provinces: Continental areas: Volcanic flood basalts, Tholeiites (Deccan

Traps, Columbia River basalts, Parna basalts); Layered gabbroic intrusions: The Bushveld Complex, Skaergaard intrusion, Stillwater Complex;

Unit VIII

Plutonic: Carbonatites and alkaline rock complexes of India. Oceanic areas: Hawaiian, Kerguelen and Reunion Islands; Oceanic Rift valleys: MORB-Tholeiites-Ophiolites; Granite, its types and salient differences. Andesite, Kimberlites, Anorthosites, Charnokites,

Practical

Megascopic and microscopic study of representative igneous rocks. Calculation of CIPW norms. Niggli calculations. Preparation of variation diagrams. Quantitative mineralogical studies in thin section and rock classification. Use of computer programming in Petrological studies.

Reference Books

1. Igneous Petrology: Mihir K. Bose, 1997, World Press.
2. Igneous Petrology: Best, M. G., 1986, CBS Publication.
3. Igneous Petrology: McBurney, A. R., 1993, Jones and Bartlet Publication.
4. Igneous Petrology: Carmichael, Turner and Verhoogen.
5. Evolution of Igneous Rocks: Brown.
6. Igneous and Metamorphic Petrology (2nd edition): F. J. Turner, J. Verhoogen.
7. Igneous and Metamorphic Petrology: Dest.
8. Igneous and Metamorphic Petrology: Philipotts, A., 1992, Prentice Hall.
9. Physical Chemistry of Magmas: Perchuk, L. L. and Kushiro, I. (eds), 1991, Springer – Verlag.
10. Laboratory Handbook of Petrographic Techniques, Hutchinson, C.S., 1974; John Wiley.

Paper III: Metamorphic Petrology

Theory

Unit I

Definition of metamorphism, Agents of metamorphism, Types of metamorphism and controlling factors in each type including those of - Ocean floor metamorphism. Metamorphic minerals. Metamorphic reactions.

Unit II

Field observations: Recognition of Textures and structures related to metamorphism- Deformation textures and structures, Recrystallisation textures and structures, Petrographic classification of metamorphic rocks,

Unit III

Regional and thermal metamorphism of pelitic rocks, Regional and thermal metamorphism of Basic igneous rocks, Regional and thermal metamorphism of impure, siliceous carbonate rocks.

Unit IV

Concepts of Metamorphic Grades and Facies. Very low grade, low grade, medium grade, high grade metamorphism. Elemental exchange and P-T conditions of isograds. Different metamorphic facies.

Unit V

Mineralogical phase rule of closed and open system, Phase diagram and graphic representation of mineral assemblages. Schreinmarker's rule and chemographic diagrams such as ACF, AKF and AFM diagrams,

Unit VI

Granulites, Charnockites and Eclogites. Palingogenesis, Anatexis and migmatites, Granitization, Prograde and Retrograde metamorphism, polymetamorphism.

Unit VII

Metasomatism, Relationship of metamorphic rocks and associated mineral deposit, Geothermometers and geobarometers.

Unit VIII

Metamorphism in space and time: Plate Tectonics and metamorphic processes, Paired metamorphic belts, Archaean and Proterozoic terrains.

Practical

Megascopic and microscopic study of textures, structures and minerals in metamorphic rocks and their classification.

Study of representative metamorphic rocks.

Calculation and plotting of ACF, AFM and AKF diagrams and their interpretation.

Modal Analysis and its significance in determination of parentage of metamorphic rocks.

Reference Books

1. Metamorphic Petrology: F. J. Turner, 1980/1981; McGraw Hill, Newyork
2. Metamorphic Petrology: C. B. Rao.
3. Metamorphic Petrology, 4th edition: Winkler
4. Metamorphic Petrology: Harker.
5. An Introduction to Metamorphic Petrology: Yardley, B. W., 1989, Longman, Newyork
6. Petrogenesis of Metamorphic Rocks: Bucher, K. and Frey, M., 1994, Springer – Verlag.
7. Igneous and Metamorphic Petrology: Philipotts, A., 1992, Prentice Hall.
8. Metamorphic Crystallisation: Kretz, R., 1994, John Wiley.
9. Metamorphism and Metamorphic Belts: Miyashiro, A., 1973.
10. Characterisation of Metamorphism through Mineral Equilibria: J. M. Ferry ed., Reviews in Mineralogy, Vol. 10, Mineralogical Society of America.
11. Experimental Petrology: Alok Gupta.

Paper IV: Sedimentary Petrology

Theory

Unit I

Origin of sediments – Parent rocks and their products, Sediment transport mechanism; Deposition by fluids- simple fluid flow concepts- Reynold number and Froude number.

Unit II

Lithification and Diagenesis: Definition, principles, major stages in lithification and diagenesis of clastic and chemical rocks with reference to sandstones and limestones.

Unit III

Sedimentary Textures: Textural elements of clastic and non-clastic rocks, Concept of size and shape, Shape aspects- sphericity, roundness, form; Surface textures, *fractal*, fabric- their measurement, statistical treatment and interpretation, Methods of mineral separation and quantitative and qualitative analysis.

Unit IV

Genesis and Significance of Sedimentary structures - Syndepositional and Post-depositional, Principles of statistical treatment of palaeocurrent analysis. Application of textures and structures in sediment dispersal and basin analysis studies. Purpose and scope of basin analysis.

Unit V

Provenance: Introduction, definition and concepts, Minerals and source rocks; Mineral stability in the soil profile and during transit, intrastratal mineral stability, Heavy mineral zones, Theoretical and other considerations related to mineral stability, Reading provenance history.

Unit VI

Sedimentary Environments: Classification of environments- continental, marine, transitional; their physical and chemical parameters, lithology and lithological associations;

Importance of Structures in interpretation of alluvial, fluvial, deltaic, lacustrine, coastal, shallow marine, deep marine, glacial and aeolian environments.

Concept of sedimentary facies - Extrabasinal and Intrabasinal.

Unit VII

Sandstones: Classification, light and heavy minerals, tectonic setting;

Limestones: Classification, mineralogy, environment of deposition, Dolomitisation and dedolomitisation;

Evaporites, phosphorites, Chert and Fe-Mn rich rocks- genesis and environment of deposition. Volcanogenic sedimentary rocks.

Unit VIII

Sedimentation and Tectonics: Tectonic controls of sedimentation, diastrophic cycle, Sediment cycle, Basin classification in relation to plate tectonic setting.

Practical

Megascopic and microscopic characters of clastic and non-clastic rocks,
Study of sedimentary textures, structures and their significance.
Identification of types of sandstones and limestones in micro-sections.

Study of heavy minerals.

Determination of sphericity and roundness of grains, Sieve analysis, Graphical presentation of data and determination of statistical parameters.

Detailed study of diagenetic features under thin sections, Exercise on mineralogic and geochemical data plots for environmental interpretation by using computer.

Paleocurrent analysis for different depositional environments. Lithofacies analysis (both lateral as well as vertical).

Reference Books

1. Sedimentary Petrology 3rd edition : Pettijohn, F. J., 1984, CBS Publi.
2. Origin of Sedimentary Rocks, 2nd edition : Blatt, Middleton and Murray.
3. Depositional Sedimentary Environments: Reineck and Singh.
4. An Introduction to Sedimentary Rocks: R. C. Selley.
5. Sedimentary Rocks: R. K. Sukhatankar.
6. Palaeocurrent and Basin Analysis: Potter, Pettijohn and Siever.

Field Visits

At least four 'One-day Field Visits' to nearby locations of geological interest.
Submission of Report thereof along with collected samples.

Semester II

Paper V: Structural Geology and Geotectonics.

Paper VI: Stratigraphy and Palaeontology.

Paper VII: Economic Geology.

Paper VIII: Remote Sensing and Geomorphology.

Practical III: Related to Paper V and VI

Practical IV: Related to Paper VII and VIII

Paper V: Structural Geology and Geotectonics.

Theory

Unit I

Concept of stress and strain, stress strain relationship of elastic, plastic and viscous materials. Theory of rock failure, Behavior of rocks and minerals with respect to stress and strain.

Unit II

Mechanics of folding, Classification of folds, Folding in shear zones.

Faults: Classifications and Genesis. Thrust belts and Nappes. Shear zones: Sense of movement and its determination in shear zones,

Unit III

Joints: Classification and Genesis. Origin and significance of different types of minor structures within shear zones.

Rock cleavages, foliation and lineation.

Unconformity – Development and Types. Significance in stratigraphy.

Unit IV

Structural Analysis: Principles, phases, Scale, homogeneity and symmetry of structural analysis. Structural analysis on microscopic, mesoscopic and megascopic scales.

Structural analysis of areas of one, two and three phases of structural deformation.

Interference structures of different scales and their origin.

Unit V

Internal structure of the earth. Significance of asthenosphere and outer core in geodynamics. Physical characters of continents and ocean basins – Shields, Cratons, Platforms, Continental shelf, continental slope and abyssal plains; Island arcs, Trenches, Rift valleys and Mid-Oceanic Ridges.

Unit VI

Outlines of hypotheses of contraction, expansion, convection, polar wandering.

Continental drift, Palaeomagnetism and Seafloor spreading; Isostasy, orogenesis and epirogenesis. Precambrian and Palaeozoic orogenies.

Unit VII

Concept of Plate tectonics (in detail). Plate Tectonic model of the origin of folded mountain belts. Hot spot activity. Seismicity and plate movement.

Unit VIII

Tectonic features of India: Structural trends during Archaean and Proterozoic Era. Proterozoic sedimentary platform basins- their trend and tectonics. Tectonic model of the evolution of Himalayas- Geodynamics of the Indian plate.

Practical

Structural Geology

Description of structural geological maps and drawing their sections, Exercises in determination of finite strain, Exercises in fold analysis by 't' and graphs, Exercises in structural analysis, Exercises in shear zones, Exercises in syntectonic fabrics for determination of strain history.

Geotectonics

Recognition of Plate boundaries and their types in maps
Study of tectonic maps of different parts of India.

Reference Books

1. Structural Geology: Billings M. P.
2. Structural Geology- Fundamental and Modern Developments: Ghosh, S. K.
3. The Techniques of Modern Structural Geology-1. Strain Analysis: Ramsey, J. G. and Hubber, M. I.
4. The Techniques of Modern Structural Geology- 2. Folds and Fractures : Ramsey, J. G. and Hubber, M. I.
5. Folding and Fracturing of Rocks: Ramsey, J. G.
6. Structural Geology: Davis, G. A.
7. The Evolving Continents: V. F. Windley
8. Plate Tectonics and Crustal Evolution: K. C. Condie
9. Aspects of Tectonics: K. S. Valdiya

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Paper VI: Stratigraphy and Palaeontology

Theory

Unit I

Standard stratigraphic nomenclature code; Lithostratigraphy, Biostratigraphy, Chronostratigraphy, Concepts of Magnetostratigraphy, Chemostratigraphy, Event stratigraphy, Sequence stratigraphy, Cyclostratigraphy and Pedostratigraphy.

Unit II

Correlation: Modern methods of stratigraphic correlation.
Stratigraphic procedures: Surface and subsurface.
Concept of lithofacies and biofacies.
Stratigraphic boundary problems

Unit III

Precambrian stratigraphy of India with world equivalence - Distribution, lithology, tectonic history and correlation of Archaean and Proterozoic of Peninsula and Extra-peninsula, their equivalents in other parts of the world.

Unit IV

Phanerozoic stratigraphy of India with world equivalence - Distribution, lithology, tectonic history and correlation of Phanerozoic sequences of India, their equivalents in other parts of the world.

Unit V

Distribution of organisms in space and time, Evidence of life in Precambrian times. Techniques in the study of megafossils, microfossils, nanofossils, ichnofossils - Collection, reformation, and illustration, binomial nomenclature. Use of palaeontological data in- stratigraphy, palaeoecology, evolution, mineral (fuel) exploration, and palaeography.

Unit VI

Brief study of morphology, classification, evolutionary trends and distribution of Invertebrate phyla: Mollusca, Brachiopoda, Echinodermata, and Corals. Plant fossils: Gondwana and Intertrappean flora.

Unit VII

A brief account of the vertebrate sequence through geological time. Brief study of evolution of Fishes, Elephant, Horse and Man. Brief account of Siwalik fauna.

Unit VIII

Introduction to Micropalaeontology, Types of microfossils, Palynology, Foraminifera and Ostracods, Molecular palaeontology.

Practical Stratigraphy

Drawing of geological maps of different Supergroups and Groups of India
Preparation of palaeogeographic maps of India for different geological periods.

Palaeontology Identification and study of invertebrate fossils, illustrating functional morphology and classification.

Identification of plant fossils- Gondwana and intertrappean flora.

Sample preparation for micropalaeontological studies, Identification of microfossils- Foraminifera and Ostracoda.

Reference Books

1. Historical Geology and Stratigraphy of India: Ravindra Kumar.
2. A Manual of Geology of India and Burma, Vol. 1, 2, 3, and 4: E. H. Pascoe.
3. Geology of India: M. S. Krishnan.
4. Geology of India Vol. I and II : M. Ramkrishnan and R. Vaidyanathan
Geological Society of India, Bangalore.
5. Purana Basins of India, Memoir: Geological Society of India, Bangalore.

6. Precambrian of South India: Geological Society of India, Bangalore.
7. Precambrian Stratigraphy of India: Naqvi and Rogers.
8. G. S. I. Memoirs and Record Volumes.
9. Invertebrate Palaeontology and Evolution, 2nd edition: Clarkson E. N. K.
10. Elements of Palaeontology: Babin C.
11. Principles of Invertebrate Palaeontology, 2nd edition: Shrock and Twenhofel.
12. Palaeontology of Vertebrates: Jean Chaline.
13. The Elements of Palaeontology: R. N. Black.
14. Micropalaeontology: Bignot
15. Invertebrate Palaeontology: Woods H.
16. Fossils in Earth Science: Anis Kumar Ray, Prentice Hall India
17. Fundamentals of Micropalaeontology- M.A.Koregave

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Paper VII: Economic Geology

Theory

Unit I

Mode of occurrence of mineral deposits, their morphology and relationship with host rock. Organic matter in ores and their significance.

Unit II

Paragenesis and zoning. Tectonic controls on mineralisation. Stratigraphic controls on mineralisation.

Unit III

Metallogenic epochs and metallogenic provinces.

Unit IV

Study of the following ore deposits of India with reference to their geological and tectonic setting, genesis and distribution: Cu, Pb, Zn, Mn, Fe, Cr, Al, Sn, W and Au.

Unit V

Study of following non-metallic deposits of India: Magnesite, talc, barite, kyanite, sillimanite, asbestos, phosphorite, mica, precious and semiprecious stones.
Atomic minerals- occurrences in India and their applications.

Unit VI

Coal- origin of peat, lignite, bitumen and anthracite; classification, rank and grading of coal, coal petrography, coal measures of India;

Unit VII

Petroleum and natural gas- origin, migration and entrapment of petroleum, properties of source and reservoir rocks, structural; stratigraphic and combination traps, petroliferous basins of India.

Unit VIII

Significance of mineral resources in national economy. Uses of various minerals in industries. Strategic, critical and essential minerals. National mineral policy.

Practical

Economic Geology

Megascopic study of typical ore minerals, Study of ore microscope, Processing of ore sections for optical study, Study of ore textures, Study of ore minerals under ore microscope- optical parameters, determinative mineralogy, Preparation of paragenetic sequence, Assay value and Ore reserve calculations. Microchemical techniques. Methods of surveying in geological mapping.

Reference Books

1. Economic Mineral Deposits: Jensen and Betman
2. Ore Deposits: Betman
3. Ore Deposits: Evans
4. Minerals of India: R. K. Sinha.
5. Ore Deposits: Gokhale and Rao.
6. Metallisation associated with Acid magmatism: Evans.
7. Ore Deposit Geology: Edvends and Atkinson.
8. Geology of Ore Deposits: Gilbert.
9. Ore Petrography: Cameran
10. Ore Petrography: Ramdhor.
11. Ores in Sediments: Amstutz and Bernard.
12. Mineral Economics: R. K. Sinha.
13. Mineral Economics: Chaterjee.

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Paper VIII: Remote Sensing and Geomorphology

Theory

Unit I

Concept of Remote Sensing, Electromagnetic Energy and spectrum, Interaction of electromagnetic energy with water, soil and vegetation. Types of sensors, Aerial photographs and their types, Aerial cameras and films, Scale of aerial photographs, Aerial mosaics and Photo-recognition elements.

Unit II

Global and Indian space missions, Different exploration-satellite programs and their characteristics- IRS, LANDSAT, METEOSAT, OCEANSAT, CARTOSAT, SPOT.

Unit III

Satellite Remote Sensing, Visual interpretation and Digital Image Processing Techniques. Principles of Terrain Analysis. Interpretation of topographic and tectonic features-Lineaments, Joints, Folds and Unconformity, Rock type identification.

Unit IV

Uses of remote sensing in Resource Exploration, Applications in Environmental Studies and Natural Hazards mitigation, Groundwater Potential Evaluation.

Unit V

Influence of climate on weathering, Soil and mass wasting, Development and types of soils.

Unit VI

Geomorphic processes with associated dynamics and resulting landforms- slope, channel, coastline, glacial, aeolian and karst landscapes. Evolution of major geomorphological features of Indian sub-continent.

Unit VII

Morphometric Analysis, slope analysis, drainage analysis; Geomorphological mapping based on genesis of landforms.

Unit VIII

Terrain evaluation for strategic purpose. Principles and applications of Geographic Information System.

Practical

Remote Sensing

Determination of geometrical properties of aerial photographs, Study of landforms, Interpretation of lithology and structure in aerial photographs and satellite imageries, Study and analysis of lineaments and drainage in aerial photographs.

Geomorphology

Basin demarcation, ordering of streams by Strahler's and Horton's methods, Calculation of drainage density and bifurcation ratio; Slope of the basin- Schumm's method.

Slope analysis, Texture ratio, Planar surfaces, Determination of altitude frequency, Hypsometric curves and hypsometric integer, Source heads and confluence points.

Reference Books

1. Principles and Applications of Photogeology: S. N. Pandey.
2. Photogeology and Regional Mapping: J. A. E. Allum.
3. Remote Sensing and Image Interpretation: Lillesand Kiefer.
4. Photogeology: Miller and Miller.
5. Fundamentals of Geomorphology: R. J. Rice
6. Geomorphological Techniques, 2nd edition: Andrew Gaudia
7. Principles of Geomorphology: W. D. Thornbury.
8. Geomorphology and Remote Sensing in Environmental Management: Surendra Singh.
9. Geomorphology: Majid Hussain.
10. Indian Geomorphology: H. S. Sharma.
11. Experimental Fluvial Geomorphology: Stanley A. Schumm et al.
12. Geomorphology: Richard J. Chorley.
13. Remote Sensing, 2nd Revised Ed. : A.N.Patel, Surendev Singh

14. Remote Sensing for Environmental: Jenson.

Field Work

Geological Mapping Training in the area of geological interest for two weeks.
Submission of the Report with prepared Geological Map and sample collection is compulsory at the time of Practical Examination/ Viva voce.

Reference Books

1. Field Geology: Lahee.

11. STRUCTURE OF COURSE

FIRST YEAR – Semester I and II

Semester I

Sr. No.	Paper No.	Subjects	Marks
1.	Paper- I	Mineralogy, Optics, and Crystallography	100
2.	Paper -II	Igneous Petrology	100
3.	Paper- III	Metamorphic Petrology	100
4.	Paper -IV	Sedimentary Petrology	100
5	Practical- I	Related to Paper I and II	100
6	Practical- II	Related to Paper III and IV	100
Semester I: Total – 4 Papers and 2 Practicals			600

Semester II

Sr. No.	Paper No.	Subjects	Marks
7.	Paper -V	Structural Geology and Geotectonics	100
8.	Paper -VI	Stratigraphy and Palaeontology	100
9.	Paper- VII	Economic Geology.	100
10	Paper -VIII	Remote Sensing and Geomorphology.	100
11.	Practical- III	Related to Paper V and VI	100
12.	Practical -IV	Related to Paper VII and VIII	100
Semester II: Total – 4 Papers and 2 Practicals			600
Total of First Year - Semester I = 600, Semester II = 600			1200

SECOND YEAR – Semester III and IV

Semester III

Sr. No.	Paper No.	Subjects	Marks
13	Paper- IX	Hydrogeology	100
14	Paper -X	Geophysics and Exploration Methods	100
15	Paper -XI	Geochemistry	100
16	Paper -XII	One of the following Optional Papers- (a) Gemmology and Industrial Mineralogy (b) Mining Geology and Mineral Economics (c) Marine Geology (d) Geoinformatics	100
17	Practical- V	Related to Papers IX and X	100
18	Practical -VI	Related to Papers XI and XII	100
Semester III : Total – 4 Papers and 2 Practicals			600

Semester IV

Sr. No.	Paper No.	Subjects	Marks
19	Paper- XIII	Engineering Geology and Geo-techniques	100
20	Paper -XIV	Natural Resource Management	100
21	Paper -XV	Environmental Geology	100
22	Paper -XVI	Dissertation	100
23	Practical - VII	Related to Paper XIII and XIV	100
24	Practical -VIII	Related to Paper XV and XVI	100
Semester IV: Total – 4 Papers and 2 Practicals			600
Total of Second Year - Semester III = 600, Semester IV = 600			1200

M. Sc. Part – II

Geology Syllabus

(To be implemented from June 2009)

Semester III

Paper IX: Hydrogeology

Paper X: Geophysics and Exploration Methods

Paper XI: Geochemistry

Paper XII: One of the following Optional Papers-

- (a) Gemmology and Industrial Mineralogy
- (b) Mining Geology and Mineral Economics
- (c) Marine Geology
- (d) Geoinformatics

Practical V: Related to Paper IX and X

Practical VI: Related to Paper XI and XII

Paper IX – Hydrogeology

Unit I

Groundwater – Origin, occurrence and distribution of water in the earth crust.

Hydrological cycle – Precipitation, runoff, infiltration and evapotranspiration. Groundwater reservoir and Groundwater movement. Renewable and nonrenewable ground water resources.

Unit II

Hydrologic properties of rocks : porosity permeability specific yield, specific retention, Hydraulic conductivity, transmissivity, storage coefficient, Darcy's law

Unit III

Groundwater quality, estimation of parameters, Hydrographs, water table contour map, Hydrostratigraphic units.

Unit IV

Well hydraulics, confined unconfined, steady, unsteady and radial flow, Water level fluctuations, causative factors and their measurements, Methods of pumping test and analysis of test data, Evaluation of aquifer parameters.

Unit V

Problems of over exploitation of groundwater. Water management in rural and urban areas, Rain water harvesting, Artificial recharge of groundwater. Ground water intrusion in coastal aquifers and remedial measures.

Unit VI

Surface and sub surface geophysical and geological methods of ground water exploration. Hydrogeomorphic mapping using various remote sensing techniques. Radio isotopes in hydrogeological studies.

Unit VII

Water quality – major and minor constituents and their characters, Water well technology, types of wells, Drilling methods, construction, development and maintenance of well.

Unit VIII

Ground water quality of India, Hydrostratigraphic units of India, Paleohydrological studies. Ground water Modeling.

Practicals

Preparation of water table contours. Estimation permeability. Analysis of hydrographs and estimation of infiltration capacity. Chemical analysis of ground water. Pumping test – Time, Draw down and time recovery tests. Evaluation of aquifer parameters, step draw down test. Study of depth and yields of bore wells. Electric resistivity – sounding for delineation of fresh and saline aquifers. Study of geophysical well logs. Exercises on groundwater exploration using remote sensing techniques. Exercises related on ground water modeling with given data.

Books Recommended

Groundwater hydrogeology – D. K. Todd
Hydrogeology – S. N. Davis and R. J. M. Dewiest
Groundwater studies – R. H. Brown and others
Groundwater Hydrology – Herman Bouver
Groundwater Resources Evaluation – W. C. Walton
Hydrogeology – C. F. Fetter
Handbook of applied hydrology – Ven Te Chew
Groundwater and wells – Hohnson publication
Physical and chemical hydrogeology – Patrick A. D. Dominics
Applied hydrogeology – Chow M. Mays, Mac Graw Hil Publicaiton
Hydrogeology and wet housed conservation – Gulman – wiley publication
Groundwater survey and investigation – Gautham Mahajan ApH puls.
Hydrogeology – Raghunath HM
Hydrogeology – Karanth K R, Tata Mac Graw Hill
Groundwater Assessment Development and Management – Karanth KR, Tata Mac Graw Hill
Groundwater – S. Ramakrishnan
Paleo-hydrology and Environmental change: Bemite, V R Babar and K. J. Gregong, Wiley, Chichester
Global Environment Changes, the context of paleolydrology, J. Brauson. A. G. Brown, K. S. Gregory, Wiley Chichester.

Applied hydrogeology – Fetter C. V. (1990)

Regional Groundwater Quality – Alley W. M. (1993) VNR, New York

Paper X- Geophysics and Exploration Methods

Unit I

Variation of gravity over the surface of the earth; principles of gravimeters; gravity field surveys; various types of corrections applied to gravity data; preparation of gravity anomaly maps and their interpretation in terms of shape, size and depth.

Unit II

Geomagnetic field of the earth; magnetic properties of rocks; working principles of magnetometers; field surveys and data reductions; quantitative interpretation; magnetic anomalies due to single pole, dipole; introduction to aeromagnetic surveys

Unit III

Resistivity methods; basic principles; various types of electrode configurations; field procedure profiling and sounding and interpretation
Interpretation techniques for resistivity sounding, self-potential methods, Induced polarization methods.

Unit IV

Seismic methods; fundamental principles of wave propagation; refraction and refraction surveys; concept of seismic channels and multi-channel recording of seismic data; End-on and split spread shooting techniques; CDP method of data acquisition; sorting; gather; stacking and record section; seismic velocity and interpretation of seismic data

Unit V

Electromagnetic methods- Basic principle, instruments used and interpretation of electromagnetic surveys. Introduction to the methods using artificial and natural fields-Telluric, Magneto-telluric and Airborne electromagnetic methods.

Unit VI

Introduction to logging, Aims and objectives, Classification of logging methods and techniques, Basic principles, Instrumentation, field procedures. Interpretation of logs and their applications.

Unit- VII

Radioactivity of rocks and minerals, Occurrence of radioactive minerals, Half-life, fission, fission; Dating radioactive traces.

Unit VIII

Integrated approach of geophysical methods in mineral exploration including groundwater and petroleum exploration; Description of borehole environment.

Practicals

Application of geophysical data for geological purpose.

Interpretation of surface geophysical data in mineral exploration- gravity data, magnetic data, electrical data. Utility of seismic reflection data in recognition of subsurface structures; interpretation of seismic data.

Interpration of logging data.

Books Recommended

Sharma, P.V. (1986) Geophysical Methods in Geology

Dobrin, M.B.(1976) Introduction to Geophysical Prospecting

Paransis, D.S.(1975) Principles of Applied Geophysics

Stanislave,M.(1984) Introduction to Applied Geophysics

Rao, M.B.R. Outlines of Geophysical Prospecting Manual for Geologists

Paper XI - Geochemistry**Unit I**

Origin and abundance of elements in the Earth and its constituents.

Unit II

Atomic structure and properties of elements in the periodic table, Special properties of transition and rare – earth elements.

Unit III

Goldschmidt's Principles of Geochemistry. Geochemical classification of elements in the Earth. Principles of Geochemical Cycle.

Unit IV

Isomorphism and Polymorphism, Principles of Geothermobarometry.

Unit V

Radiogenic Isotopes; Radioactive decay scheme of V – Pb, Sm – Nd, Rb – Sr, K – Ar and growth of daughter isotopes; Radioactive dating of single minerals and whole rocks; Stable Isotopes- nature, abundance and fractionation.

Unit VI

Laws of thermodynamics, Concept of free energy; Activity, fugacity and equilibrium constant; Thermodynamics of ideal, non – ideal and dilute solutions.

Unit VII

Principles of ionic substitution in minerals; Element portioning in mineral/rock formation and Concept of simple distribution coefficients and exchange reaction distribution coefficients; Element portioning in mineral assemblages and its use in the pressure – temperature estimation.

Unit VIII

Chemistry of natural waters; mineral stability in Eh-pH diagram; Rock weathering and soil formation; Elemental mobility in surface environment; Concept of geochemical – biogeochemical cycle and Global climate.

Practicals

Preparation and Interpretation of geochemical maps.
Rocks/sediments/water/Soil Analysis.

Books Recommended

Introduction to Geochemistry – Mason B and Moore C. B. (1991)
Introduction to Geochemistry – Krauskopf K. B and Bird D. K. (1967)
Geochemistry – Goldschmidt V. M (1962), Clarendon Press.
Encyclopedia of Geochemistry – Marshal C. P and Fairbridge R. W. (1999)
Stable Isotope Geochemistry – Hoefs J. (1980)
Principles of Isotope Geology – Faure G. (1986)
Handbook of Exploration Geochemistry – Govett G. J. S. (1983)
Geochemistry of Natural Waters – Drever J. I. (1982)
Marine Chemistry – Home R. A. (1969)

Paper XII (a)- Gemmology & Industrial Mineralogy

Unit I

Introduction to Gems –Precious and Semiprecious stones and their economic importance. Basic Properties of Gems- Hardness, Specific Gravity, Refractive Index, Luster, Play of colours, Qualities & Classification of gem materials- the 4 ‘C’s;

Unit II

Introduction to Special optical properties like Chatoyancy, Asterism, Luminescence, Play of colours, Labradorescence, Inclusions.

Unit III

Gem Testing- Refractometers, Polariscope, Dichroscope, Ultra Violet lamps- Principles and Uses. Methods of determination of Specific Gravity. Distinction between synthetic and natural gemstones

Unit IV

Formation of Gemstones. Occurrence of Gems in India. Gem Industry in India.

Unit V

Introduction to industrial specifications and preparations of raw material used in Ceramics and Refractories, Abrasives, Construction / Building Materials, Cement, Drilling mud

Unit VI

Outline of techniques for testing raw materials in Ceramics and Refractories, Abrasives, Construction / Building Materials, Cement, Drilling mud

Unit VII

Introduction to industrial specifications, and preparations of raw material used in Paints, Fertilizers, Electronics, Chemical Industry, Glass Industry, Metallurgical Industry.

Unit VIII

Outline of techniques of testing raw materials in Paints, Fertilizers, Electronics, Chemical Industry, Glass Industry, Metallurgical Industry.

Practicals

Visual observation and identification of Gemstones - Diamond, Ruby, Blue & Yellow sap hive, Emerald, Aquamarine, Tourmaline, Alexandrite, Torques, Malachite.

Visual observation and identification of Precious & Semi precious tones- Rose quarts, Amethyst, Agate, Opal, coral, Pearl, Amber, Synthetic stones.

Use of refractometers. Determinations of Specific Gravity.

Observation of inclusions for distinction between synthetic and natural gem stones.

Study of physical properties of Industrial minerals and materials in hand specimens with respect to industrial specifications.

Preparation of charts showing specifications of materials required for different industries.

Use of DTA & DTG techniques in cauterization of raw materials.

Books Recommended

Beginner's Guide to Gemmology-Read

Gems – Webster Anderson

Gem Testing – Anderson B. W.

Practical Gemmology – Webster R.

Geology of Industrial Rocks and Minerals – Bates

Indian Mineral Resources – Roy

Process Mineralogy of Ceramic Materials – Boungart, Dunham, and Amstutz

Gems and Gem Industry in India – Karanth, R.V.

Enhancement of Gems –Karanth, R.V.

Gems of the World – Phillips Series

Diamonds in India - Babu T. M.(1998) Geological Society of India, Bangalore

Paper XII (b)- Mining Geology

Unit I

Appraisal of exploration data for exploratory mining. Terms used in exploratory mining, Introductory aspect of mine planning.

Types of mining- Alluvial Mining, Quarrying and Open cast Mining, Underground Mining.

Open Cast Mining Methods- Excavation, Benching, Levelling. Methods of breaking rocks- Blasting practices- Drilling blast holes, Explosives used in mining.

Unit II

Underground Mining Methods- Modes of entry to mineral deposits Adit, Tunnel, Incline or vertical Shaft.

Mine organization and operations- Shaft Sinking, drifting, cross cutting, winzing, stopping, room & pillaring, top – slicing, sub – level caving and block caving; Mine drainage; ventilation; illumination.

Unit III

Mine hazards and Safety works- Mine inundation, Fire and Rock burst, Subsidence. Support of mine excavation; timber treatment

Unit IV

Factors in evaluating mineral deposits. Mine examination. Theory and methods of Sampling, Sampling calculations, recoverable values.

Unit V

Cost of mining, Life of mine, Future costs and profits, Present value of mine and its determination by compound interest and Hoskold formula method. Amortization; Calculation pertaining to valuation of mines of uniform and non- uniform annual income, Sale of mineral products, Metal prices and mine valuation; Valuation of prospects; Developed mines and working mines; Valuation report.

Unit VI

Scope of Mineral Dressing; Historical Outline; Properties of Ores and minerals applied to mineral beneficiation – Hardness, specific gravity, Colour, Diaphaneity. Ore microscopy. Operating steps involved- Size reduction– Crushing- Crushers – Jaw Crushers, Blake type, and Dodge type. Gyratory crushers, Cone crushers, Roll crushers – Angle of NIP, Fine crushers, Special crushers. Rittinger's Law, Kick's Law, Bond's Theory. Screening – Hand screening, Automatic screening, Sieve shakers. Laboratory sizing – Graphical representation of size analysis.

Unit VII

Principles of Concentration Processes, Flowing film Concentration Process, Gravity Concentration Process. Jigging, Tabling, Comparison between Jigging & Tabling, Jigging cycles. Magnetic separation- Principles and applications, Classification of magnetic separators- Ball Norton Drum Separator, Ding's Wet Magnetic Separator. Principle of Electromagnetic separators.

Unit VIII

Pneumatic concentration – Amalgamation, Flotation principles, Types of flotation, Reagents used in flotation, Collectors, Frothers, Depressants, Modifiers, Coal Dressing – Heavy Media separation. Agglomeration Techniques – Pelletisation Process, Nodulizing Process, Briquetting process, Sintering process.

Practicals

Determination and evaluation of ore in mines; Sampling calculations; recoverable values; cost of mining; Future costs and profits, Life of a mine. Determination of present value of mine. Drawing cross section of mine with the help of available data. Problems – Roll crusher angle of NIP, Relation between size of feed and size of produce; Size analysis of ground material their graphical representation; Study of settling rate of solids with respect to Stoke's Law and Rittinger's Law using clay samples; Calculation of ratio of concentration and recovery percentages.

Books Recommended

Elements of Mining – Young G. J.
Elements of Mining – Lewis R. A. & Clark G. A.
Mining Geology – Arogyaswami
Mining Geology – McKinstry H. E.
Mining of Mineral deposits – Sheryanthov L.
Principles of Mineral Dressing – Garudin A. M. (McGraw Hill)
Elements of Ore Dressing – Taggart A. F. (John Wiley)
Principles of Mineral Beneficiation – Wells & Wells
Mineral Processing – Pray (Elsevier)
Ore Processing – Jain S. K. (Elsevier)

Paper XII (c)- Marine Geology**Unit I**

History of Marine Geology, Distribution of Land and Sea, World's Oceans- Oceans and Seas, Origin of the seawater, Bathymetric Provinces.
Instruments used in Marine Geology, Position fixing, Depth measurement and sea bed mapping technique, Side-scan Sonar, Hydrography, Hydrographic chart.
Marine mineral resource management, Law of the sea, Indian strategy and future perspectives.

Unit II

Origin of Ocean Basins, Isostasy, Rock Magnetism, Sea-floor Spreading, Submarine earthquakes and tsunamis. Vulcanism, Marine slides.
Classification of shores and coasts. Clifed coast, Estuaries, Delta, Beach.
Beach profile. Near shore geological processes- Circulation in the surf zone, erosion, transport and deposition sand budget. Beach morphodynamics- variations in beach morphology, and its significance.
Petrology of the Ocean Floor, Submarine geomorphology;

Unit III

Marine depositional environments-coastal, shallow marine, and deep sea.
Shelf sedimentation- Concept of Sedimentary facies, Factors controlling nature and distribution of facies.
Coral reefs.

Deep- sea sedimentation, Sources of sediments to deep sea.
Rate of sedimentation in the oceans.
Sedimentary and faunal markers of palaeoenvironmental conditions.

Unit IV

Dissolved Organic Matter in the sea water- Chemical and biological aspects, Source of supply and processes of removal of dissolved organic matter.
Suspended Matter in sea water- Composition and characteristics of suspended matter, Settling rate of suspended matter.
Component composition and geochemistry of deep-sea sediments.
Origin and distribution of gas hydrates in marine sediments.
Radioactivity- Classification-Primary, cosmogenic and artificial radio nuclides, their occurrence,distribution and decay series. Sampling and storage of radionuclides and their application in geochronology of marine sediments.

Unit V

The role of micropalaeontology in Marine Geology and Oceanography including palaeo-oceanography, palaeoclimate, marine archaeology. Environmental significance of microfossils. Micropalaeontology in Petroleum Exploration.
Fossilisation process, Types of microfossils and their classification,
Brief account of dinoflagellate – Marine diatoms and silicoflagellates.
Techniques for palaeoclimate reconstruction with respect to oxygen isotope studies.

Unit VI

Physical and Chemical structure of the ocean. Physical and Chemical nature of sea water, Ocean circulation – Wave motion, Wave phenomenon, Tides, Ocean currents. Astronomical tides of ocean, Wind waves, swells-seiches-storm surges, Tsunamis, Turbulence – stirring – mixing – diffusion.
Littoral current- Longshore sediment transport, Wave refraction, diffraction.
Atmosphere- Ocean climate coupling, Climatic role of the ocean, Carbon Cycle, Global energy budget.

Unit VII

Concentration of Heavy Minerals in Beaches and submerged beaches
Placer deposits of drowned river valleys.
Manganese Nodules- Occurrence and distribution, Physical characters, Morphology, Mineralogy, Chemical composition of Mn-nodules, Nodule growth. Hydrothermal sulphates, Manganese crust.
Sea bed minerals with emphasis on Indian Ocean- Polymetallic nodules, phosphorites, carbonates,
Petroleum resources. Gas hydrates.

Unit VIII

Submarine beach exploration method, Mining of beach sands. Method of exploration and mining of drowned river valleys.
Deep sea exploration and mining methods, Shallow sea exploration and mining

methods, Environmental disturbance caused by mining and remedial measures.
Petroleum exploration and monitoring marine pollution.

Practicals

Beach profile survey and sediment sample collection using grab and corer, Sample preservation, Grain size (sand grade) analysis and data computation, Graphical representation and interpretation.

Depositional environment studies using a data set. Techniques for heavy mineral separation and identification.

Study of microfossils.

Study of bathymetry maps, Graphical representation and interpretation of bathymetry data set.

Determination of dissolved organic N and P in seawater. Determination of particulate organic C, N and P in seawater. Determination of Fe and B in seawater by Spectrophotometric method.

Sediment digestion procedure- Determination of Mn, Cr, and Ni in sediments by AAS method, Determination of organic C, N and P in sediments.

Books Recommended

Submarine Geology- Shephard, F. P. 1973, Harper and Row

The Sea Floor – Seabold, E. and Berger, W. H., 1982, Springer Verlag

Introduction to Marine Geology and Geomorphology- King, C. A. M. 1975, Edward Arnold, London.

Geological Oceanography- Shephard, F.P. 1978, Heinmann, London

Coastal and estuarine sediment dynamics- Dyer, K. R. , 1986, John Wiley and Sons

Beach Process and sedimentation – Komar, P. D. , 1976, Prentice Hall

Depositional Sedimentary environments – Reineck, H. E. and Singh, I. B., 1986, Springer Verlag

Introduction to geochemistry, Krauskopf, K.B., 1967, McGraw-Hill

Geochemistry-Goldschmidt, V. M., 1962, Clarendon Press.

Chemical Oceanography (Vol.1 to 3)- Riley, J. P. and Skirrow, G., 1975.

Marine chemistry- Home, R. A. 1969.

Introduction to Marine Micropalaeontology- B.U.Hag and A. Boersma

Microfossils – Brasier M.D.

Elements of Micropalaeontology – B'gnor B.

Waves and Beaches- The dynamics of the ocean surface –Basiom W.

Coastal Sedimentary Dynamics – Daris R.A.

CRC Handbook of coastal process and erosion – Komar P.D.

Oceanography – Paul R. Pinet

Principles of Physical Oceanography- G. Neumann and W. J. Pierson

Mineral wealth of ocean – A. K. Ghosh and Randhir Mukhopadhyay

The mineral resources of the sea – J. L. Mero

Handbook of marine mineral deposits- D. S. Cronon

The Indian Ocean- Exploitable mineral and Petroleum resources – Roonwal G. S.

Paper XII (d)- Geoinformatics

Unit I

What are Geographical Information Systems (GISs), Definitions & Terminology, Roots of GIS, Need of GIS, Component of GIS. Spatial analysis- spatial elements, entities and attributes, patterns.

Unit II

Map as geographic data base- Map scale, Classes of Map, Geographic Coordinate system, map projections,

Unit III

Cartographic processes, Georeferencing, Attribute data for Thematic Mapping & Preparation of Thematic maps

Unit IV

Graphic representation of data Raster & Vector, Relation between data representation & Data Analysis

Unit V

Input & Output methods, Remote sensing as raster data input

Unit VI

Editing- importance, editing errors, edge matching and rubber sheeting,

Unit VII

Digital Terrain Models(DTM)- Definition & Terminology, Approaches to DTM, Acquisition of Data, data processing & Visualization, Applications of DTM

Unit VIII

Applications of GIS- geological, geographical, Land use/Land cover, Watershed development, Environmental, Urban planning

Practicals

Identification of Geographic features, Map registration, digitisation and editing, Linking external tables, Vector analysis, Raster analysis, Terrain analysis and watershed delineation.

Books Recommended

Remote Sensing and Geographical Information System – Anji Reddy

Concepts and Techniques of Geographical Information System – C. P. Lo and Albert K. W. Yeung

Field Work: Fieldwork in the areas of geological interest for one week. Submission of Report of the fieldwork along with collected samples is compulsory at the time of Practical Examination / Viva voce

Semester IV

Paper- XIII: Engineering Geology and Geotechniques

Paper- XIV: Natural Resource Management

Paper XV: Environmental Geology

Paper –XVI: Dissertation

Practical –VII: Related to Paper XIII and XIV

Practical –VIII: Related to Paper XV and XVI

Paper XIII- Engineering Geology and Geotechniques

Unit I

Introduction: Definition, Scope of Engineering Geology in Civil Engineering.
Building Stones: Engineering properties of rocks and their dependence upon geological characters, in built stresses in rocks, measurements of these stresses by Flat Jack Method. Requirement of good building stone, Building stones of India, Reservoir Induced Seismicity.

Unit II

Preliminary Geological Investigation: Geological studies for various projects, Engineering consideration of structural features.

Unit III

Exploratory drilling: Observations, Preservation of cores, Core logging, Core recovery, R.Q.D., Graphical representation of core log, Limitation of exploratory drilling method, numerical problems on core drilling.

Unit IV

Geology of dam site: Important terms in dams and reservoirs, Preliminary geological survey, Influence of geological conditions on Location, Alignment, Design and Type of a dam, Requirement of good dam site, Influence of geological structures and rock types on strength and water tightness of foundation rocks, Unsuitable geological conditions for locating a dam site, Precautions to be taken for unsuitable conditions such as structural weaknesses, Dams on carbonate rocks, sedimentary rocks, folded strata.

Unit V

Geology of Reservoir site: Requirement of good reservoir site, water tightness of reservoir, Suitable and unsuitable for reservoir site, Effect of water table and rate of silting on reservoir.

Unit VI

Tunnelling: Definition, Civil Engineering terms, difficulties during tunnelling, Influence of geological conditions on tunnelling, Lining after tunnelling, Geological

consideration while choosing tunnel alignment, Tunnel in folded strata, sedimentary rocks.

Unit VII

Geology of Bridge sites: Types of bridges, Geological investigation for selection of sites for bridge.

Unit VIII

Engineering Geology of Deccan Traps: Types of basalts and associated volcanic rocks, Engineering characteristics of these rock types, Engineering significance of variation in size, number and infillings of gas cavities, Compact and amygdaloidal basalt as construction material, Effects on jointing, hydrothermal alteration and weathering on engineering behaviour of various varieties of Deccan traps. Tail channel erosion problem in Deccan Trap region, suitability of basalts from tunnelling point of view, Problems due to columnar basalt, dykes, red bole, tachylitic basalt, Volcanic breccia and fractures, Laterites-Origin, occurrence and engineering aspects. Ground water bearing capacity of the rocks of Deccan Trap region, Percolation tanks, Geological conditions suitable and unsuitable for construction of percolation tanks.

Practicals

Study of geological map of Maharashtra state and India.

Core logging of exploring drill hole.

Study and construction of subsurface sections based upon data of the series of drill holes.

Use of Electrical Resistivity Method of for determining depth of bedrock.

Books Recommended

Engineering and General Geology – By Prabin Singh, S. K. Katariya and sons, Delhi.

A Text Book of Geology – By P. K. Mukerjee, The World Press Pvt.Ltd., Calcutta.

Geology Hand book in Civil Engineering- By R. F. Legget – McGrawHill, New York.

Principles of Engineering Geology and Geotechnics- By D. P. Krynine & W. R. Judd, CBS Publishers & Distributors, New Delhi.

Engineering Properties of Rocks – By L. W. Farmer, Chapman & Hall, London.

Experiments in Engineering Geology – By K. V. G. K. Gokhale & D. M. Rao, TMN, New-Delhi.

A Text Book of Engineering Geology – By R. B. Gupte, Pune Vidyarthi Griha Prakashan, Pune.

Engineering Geology for Civil Engineering – By Dr. D. V. Reddy, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Engineering Geology - By B. S. Sathya Narayanswami, Dhanpat Rai & Co.(P) Ltd, Delhi.

Engineering Geology Laboratory Manual.

Geology of India and Burma- M. S. Krishnan, Higginbothams Pvt. Ltd.

Koyana Earthquake Journal (1968) Indian Geophysics Uni.

Introduction to Rock Mechanics by Verma B. P., Khanna Publisher, Delhi.

Paper XIV: Natural Resource Management

Unit I

Meaning and Classification of Natural Resources- Renewable and non-renewable resources.

Identification of natural resources – Economic minerals, Natural Fuels, Water, Land, Soil, and Forests. Human use and its impact on the resources.

Management tools and techniques. Planning for Sustainable Development. National Policy for Natural Resources.

Unit II

Classification of economic minerals based on their use, Ore minerals- Production, treatment and use of Precious metals, Ferrous metals, Rare earth / minor element resources. Non-metallic minerals-Classification, Production, treatment and uses in - Ceramic, refractory, pigments, paints, fertiliser etc. industry.

Mineral resources management and conservation. Principles and Criteria of management. Scientific methods of mineral processing and recycling.

Unit III

Marine Mineral Resources- Factors controlling occurrence and distribution of Polymetallic / Manganese nodules, Phosphorites, Hydrocarbons, Beach Placers, Evaporites, Rare metals, Ornamental stones- Corals, Pearls, and Shells.

Management of Marine Resources- Principles and parameters.

Unit IV

Land Resources- Land as a natural resource, Land use and Land cover classification system. Physiography, climate, structure and composition of –Forest, Croplands, Grazing, Desert and Wastelands. Land use evaluation and planning. Techniques of terrain evaluation.

Management of Land Resources – Croplands, Wasteland, Grazing land, Forests and Deserts.

Unit V

Soil resources – Soil profile, Soil Types – Components and Genesis. Physico-chemical parameters of soil in relation to Agriculture and Engineering Practices. Soil erosion- preventive measures. Soil Conservation Practices.

Unit VI

Water resources – Water as a Renewable Resource – River resources and Flood control, Groundwater resources- Occurrence and Distribution.

Management of water resources- Identification of problems of overdraft, over-irrigation- Salination of soil and water, Seawater intrusion in coastal aquifers, Surface water and Groundwater Pollution.

Remedial Measures- Water budgeting-Demand and Supply evaluation. Sustainable Watershed Development. Surface water conservation methods. Groundwater Recharge- Natural and Artificial methods,

Water Quality parameters and standards for domestic, agriculture and industrial use.
Water use and Law, National and Maharashtra State Water Policy.

Unit VII

Natural Energy Resources –Role of energy resources in the development of a Nation.
Non- Renewable energy resources-Coal, Petroleum, Natural Gas and Atomic
Minerals- Production, treatment and use. Indian occurrences. Planned development
and Integrated use.

Unit VIII

Conventional and Non-conventional Energy Resources. Wind Energy as a Resource,
Wind availability, Geomorphological considerations in the site selection for
windmills. Solar Energy as a Resource, Geological, Climatological aspects in
Harnessing Solar Energy.
Forests resources – Forest cover, Integrated use of forest resources, Degradation of
forest resources and remedial measures.
Coastal resources and problems.

Practicals

Study of Mineral Map of India. Preparation of land use pattern maps from field
studies, Water budgeting, Determination of Water Quality Parameters, Study of
Toposheets and Remote Sensing data, Analyses of multidisciplinary data such as
water availability, land use, agricultural practice, soil character and composition for
optimum and sustainable development.

Books Recommended

Natural Resource Ecology, Economics and Policy - Holechek, J. L., Cole, R. A.,
Fisher, J. T., and Valdez, R., 2nd Edition, 2003, Prentice Hall Education.
Modelling in Natural Resource Management Development, Interpretation and
Application- Shenk, T. M. and Franklin A. M., 2001, Island Press.
Making Collaboration Work- Lessons from Innovation in Natural Resource
Management- Wondolleck, J. M. and Yaffee, S. L., 2000, Island Press
Aerial Photography and Image Interpretation for Resource Management-Paine, D. P.,
1981, John Wiley and Sons, New York, 571p.
Principles of Geographical Information System for land Resources Assessment -
Burroughs, P. A., 1986, Oxford University Press.
Understanding GIS: The Arc Info method Training Course for GIS for resource
management and development planning- Environment Systems Research Institute,
1993.
Examination and Valuation of Mineral Property- Banter and Parks
India's Mineral Wealth-Brown and Day.
Groundwater Assessment, Development, and Management- Karanth K. R.
Geology of Petroleum- Levenson
Petroleum Geology- Russel

Paper XV- Environmental Geology

Unit I

Introduction, Fundamental concepts of Environmental Geology, Concepts of lithosphere, hydrosphere and atmosphere and their Physico–chemical characteristics.

Unit II

Ecology –Meaning and Scope, Concept of Ecosystem, Energy flow in ecosystem, Carbon Cycle, Nitrogen Cycle, Oxygen Cycle, Phosphorus cycle.

Unit III

Natural hazards – Types, causes and effects of natural disasters- Volcanism, Earthquakes and tsunamis, Floods, Landside, Coastal hazards, and Desertification. Planning for disaster mitigation.

Unit IV

Air Pollution – Sources and Classification of air pollutants, Effects of air pollution on environment, Acid rain, Ozone depletion, Green House Effects & Global Warming, Remedial measures. Water pollution – Sources and Classification of surface water and groundwater pollutants -. Domestic waste, Agricultural waste, Fertilizers and pesticides, Remedial measures.

Unit V

Soil Pollution – Geological conditions vulnerable to soil pollution- Rock type, Soil cover, Depth of weathering, Porosity and Permeability. Sources and Classification of pollutants effects on soil, alkaline / saline soil, acidic soils.

Unit VI

Environmental aspects of mining and refineries- Open cast and underground mining, refineries. Hazardous Waste Disposal - Solid and liquid waste. Geological factors in selection of sites for solid, liquid, hazardous waste disposal, remedial measures.

Unit VII

Environmental Impact Assessment – Risk Assessment and Analysis. Remedial Measures.

Unit VIII

Role of Geology in Environmental management. Hazard Zonation Maps and Preparedness Plans with respect to Mining, Earthquakes and Tsunamis, Volcanism, Landslides, Floods and Desertification.

Practicals

Collection of samples air, water and soil.

Analysis of water and soil samples water – pH, EC, (Electrical Conductivity) Total Hardness, Ca, Mg, Na, K, Chloride, Total Alkalinity, SO₄, PO₄. Soil – pH, EC, Organic matter, CaCO₃, texture.

Disaster management – Preparation of hazard zonation maps for different hazards.

Books Recommended

Principles of Environmental Science- Watt K. E. F., McGraw Hill Book Company
Environmental Geology- K.S. Valdiya, 1987, Tata McGraw Publication
Environmental Geology –Keller, E. A. 1978, Bell and Howell, USA
Fundamentals of Ecology- E. P. Odum
Natural Hazards – Bryant, E., Cambridge University Press
Geological Hazards – Bell, F. G., 1999, Routledge, London
Disaster Management- Prakash I., Rashtriya Prahari Prakashan.
Disaster Management- Sharma, V. K. I. I. P.A. New Delhi
Chemical and Biological Methods for Water Pollution Studies- R. K. Trivedi and P. K. Goel, Enviro Publication
Environmental Biology- K. C. Agalwal, Agro-Bios Jodhapur.
Environmental Impact Assessment – Larry W. Canter, McGraw Hill Industrial Edition.
The Dynamic Earth System – Patwardhan, A. M., 1999, Prentice Hall

Paper XVI- Dissertation

Each student is required to undertake a dissertation work under the supervision of a faculty member. The work may involve field investigations, survey of uses of earth materials in industries, laboratory studies, a theoretical investigation accompanied by computational work, data processing and analysis or a combination of these. The student should prepare and submit a dissertation / thesis based on the results obtained prior to the Practical Examination.

The dissertation work carries 100 marks. It will be evaluated on the basis of following points:

- 50 marks- Evaluation by Supervising Faculty Member and Head of the Geology Department on the basis of performance of the student – punctuality, enthusiasm, and aptitude- during fieldwork / survey of industries / laboratory work / theoretical investigations / data processing as applicable.
- 25 marks for preparation and presentation of the Report of work-done – Evaluation by the Internal and External Examiners.
- 25 marks for Viva voce- Evaluation by Internal and External Examiners.

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