# Shivaji University, Kolhapur.


Revised Syllabus For

# M. Sc. I Geology

to be implemented from the academic year 2018-19

(June 2018) onwards.

# Shivaji University, Kolhapur

CBCS 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 2018 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 | Internal marks | Credits |
|---|---|---|---|---|---|
| 1. | CG-I | Mineralogy, Optics, and Crystallography | 80 | 20 | 4 |
| 2. | CG-II | Igneous Petrology | 80 | 20 | 4 |
| 3. | CG-III | Metamorphic Petrology | 80 | 20 | 4 |
| 4. | CG-IV | Sedimentary Petrology | 80 | 20 | 4 |
| 5 | Practical I | Related to CG-I and CG-II | 100 | | 4 |
| 6 | Practical II | Related to CG-III and CG-IV | 100 | | 4 |
| | **Semester I Total: 4 Papers and 2 Practicals** | | **520** | **80** | **24** |

## Semester II

| Sr. No. | Paper No. | Subjects | Marks | Internal marks | Credits |
|---|---|---|---|---|---|
| 1 | CG-V | Structural Geology and Geotectonics | 80 | 20 | 4 |
| 2 | CG-VI | Stratigraphy and Palaeontology | 80 | 20 | 4 |
| 3 | CG-VII | Economic Geology | 80 | 20 | 4 |
| 4 | CG-VIII | Remote Sensing and Geomorphology | 80 | 20 | 4 |
| 5 | Practical III | Related to Paper CG-V and CG-VI | 100 | | 4 |
| 6 | Practical IV | Related to Paper CG-VII and CG-VIII | 100 | | 4 |
| | **Semester II<br>Total: 4 Papers and 2 Practicals** | | **520** | **80** | **24** |

| | | | |
|---|---|---|---|
| **Total Marks of First Year**<br>(Semester I = 520, Semester II = 520) | **1040** | **160** | **48 Credits** |

**Total marks for first year will be 1200**

**There will be an internal test/ seminar/ tutorial of 20 marks for each paper in both the semesters. The test/seminar/tutorial is to be conducted internally by the concerned department.**

## 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 × 4 periods | 16 |
| 2 | 2 Practicals × 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 80 marks each.
There will be internal examination of 20 marks for each paper

**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 5 questions of 16 marks each. All questions are compulsory amounting to maximum 80 marks as detailed below:

**Q. No. 1:** Objective Question with 4 multiple choice of 1 mark each, total 16 Questions ( Fill in the Blanks type )

**Q.No. 2, 3, 4:** Each question is either one long answer type descriptive question of 16 marks or 2 brief answer type questions of 8 marks each.

**Q. No. 5 :** Six short notes of 4 marks each, out of which four to be solved for 16 marks

## 16. STANDARD OF PASSING:-

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

## 17. EQUIVALENCE IN ACCORDANCE WITH TITLES AND CO NTENTS OF PAPERS- (FOR REVISED SYLLABUS w. e. f. June 2018)

### Semester I

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

## Semester II

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

M. Sc. Part – I: Geology
Detailed CBCS Syllabus

# Semester I

| | |
|---|---|
| CG-I: Mineralogy, Optics and Crystallography | (4-credits) |
| CG-II: Igneous Petrology | (4-credits) |
| CG-III: Metamorphic Petrology | (4-credits) |
| CG-IV: Sedimentary Petrology | (4-credits) |
| Practical I**:** Related to CG-I and CG-II | (4-credits) |
| Practical II**:** Related to CG-III and CG-IV | (4-credits) |

## CG-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; Fluid inclusions-formation, composition and importance; Partitioning of elements between melt and silicates

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, Alumino-silicates, Garnet, Feldspathoids, and Zeolites.

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

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

Unit IV

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

Analytical methods in mineralogy - Introduction to Multiple differential thermal analysis, Electron microscope analysis, Scanning and transmission electron microscopy, Electron-Probe Micro-Analysis (EPMA), Cathodoluminiscence , 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 $2\theta$ 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 Bereck 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.Karanth Geological Society of India, Banglore, Publication.
13. Crystals and their structure: Cracknell .
14. Modern Mineralogy: Frye Keith.

******

## CG-II: Igneous Petrology

**Theory**

Unit I

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.

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 II

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

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. Orthothoclase – Albite system, its relevance to petrogenesis. Formation of perthite.

Unit III

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

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 IV
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;
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, Charnockites,

**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 ($2^{nd}$ 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 Techiques, Hutchinson, C.S., 1974; John Wiley.


*****

## CG-III: Metamorphic Petrology

**Theory**

Unit I

Types of metamorphism, Ocean floor metamorphism. Metamorphic minerals. Metamorphic reactions.

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

Unit II

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

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 III

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,

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

Unit IV

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

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 Equillibria: J. M. Ferry ed., Reviews in Mineralogy, Vol. 10, Mineralogical Society of America.
11. Experimental Petrology: Alok Gupta.


*****

## CG-IV: Sedimentary Petrology

**Theory**

Unit I

Sediment transport mechanism; Deposition by fluids- simple fluid flow concepts- Reynold number and Froude number.

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

Unit II

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.

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 III

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.

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, laccustrine, coastal, shallow marine, deep marine, glacial and aeolian environments.
Concept of sedimentary facies - Extrabasinal and Intrabasinal.

Unit IV
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.
Sedimentation and Tectonics: Tectonic controls of sedimentation, diastrophic cycle, Sediment cycle,

**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 day Field Visits to nearby locations of geological interest.
Submission of Report thereof along with collected samples.

**********

# Semester II

| | |
|---|---|
| CG-V: Structural Geology and Geotectonics. | (4-credits) |
| CG-VI: Stratigraphy and Palaeontology. | (4-credits) |
| CG-VII: Economic Geology. | (4-credits) |
| CG-VIII: Remote Sensing and Geomorphology. | (4-credits) |
| Practical III: Related to CG-V and CG-VI | (4-credits) |
| Practical IV: Related to CG-VII and CG-VIII | (4-credits) |

## CG-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.

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 II

Joints: Classification and Genesis. Origin and significance of different types of minor structures within shear zones. Rock cleavages, foliation and lineation.

Folds :Mechanisms 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,

Unconformity : Development and Types. Significance in stratigraphy.

Unit III

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.

Outlines of hypotheses of contraction, expansion, convection, polar wandering. Continental drift, Palaeomagnetism and Seafloor spreading; Isostasy, orogenesis and epirogenesis. Precambrian and Palaeozoic orogenies.

Unit IV

Plate tectonics ,. Plate Tectonic model of the origin of folded mountain belts. Hot spot activity. Seismicity and plate movement.

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


* * * * *

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

Unit II

Precambrian stratigraphy of India-Distribution, lithology, tectonic history and correlation of Archaean and Proterozoic of Peninsula and Extra-peninsula,
Phanerozoic stratigraphy of India - Distribution, lithology, tectonic history and correlation of Phanerozoic sequences of India,

Unit III

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

Unit IV

A brief account of the vertebrate sequence through geological time. Brief study of evolution of Fishes, Elephant, Horse and Man. Introduction to Micropalaeontology, Types of microfossils, Palynalogy, 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


* * * * *

## CG-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.

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

Unit II

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

Metallogenic epochs and metallogenic provinces.

Unit III

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.

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 IV

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

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.

**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.


* * * * *

## CG-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.

Global and Indian space missions, Different satellite programs of India.

Unit II

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.

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

Unit III

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

Geomorphic processes with associated dynamics and resulting landforms- slope, channel, coastline, glacial, aeolian and karst landscapes.

Unit IV

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

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.


*****