

ಮೈಸೂರು



ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

ವಿಶ್ವವಿದ್ಯಾನಿಲಯ ಕಾರ್ಯಸೌಧ  
ಕ್ರಾಫರ್ಡ್ ಭವನ, ಮೈಸೂರು-5

ದಿನಾಂಕ 28-12-2020

ಸಂಖ್ಯೆ:ಯುಎ.2/379(12)/2016-2017

ಗೆ:

ಭೂ ವಿಜ್ಞಾನ ಅಧ್ಯಯನ ಮಂಡಳಿ(ಸ್ನಾತಕೋತ್ತರ)ಯ  
ಅಧ್ಯಕ್ಷರು ಮತ್ತು ಸದಸ್ಯರುಗಳಿಗೆ.

ಮಾನ್ಯರೇ,

ವಿಷಯ: ದಿನಾಂಕ 27-11-2020 ಮತ್ತು 28-11-2020ರಂದು ನಡೆದ ಭೂ ವಿಜ್ಞಾನ  
ಅಧ್ಯಯನ ಮಂಡಳಿ(ಸ್ನಾತಕೋತ್ತರ)ಯ ವಾರ್ಷಿಕ ಸಭೆಯ ನಡವಳಿಯನ್ನು  
ಕಳುಹಿಸುತ್ತಿರುವ ಬಗ್ಗೆ.

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ದಿನಾಂಕ 27-11-2020 ಮತ್ತು 28-11-2020ರಂದು ನಡೆದ ಭೂ ವಿಜ್ಞಾನ ಅಧ್ಯಯನ  
ಮಂಡಳಿ(ಸ್ನಾತಕೋತ್ತರ)ಯ ವಾರ್ಷಿಕ ಸಭೆಯ ನಡವಳಿಯನ್ನು ಈ ಪತ್ರದ ಜೊತೆ ಲಗತ್ತಿಸಿ  
ಕಳುಹಿಸಲಾಗಿದೆ.

Lingappaiah  
ಉಪ ಕುಲಸಚಿವ (ಪ್ರಾಧಿಕಾರ)

ಪ್ರತಿ:

1. ಅಧ್ಯಕ್ಷರು, ಭೂ ವಿಜ್ಞಾನ ಅಧ್ಯಯನ ವಿಭಾಗ, ಮಾನಸಗಂಗೋತ್ರಿ, ಮೈಸೂರು
2. ಪ್ರೊ. ಜಿ.ವೆಂಕಟೇಶ್ ಕುಮಾರ್, ಡೀನರು, ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ ನಿಕಾಯ, ಮನೋವಿಜ್ಞಾನ  
ಅಧ್ಯಯನ ವಿಭಾಗ, ಮಾನಸಗಂಗೋತ್ರಿ, ಮೈಸೂರು
3. ಕುಲಸಚಿವ(ಪರೀಕ್ಷಾಂಗ), ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಮೈಸೂರು.
4. ಉಪಕುಲಸಚಿವರು (ಶೈಕ್ಷಣಿಕ), ಆಡಳಿತ ವಿಭಾಗ, ಮೈವಿವಿ ನಿಲಯ, ಮೈಸೂರು-ಅಧ್ಯಯನ ಮಂಡಳಿಯು  
ಶಿಫಾರಸ್ಸು ಮಾಡಿರುವಂತೆ ಸೂಕ್ತ ಕ್ರಮಕೈಗೊಳ್ಳಬೇಕಾಗಿ ಕೋರಿದೆ.
5. ಸಹಾಯಕ ಕುಲಸಚಿವರು/ಅಧೀಕ್ಷಕರು (ಶೈಕ್ಷಣಿಕ), ಆಡಳಿತವಿಭಾಗ, ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ,  
ಮೈಸೂರು
6. ಕುಲಪತಿ/ಕುಲಸಚಿವ/ಕುಲಸಚಿವ(ಪರೀಕ್ಷಾಂಗ) ಅವರ ಆಪ್ತ ಸಹಾಯಕರು, ಮೈವಿವಿ ನಿಲಯ, ಮೈಸೂರು.
7. ಕಾರ್ಯನಿರ್ವಾಹಕರು, ಎಸಿ2(ಎಸ್), ಆಡಳಿತ ವಿಭಾಗ, ಮೈವಿವಿ ನಿಲಯ, ಮೈಸೂರು.

**PROCEEDINGS OF THE BOS (PG) MEETING HELD ON 27-11-2020 & 28-11-2020 AT 11.00 AM IN THE CHAMBERS OF THE CHAIRMAN, DOS IN EARTH SCIENCE, MGM**

Chairperson, BOS (PG), welcomed the members to the meeting and discussed the following agenda.

**Agenda 1.**





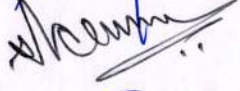
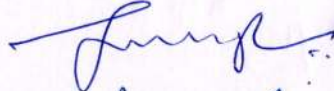

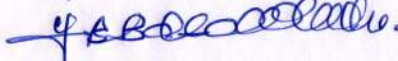
Chairperson briefed the members regarding the revision of M.Sc. Geology and M.Sc. Applied Geology syllabus, accordingly changes in the syllabus were incorporated and approved. Syllabus for M.Sc. Geology & M.Sc. Applied Geology courses are slightly modified. Fourth semester in both the courses is dedicated for 18 credits dissertation work.

**Agenda 2.**

Examiners List for the academic year 2021-22 is Approved

**Members Present :**

- 1) Prof. K.G.Ashamanjari
- 2) Prof.H.T.Basavarajappa
- 3) Prof.P.Madesh
- 4) Prof.Prakash Narasimha
- 5) Prof.D.Nagaraju
- 6) Prof.B.V.Suresh Kumar
- 7) Dr.Govindaraju
- 8) Prof.M.Bhagya
- 9) Prof.Y.B.Basavaraju

**Members Absent :**

- 1) Dr.H.M.Hussain



Proceedings of the BOS meeting held on 27.11.2020 & 28.11.2020 at 11 AM in the DOS in Earth Sciences, UoV of Mysore, Manasagangothri, Mysore.

Chairman BOS (PG) welcomed the members for a meeting and discussed the following agenda.

Agenda: ~~Chairman~~ Chairman briefed the members regarding the revision of M.Sc (Geology) and M.Sc (Appl. Geology) syllabus. Accordingly, changes in the syllabus were incorporated and approved. Syllabus for M.Sc (Geology) & M.Sc (Appl. Geol) courses are slightly modified. Fourth Semester in both the courses, is dedicated for 18 credits dissertation work.

Agenda: 2: Preparation of the examiners list for the academic year 2021-22.

Approved.

### Members Present

1. Prof. K.G. Ashamanjan
2. Prof. H.T. Basavarajappa
3. Prof. P. Madhukar
4. Prof. K.N. Prakash Narasimha
5. Prof. D. Nagaraju
6. Prof. Y.B. Basavaraju (Chemistry)
7. Prof. H. Bhagya
8. Dr. Govindaraju
9. Prof. H. Bhagya (Zoology)
10. Prof. B.V. Suresh Kumar (Co-opted member)

### Members Absent

1. Dr. H.T. Hussain.



**Name of the Department: Department of Studies in Earth Science**

**Program: M.Sc., GEOLOGY, Code: MSGEL**

<b>I Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
1	Crystallography & Mineralogy	Hard Core	202	4		20
2	Geomorphology & Structural Geology	Hard Core	301	4		
3	Ore Geology	Hard Core	301	4		
4	Fuel Resources & Mineral Economics	Soft Core	400	4		
5	Environmental Geology & Disaster Management	Soft Core	400	4		

<b>II Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
6	Paleontology	Hard Core	301	4		24
7	Igneous, Sedimentary and Metamorphic Petrology	Hard Core	301	4		
8	Geochemistry & Petrogenesis	Soft Core	301	4		
9	Minor Project (FW & Technical Report)	Hard Core	400	4		
10	Precambrian Crustal Evolution	Soft Core	400	4		
11	Basics of Earth Science	Open Elective	400	4		

<b>III Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
12	Geoinformatics	Hard Core	202	4		24
13	Indian Stratigraphy & Sequence Stratigraphy	Hard Core	400	4		
14	Exploration Geology & Mining Methods	Hard Core	301	4		
15	Hydrogeology	Soft Core	400	4		
16	Engineering Geology and Surveying	Soft Core	400	4		
17	Industrial Mineral Resources	Open Elective	400	4		

<b>IV Semester</b>	<b>Course</b>	<b>Hard/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
18	Major Project/ Dissertation	Hard Core		08		08
<b>Total Credits</b>						<b>76</b>



## SEMESTER – I

### **PAPER 1: CRYSTALLOGRAPHY AND MINERALOGY [LTP / CREDITS = 202/4]**

**UNIT 1: Crystallography:** Form theory of Crystals, Projections, Derivation of 32 point groups. Zone and Zone Laws, Atomic and ionic radii, Bond length and measurements of Radius, Radius ratio and co-ordination polyhedra, Coordination Number, Pauling's Rules, Spheres in Closest packing, Packing Index. Voids in closest packing, Classification & Co-ordination of voids, Derivative Structures. Crystal Defects / Crystal Imperfections,

**UNIT 2: Mineralogy:** Structure, Chemistry, Paragenesis, optical and physical properties of Olivine, Garnet,  $Al_2SiO_5$  group, Epidote, Pyroxene, Amphibole, Mica, Feldspar and Silica group of Minerals.

**UNIT 3: PRACTICALS in Crystallography:** Determination of grades of symmetry in Crystals and their projections. Determination of Axial Ratios and angle between the faces by using Stereonet.

**UNIT 4: PRACTICALS in Mineralogy:** Identification of rock forming minerals. Determination of mineral formula based on mineral analysis. Plotting of mineral compositions on a trilinear diagrams

#### **References**

- 1) Modern Mineralogy – Keith Frye
- 2) Dana's Text book of Mineralogy – W.E Ford
- 3) Introduction to Rock forming minerals – W.A. Deer, R.A. Howie, J. Zussman
- 4) Rutley's Elements of Mineralogy – Revised by C.D. Gribble
- 5) Fundamentals of Optical, Spectroscopic and X-ray Mineralogy
- 6) A Basic Course in Crystallography – JAK Tareen and TRN Kutty
- 7) Fundamentals of Crystal Chemistry – JAK Tareen and TRN Kutty
- 8) Mineralogy A First Course by John Sinkankas
- 9) Essentials of Crystallography – E. Flint

### **PAPER 2: GEOMORPHOLOGY AND STRUCTURAL GEOLOGY [LTP / CREDITS = 301/4]**

#### **UNIT 1: GEOMORPHOLOGY:**

Basic Principles of Geomorphology and their interpretation., Relief orders of Earth. Identification and interpretation of exo and endogenetic geomorphic agents responsible for the formation of various land forms ( fluvial, karst, glacial, aeolian and coastal landforms). Terrain classification – landscape and parametric approach. Role of geologist in selecting sites for Irrigation in arid and semi arid regions. Significance of Drainage patterns.

**UNIT 2: ROCK DEFORMATION:** Earth forces, Static and dynamic conditions, Mechanical characters of the rock. Kinds of Rock deformation: Mechanics of deformation. Relationship between Stress and Strain in rock compressive strength, tensile strength, Shear strength in rock;, Mechanics of Plastic deformation, Stress and strain ellipsoids. Behavior of minerals and rocks under deformation conditions. Stress strain relationship of elastic, plastic and viscous materials. Experimental studies of rock deformation, evidences of formal deformation. Uses of Mohr representation in various stress conditions. Mohr's circle and Envelope. Modulus of Elasticity.

**UNIT 3:** Folds and Fold systems, classification, Fold related micro structures, Fold-



Cleavage-bedding relationship, Concept of Vergence and Facing, Boudins and Boudinage, Symmetric and asymmetric boudinage, Mechanism of development of folds, **Fault and faulting**: faulting terminology, Breccias and Mylonite. Slickensides's and drag structures, classification: Genetic and Geometrical, types of faults. Recognition of fault in the field, uses of faults. **Joints**: classification and types of joints, joint sets and system, joint surfaces, relation of joints to other structures origin of joints. Unconformities: Classification and recognition, Types of Plutons, Cleavage and Schistosity, Foliation: axial plane of foliations, origin of axial plane foliation, preferred orientation of layer silicates. Transposed foliation-Development of transposed foliation, Recognition of transposition. Lineation: slickenside, striations, mineral lineation, pebbles, boulders, mullion and boudins, Origin of lineation.

**UNIT 4: PRACTICALS**: Construction of geological cross-section, structural contour maps, Tracing of outcrops, Interpretation of underground structure from borehole data, solution to fault problems, use of stereographic projection in structural calculation, construction of rose diagram for structural data.

**Reference:**

1. Billings, M.P.(1978) Structural Geology – Prentice – Hall of India Private Ltd. New Delhi.
2. Suppe, J.(1985) – Principles of structural geology – Prentice – Hall.
3. Price, N.J. and Cosgrove, J.W. (1990) Analysis of Geologiucal Structure. Camb. Univ. Press.
4. Hobbs, B.E. Means D and Millions, P.F. (1976) an outline of structural geology. Press.
5. Ramsay, J.G. (1967) – Folding and fracturing of rocks. Mc.Graw Hills New Yark.
6. Badgley P.C. – Structural Geology for the exploration geologist.
7. Whitten, T- Structural Geology.
8. Thornbury S.D – Principles of Geomorphology
9. Hails – Applied Geomorphology
10. Geomorphology by William D. Thornbury.
11. Modern Physical Geography by Arthur N. Strahler & Alan H. Strahler.
12. Applied Geomorphology by Hails.
13. Hobbs, B.E. Means D and Millions, P.F. (1976) an outline of structural geology. Press.
14. Ramsay, J.G. Structural Analysis of Metamorphic Tectonites.

**PAPER 3 : ORE GEOLOGY | LTP / CREDITS = 301/4|**

**UNIT 1: Ore – bearing fluids**: magma, hydrothermal fluids, meteoric waters, sea-waters, connate waters, metamorphic fluids. Depositional textures: exsolution, replacement, colloidal – colloform and open-space filling textures. Wall rock alteration: reaction between wall rocks and fluids, alteration assemblages and types of alteration. Paragenesis and zoning in mineral deposits. Classification of ore deposits. Deposits related to ultramafic-mafic rocks (layered intrusions, anorthosites, kimberlites, carbonates, komatiites). Deposits related to intermediate to felsic rocks (Iron deposits, porphyry Mo, pegmatites, granitic Tin and U, skarn deposits with typical examples).

**UNIT 2: Deposits related to weathering** – Nickel laterite deposits, Deposits related to clastic sedimentation: placer deposits – Witwatersrand gold and U deposits. Chemical sedimentation: phosphate deposits, evaporates, manganese nodules, Ore deposits related to subaerial (Epithermal gold – Au) and submarine volcanism (Kuroko Cu–Zn, Japan, BIFs). Ore deposits related to metamorphism, metallogenic provinces, Epochs and plate Tectonic – classification of ore deposits.

**UNIT 3: Metallic deposits of India**: Iron, Manganese, Copper, Chromium, Gold, Lead, Zinc and Bauxite deposits, Non-metallic deposits (Industrial minerals) – Minerals used as



fertilizers, refractories, abrasives, pigments, ceramic and glass-making materials.

**UNIT 4: PRACTICALS: Optical methods in minerals:** Determination of pleochroic scheme and optic sign in minerals. Birefringence. Identification of ore minerals based on optical properties: chromite, ilmenite, Ti-magnetite, hematite, pyrite, sphalerite, galena, chalcopyrite, covellite, bornite, pyrrhotite, arsenopyrite and pyrolusite.

**REFERENCE:**

1. The geology of ore deposits-John M. Guilbert and Charles F. Park, Jr. W.H. Freeman & Co., New York. 1986.
2. Interpretation of ore textures - Bastin, E.S.
3. Economic Mineral deposits by Jenson and Bateman, A.M.
4. Ore microscopy - Cameron, E.N.
5. Textures of the ore minerals - Edwards, A.B.
6. Ore deposits - Park, Jr. C.F.
7. Geology of Mineral deposits - Smirnov, U.J.
8. The minerals and their intergrowths - Ramhor, Dr. Paul.
9. Ore Petrology - Stanton, R.L.
10. India's mineral resources - Sinha and Krishnaswamy, S.
11. Metallic and Industrial minerals - Lamey Carl, A.
12. Introduction to India's economic minerals - Sharma, N.L. & Ram. K.S.
13. A treatise on industrial minerals of India-Sinha, R.L.
14. Mineral deposits of India, Mukerjee 1999: Allied publications.

**PAPER 4: FUEL RESOURCES & MINERAL ECONOMICS**

**[LTP / CREDITS = 400/4]**

**UNIT 1: Coal:** Definition and origin of coal. Stratigraphy of coal measures. Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Indian coal deposits. **Petroleum:** Origin, migration and entrapment of hydrocarbons. Characters and source and reservoir rocks. Structural, stratigraphic and mixed traps. Geographical and geological distributions of onshore and offshore petroliferous basins of India.

**UNIT 2: Radioactive minerals:** Mineralogical and geochemical studies of radioactive minerals. Detection and measurement of radioactivity. Prospecting and assaying of Radioactive mineral deposits. Occurrence and distribution of radioactive minerals in India. Nuclear waste disposal=geological constraints.

**Unit 3: Introduction and concepts of mineral economics.** Peculiarities in mineral deposits. Concepts in mineral exploration and mineral resource estimation. Classification of Indian mineral resources. Role of mineral industry in national economy. Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption.

**Unit 4: National Mineral Policy.** Mineral Concession Rules. Mineral legislation in Karnataka and India. Mining Acts, Mineral production, processing, coproducts and byproducts. Mineral inventory. Consumption and substitution of minerals. Demand Analysis and market survey. Mineral conservation and environment. Mineral information system. Marine mineral resources and Law of Sea.

**Reference:**

1. Nuclear geology and Atomic mineral Resources - S.N. Virnave. Published by Bharati Bhawan 1995



2. Mineral Resources of India – D.K. Banerjee. Published by the world press.
3. Radioactive minerals – R. Dhanaraju –2005 published by Geological Society of India.
4. Economic Mineral deposits – A.M. Bateman
5. Geology of Mineral deposits – Smirnov U.G.
6. Indian Mineral Resources – Krishna Swamy.S.
7. Introduction to India Economic Mineral deposits – Sharma, N.L. & Ram, K.S.
8. Basic Petroleum Geology – P.K.Link
9. Petroleum Stratigraphy – R.L.Breuner
10. World Oil Energy Economics – H.A.Kerklelin
11. Jaharia Coal Field – D.Chandra
12. Petroleum Formation and Occurrence – B.P. Tissot
13. Petroleum Geology – Levorsen
14. Mineral Economics by Truscot, John Wiley and Sons, Inc, 1987.
15. An introduction to mineral Economics – K.K.Chatterjee. publisher : - Wiley Eastern. 1993.
16. Mineral Economics : - R.K. Sinha and N.L.Sharma. Oxford and IBH publication
17. Five year plan Gezzetier Central government and State government.
18. Central Government weekly employment news.

**PAPER 5: ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT (SOFT CORE) (LTP/CREDITS = 400/4)**

**Unit 1 : Environmental Geology :** Fundamental concepts of Environmental Geology - it's scope, objectives, and aims. Earth's thermal environment and Climates. Global warming. Green house effect. Ozone depletion–Ice sheets and fluctuation in sea levels. Concepts of ecosystem. Earth's major ecosystems terrestrial and aquatic. Meteorology as environmental science. Air Pollution, sources of pollution, pollution due to dust and waste disposal. National and International standards. Environmental health hazards. Mining, opencast, underground, disposal of industrial and radio-active waste, dumping stacking, rehandling, management, mineral processing, tailing ponds, acid mine drainage, siltation, case studies. Mining below water table, mine water discharges, regional effects on water regime. Noise levels- national standards, mining machinery, ill effects. Air sampling techniques – respirable dust samplers, high volume air samplers, personal sampling pumps, weather monitoring equipments and automatic recorders.

**Unit 2: Environmental Impact Assessment** – impacts, primary, secondary, prediction, assessment, base-line data generation, physical, biological, cultural, socioeconomic aspects. Carrying capacity based developmental planning – Assimilative capacity – supportive capacity – Resource based planning – Institutional strategies. Sustainable Developmental Planning. Applications of GIS in Environmental Management. Environmental Legislations in India. Concepts and principles: Natural hazards – preventive/ precautionary measures – floods, landslides, earthquakes, river and coastal erosion. Distribution, magnitude and intensity of earthquakes. Neotectonics and seismic hazard assessment. preparation of seismic hazard maps. Impact of seismic hazards on long and short term environmental conditions. Mechanism of landslides, causes of major floods, cyclones and storms. Deforestation and land degradation. Coastal erosion, its causes and control of Geological hazards and crisis management.

**Unit: 3: Disaster Management:** Definition and types of disaster Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes. Man-made disasters: Terrorism, gas and radiations leaks, toxic waste



disposal, oil spills, forest fires. Study of Important disasters, Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landside and its managements case studies of disasters (e.g) Earthquakes, Landside). Social Economics and Environmental impact of disasters.

**Unit: 4: Disaster Management:** Mitigation and Management techniques of Disaster Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warning Systems, Building design and construction in highly seismic zones, retrofitting of buildings. Training, awareness program and project on disaster management Training and drills for disaster preparedness, Awareness generation program, Usages of GIS and Remote sensing techniques in disaster management, Mini project on disaster risk assessment and preparedness for disasters with reference to disasters and its surrounding areas.

#### References

1. Environmental Geology – Peter TP Flawn
2. Environmental geosciences – Arthur H Strahler & Alan Strauler
3. Geology in Environmental planning- A.D. Howard & I.Ramson
4. Focus on Environmental Geology –R Turk
5. Environmental Science –S C Santra
6. Environmental geology by Waldia K.S
7. Climatology: An Atmospheric Science, 2/e, Pearson Education India, 1993 - 423 p.
8. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
9. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
10. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
11. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

## SEMESTER – II

### PAPER 6: PALAEOONTOLOGY [LTP / CREDITS = 301/4]

**UNIT 1: Micro-Paleontology:** Origin and Evolution of Life: Introduction of Microfossils; Classification of Microfossils; Separation of various Microfossils: Morphology, stratigraphic significance and applications of – Foramanifera, Ostracoda, Palynofossils, Acritarchs, Bryozoa, Chitinozoa, conodont, Scoleconodonds. Diatom, Radiolarians, Dinoflagellates and Nanoplanktons. Application of microfossils in fossil fuel exploration, paeoclimatic interpretation and maturation of sediments, Oxygen and Carbon Isotope studies on Fossils.

**UNIT 2: Invertebrate Paleontology:** Morphology, classification, paleo-ecology and evolutionary trends of porifera. Mollusca: Pelecypoda, Classification on the basis of dentition and dental formula, dental system with example. Class Cephalopoda suture pattern. Arthropoda: Class Trilobita, Echinodermata, Trace fossils – marine & terrestrial, Hemicardata: Class Graptozoa

**UNIT 3: Vertebrate Paleontology & Paleobotany:** Vertebrates: Evolution, classification and geological significance of – Fishes; Amphibian, Reptiles, Mammals: Elephant, Horses and Man. Paleobotany: Techniques of spores and pollens analysis, Morphology, General



classification of algae and stromatolites and their stratigraphic importance. Paleozoic, Mesozoic and Cenozoic plants – Bryophytes, Pteridophytes, Gymnosperms and Angiosperms and their stratigraphic significance.

**UNIT 4: PRACTICALS:** Identification, Diagnosis and Geological distribution of the following Groups: Invertebrate – Brachiopods – 5 genera, Cephalopoda: 5 genera, Pelecypoda: 5 Genera, Trilobita: 5 genera, Graptozoa: 2 genera, Plant Fossils: 6 genera, Microfossils – Foraminifera: 8 genera, Ostracoda: 3 genera, Palynofossils: 6 genera. Problems on biostratigraphy & Palaeo-ecology.

#### REFERENCES:

1. Clarkson, E.N.K., 1998, Invertebrate Paleontology and Evolution, IV edition, publ., Blackwell
2. Stearn, C.W. & Carroll R. L. 1989, Paleontology-the record of Life, Publ. John Wiley.
3. Smith, A.B, 1994, Systematics and the Fossils Record-Documenting Evolutionary Patterns., publ., Blackwell
4. Prothero. D.R., 1998, Bringing Fossils to Life- An Introduction to Palaeontology., publ., Mc Graw Hill
5. D. J. Jones, 1956. Microfossils
6. F.T.Banner and A.R.,Lord., Aspects of Micropaleontology
7. M.P.Glaessner, Principles of Micropaleontology
8. M.D,Brasier, 1955, Microfossils, publ.George allan and Wiley & Sons
9. Romer.A, Vertebrate Paleontology
10. Colbert, Introduction to Vertebrate Paleontology
11. Sukla., A.C & Misra S.P, 1975, Study of Paleobotany Vikar Publ. House
12. Sripad.N.Agashe, Palaeobotany
13. Maohotra, A K, Ocean Science and Technology
14. Tchernia,P, Descriptive regional oceanography
15. K.Siddhartha, Oceanography- A brief introduction
16. William A Anikouchine and Richard W Stenbegr; the world Ocean- An Introduction to oceanography
17. Cuchlaine A M King, oceanography for Geographers
18. H.V. Thurman, Introduction to Oceanography

#### **PAPER 7 : IGNEOUS, SEDIMENTARY AND METAMORPHIC PETROLOGY [ LTP / CREDITS = 301/4]**

**UNIT 1: Igneous Petrology:** Introduction, definition and properties of Igneous rocks. Structure, Texture, Classification, description, mode of occurrence, petrogenetic significance and economic importance of Igneous rocks. Granite, Syenite, Gabbro, Layered Igneous complex, Kimberlite, Anorthosite, Carbonatite, Peridotite, Pegmatite, Dolerite, Lamprophyre, Basalt, Rhyolite, Trachyte and Andesite. Petrogenetic significance and economic importance of igneous rocks

**UNIT 2: Sedimentary Petrology:** Aim, Scope and importance – Historical development-Relationship with other branches of geology. **Properties of Sedimentary rocks:** textures of sedimentary rocks, Sedimentary facies and environment. Diagenesis of sediments. **Classification and description of sedimentary rocks:** Gravels, Conglomerates, Sands and Sandstones, Argillite, Non-evaporates and Evaporates, Heavy mineral studies, Grain size parameter Modes and Mechanism controls of sedimentation, Stock's law, Primary Sedimentary structures, Tectonics and sedimentation. **Applications of sedimentary rocks:** in Petroleum Geology.



**Unit 3: Metamorphic Petrology:** Introduction. Definition. Limits and agents of Metamorphism. Structure and Texture of Metamorphic rocks- Types of metamorphism based on principal process ( Orogenic, Hydrothermal, Burial, regional, fault zone, Prograde-Retrograde, progressive Retrograde). Regional and Contact Metamorphism of Pelitic and impure Calcareous rocks. Major metamorphic rocks. Metamorphism of mafic rocks. Protoliths and types- Zones of Metamorphism, Metamorphic reactions- Kinetics of metamorphism- Mineral assemblages equilibrium / reaction, texture and geo-thermo barometry. Characteristics of different grades and facies of metamorphism, Metasomatism and granitization, Migmatites. Plate tectonics and Metamorphic Zones. Paired metamorphic belts.

**Practicals: Igneous petrology Practical:** - Identification and classification of Igneous rocks in hand specimens and thin Sections. Interpretation and significance of structure and micro-textures in understanding tectono magmatic history..

**Sedimentary petrology Practical:** Identification of Sedimentary rocks in hand specimens and thin sections. Identification of Structures in Sedimentary rocks. Grain size analysis - sieving, analysis of roundness and sphericity by visual method

**Metamorphic Petrology Practicals:** Megascopic and Microscopic identification of different types of metamorphic rocks and significance of structure and micro textures in understanding metamorphic and tectonic process.

#### REFERENCE:

1. Petrology of Igneous and Metamorphic rocks by **Hyndman**
2. Principles of of Igneous and Metamorphic rocks by **Anthony R. Philpotts.**
3. Igneous petrology by **Anthony Hall**
4. Petrology of Igneous and Metamorphic rocks by **Best.**
5. Sedimentary Petrology – Pettijohn
6. Petrography – An introduction to the study of rocks in thin sections – H Kowell, Williams and Turner.
7. Manual of sedimentary petrology – Krumbein and Pettijohn.
8. Principles of sedimentation – Twenhofel.
9. Sequence in layered rocks – Shrock, R.R
10. Procedures in sedimentary petrology – R.E. Carver
11. Origin of sedimentary rocks – Blatt, Middleton and Murray.
12. Microscope sedimentary petrology – A.V. Carrozi.
13. Sand and Sand Stones – Pettijohn, Potter and Siever.
14. Petrology of Sedimentary rocks – R.L. Folk.
15. Hand book of subsurface geology – C.A. Moore
16. Marine geology and Oceanography of the Arctic seas- Yvonne Herman.
17. Petrography – An introduction to the study of rocks in thin sections – H Kowell,, Williams and Turner.
18. Migmatites - Ashworth.
19. Metamorphism - A. Methuen & Co.
20. Migmatites and the origin of granitic rocks - Mehnert K.R. Elsevier & Co.
21. Metamorphism and Metamorphic rocks - Miyashiro, A. George, Allen and Unwin.
22. Petrogenesis of metamorphic rocks- Winkler, H.G.F. Springer, verly.

#### PAPER-8: GEOCHEMISTRY AND PETROGENESIS | LTP / CREDITS = 301/4|

**UNIT 1: Geochemistry:** Basic concepts and scope of geochemistry, Age, origin and composition of the universe with special reference to solar system, Geochemical classification of elements, primary differentiation of the earth, Meteorites- classification,



composition and origin, Geochemical cycle, geochemical fractionation of trace and REE elements in magmatic process and its importance.

**UNIT 2: Dating techniques:** Radioactive decay schemes, Radioactive dating, Radiogenic isotope systematics: U-Pb, Rb-Sr, K-Ar systematics. Stable isotopes: Carbon, Oxygen, Sulphur and Hydrogen.

**UNIT 3: Petrogenesis:** Genesis- properties- emplacement- crystallisation and differentiation of magmas. Physical properties of magma. Bowen's reaction series. Mechanism of magma diversification (differentiation)- partial melting, crystal fractionation, Thermogravitational diffusion, liquid immiscibility, vapour transport, vapour phase alterations magma mixing, exsolution phenomena, assimilation. Phase equilibria studies- Basic concepts -phase and component, phase rule, unary system with examples of P-T diagrams of water and  $Al_2SiO_5$ /Silica, ternary system and binary system -Diop-An and Fo-Fa.

**UNIT 4: PRACTICALS:** P-T calculations and construction of P-T diagrams. Petrochemical calculations- Niggli vertex and Niggli base, CIPW norm calculation, Trilinear plots, construction of Variation/ Discriminant diagrams using major, trace and REE geochemistry data and interpretation. Isotopic age determination of rocks/minerals. Chemical analysis of Ore minerals.

#### REFERENCES:

1. Geochemistry- William.M.White-Wiley black well publications
2. Introduction to carbon capture and sequestration- Berend Smit, Jeffrey.A. Reimer, CurtisM. Oldenburg and Ian.C.Bourg.
3. Rare earth element Geochemistry by Henderson
4. Geochemistry by Rankama and Sahama
5. Petrologic Phase equilibria – W.G.Ernst
6. The Interpretation of Geological Phase diagrams - Ernest G Ehlers
7. Petrogenesis – Wilson
8. Solutions, Minerals and Equilibria – Garrels and Christ, 1966
9. Simulating the Earth- J.R. Holloway and B.J. Wood, 1988
10. Basic analytical Petrography – Ragland, 1989
11. Principles of Igneous and Metamorphic Petrology by Antony R Philpotts, 1979.1.
12. Geochemical Thermodynamics by Darrell Kirk Nordstrom and James L. Munoz
13. Chemical Thermodynamics for earth scientists by Philip Fletcher, 1993
14. Chemical Fundamentals of Geology by Robin Gill.
15. Elementary Thermodynamics by B.J. Wood and D.G. Fraser, 1976
16. Equilibrium Thermodynamics by Roger Powell
17. Principles of Geochemistry – Brian Mason
18. Geochemistry by Anderson
19. Chemical Thermodynamics by Bruce H Mahan

#### **PAPER 9: FIELD WORK AND TECHNICAL REPORT (MINOR PROJECT) [LTP / CREDITS = 004/4]**

**Field work and Technical Report (FW & TR) :** The candidate has to undertake field mapping and preparation of report in a particular terrain for a period of 15 days. C1, C2 & C3 marks will be evaluated as per the university guidelines.



## **PAPER 10: PRECAMBRIAN CRUSTAL EVOLUTION [ LTP / CREDITS = 400/4]**

**Unit 1: Geological time span.** Early earth features. Mountain Building activity. Era-Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth. A magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts. Lithosphere and Mantle reactions. Origin of the crust. Lower crust-first continents. early continental crust. growth of crust- Mechanism of continental growth and its growth rate. Growth of Continents.

**Unit 2: Primary Atmosphere.** Secondary Atmosphere. Oxygen in atmosphere- geologic indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory and outgassing. Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian.

**Unit 3: Precambrian Era** – Introduction, Physical features, Physiographic features and Tectonic features of India. Brief studies on – Dharwar Craton, Baster Craton, Singhbhum Craton, Bundelkhand Craton and Aravalli Craton. A brief account on – Eastern Ghats Mobile Belt, Pandyan Mobile Belt and Satpura Mobile Belt. Precambrian of Himalaya. Proterozoic Sedimentary Basins - Bijawar and Sonari, Gwalior, Abujhmar, Papaghni sub- basin, Vindhyan, Chhattisgarh, Khariar, Ampani, Indravati, Sabri, Pranhita-Godavari, Cuddapah, Kaladgi and Bhima.

**Unit 4: Precambrian mineral Deposits.** Proterozoic life. oldest rocks. Continental foundation. Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of laurestia- Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia- grenville orogeny– Proterozoic rifting. Mid-continent rift- snowball earth. Crustal provinces- Precambrian provinces of North America. Cratons of Americ- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of South Africa. Cratons- Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India.

### **Reference:**

1. Archaean Geology- C.S. Pichamuthu
2. Early Precambrian supracrustal of southern Karantaka-Memoir 112. Geol.Surv. Ind
3. Geology of Karantaka- B.P Radhakrishna
4. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
5. Geology of India and Burma- M.S Krishnan
6. Geology of India- M. Wadia
7. Crustal Evolution and Metallogeny in India- Sanib Chandra Sarkar and Anupendu Gupta.

## **PAPER 11: BASICS OF EARTH SCIENCE [ LTP / CREDITS = 400/4] OPEN ELECTIVE**

**Unit 1: Physical Geology** -Introduction to geology. Origin of the Earth. Age of the earth. Interior of the Earth. Geomorphic processes and cycles, Geological action of wind, water, glaciers. Volcanoes and earthquakes. Morphology of Oceans, Principles of Isostasy and uniformitarianism.

**Unit 2: Structural Geology** - Rock deformation. Earth forces. Folds and Foldings, Fault and Faulting, Joints, Cleavage, Unconformities, Concept of plate tectonics, sea floor spreading and geosynclines.



**Unit 3: Stratigraphy-** Introduction, Definition of Stratigraphy, Branches of Stratigraphy and its relation with other branches of Geology, Principles of Stratigraphy- Law of Uniformitarianism, Law of order of superposition, Law of Faunal Succession. Geological Record and its nature Eon, Era, Period. Geological Time Scale. Classification of Standard Stratigraphic scale. Nomenclature and units-Litho, Bio and Chrono stratigraphic units, Correlation- Lithostratigraphic and Biostratigraphic.

**Unit 4: Paleontology** -Introduction, Definition of Paleontology, Classification of Plants, Invertebrate and Vertebrate fossils. Fossils-Tophonomy (Burial Law), Types of Fossilization, Mode of preservation- Mummification, Carbonization, Silification, Casts, Moulds, Tracks and Trails. Applications of Fossils. General morphological characters and Geological age of the following Invertebrate and Plant Fossils: Brachiopoda, Cephalopoda, Pelecypoda and Trilobita. Plant fossils: Glossopteris, Gangamopteris, Ptillophylum, Calamites and Lepidodendron.

**References:**

1. Physical Geology by Arthur Holmes
2. Structural Geology by Billings
3. General Geology By P.K. Mukerjee
4. Physical Geology By Strahler
5. Stratigraphic Principles and Practice-Weller
6. Stratigraphy-Kumberlein and Sloss
7. Paleontology of the Invertebrates-Tasch Publ.Jhon Wiley and Sons
8. Paleontology- Henry Wood
9. Fossils Plants- Arnold
10. The Elements of Paleontology Black,R.M Pub. Cambridge university press

**SEMESTER - III**

**PAPER-12 : GEOINFORMATICS [ LTP / CREDITS = 202/4]**

**Unit 1: Remote Sensing:** Fundamental concepts of Remote Sensing. Electromagnetic Spectrum. Electromagnetic bands in remote sensing. Electromagnetic waves, wavelength units, Different bands ( L, S, C, X, Ku ,Ka, NIR, SWIR, MWIR, LWIR, FIR, Visible light, UV, X-rays, Gamma rays and Photons). Spectral characteristics of different objects. Spectral reflectance of land cover Principles of Aerial Photography, Photogrammetry and Remote Sensing. Energy Interactions with the matter and atmosphere. Black Body Radiation. Sensors, Scanners and their capabilities, Platforms- Types of Platforms. Satellite Remote Sensing. Resolution and Types of Resolution. Method of Image Interpretation and Classification. Digital Image Processing. Indian Remote Sensing Satellites. Remote Sensing in Visible, Infrared Rays, Micro Wave and Thermal regions. Application of Remote sensing in Geological mapping, Mineral Exploration, Soil and water resources studies. Role of Remote Sensing in Flood hazard evaluation and disaster management.

**Unit 2: GIS:** Definition of Geographic Information System. The nature of geospatial information and data representation. Cartography. Maps and spatial information. Cartographic symbology. GIS and its subsystems. Components of a GIS. Databases used in GIS. Data Structures: Relational, hierarchical and network. RDBMS. Data models used in GIS. Spatial data models. Vector data Model. Raster data Model. DEM. TIN. Vector and Raster - advantages and disadvantages. Attribute data models. Topological relationships of



spatial data. Data Sources.GPS. Data input techniques. Digitization of maps and imageries; Coordinate transformation; Attribute data generation . Spatial data layers . Data retrieval and querying. Spatial analysis -Spatial overlay operations, buffering, trend surface mapping. Network analysis and proximity analysis; 3D models. GIS Modeling for decision support. Applications of GIS in earth's resources evaluation and management.

**Unit 3 Practical: Remote Sensing:** Visual and Digital interpretation of Reading of Topo maps. Visualization and Interpretation of Satellite Imageries. Interpretation and Demarcation of lithological Units. Interpretation Drainage patterns and water bodies. Interpretation and Measurement of Lineaments Interpretation of Geological Structures, Interpretation of land use/land cover. Interpretation of vegetation Interpretation of Mining and Mineralized zones

**Unit 4: GIS:** Methods of digitizing geospatial data( toposheet/ satellite image). Methods of creating x,y,z data as database and preparing contour maps. Georeferencing co-ordinates in scanned topo sheets or maps and computing the the geometrical properties of digitized zones.

#### Reference:

1. Text book of Remote sensing and geographical Information system, 1<sup>st</sup> & 2<sup>nd</sup> Ed. By M. Anjireddy, BS Publications, Hyderabad
2. Remote sensing principles and Interpretations, 3<sup>rd</sup> edition, Floyd. F. Sabins
3. Applications of Remote sensing and GIS by H T Basavarajappa, Et. Al
4. Cartography: Visualization of Geospatial data – Menno-Jan Kraak and Ferjan Ormeling
5. Principles and application of Photogeology – Shiv N Pandey
6. Aerial photographic interpretation, Principles and applications - D.R.Leuder.
7. Photogeology - Miller, J.C.
8. Manual of colour aerial photography -Ed. Smith, J.T.Jr.
9. Manual of photogrammetry - Ed: Morrie M. Thompson.
10. Manual of Remote sensing - Ed: Robert G Reeves.
11. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
12. Remote sensing in Geology - Parry S. Siegal & Alan. R.Gillespie
13. Manual of photographic interpretation - Ed: Colwell, R.N.
14. Principles of Remote Sensing – Patel Singh; SP publication
15. Digital Remote Sensing – Pritivish Nag M Kudrat ; Concept publication
16. Principles of GIS for land and resources assessment, Burrough, P.A., 1986, Oxford.
17. Introductory cartography, Campbell, 1984, Prentice Hall
18. Map data processing, Freeman and Pieroni, 1980, Academic Press.
19. An introduction to Geographical information systems: Ian Heywood et. al.
20. Geographical information systems and digital image processing – Muralikrishna 1999. Allied Publication
21. Fundamentals of remote sensing and Geoinformatics , by Anjireddy, Hyderabad ed. 1 and 2.
22. Geographic Information Systems: An Introduction, 3rd Ed, Bernhardsen, John Wiley & Sons, 01- Jan-2007 - 444 pages
23. Geographic information systems and science, Paul Longley, Wiley, 13-Jul-2001 - Education - 454 pages
24. Geographic Information Systems for Geoscientists: Modelling with GIS, Graeme F. Bonham- Carter, Elsevier, 18-May-2014 - Science - 416 pages
25. Geographic Information Systems and Science, Paul Longley, John Wiley & Sons, 22- Mar-2005 - Science - 517 pages
26. Handbook on Geographic Information Systems and Digital Mapping, United Nations. Statistical Division, United Nations Publications, 2000 - Census - 197 pages
27. Introductory Readings In Geographic Information Systems, D J Peuquet, D F Marble, CRC



- Press, 16-Dec-2003 - Technology & Engineering - 371 pages
28. Geographic Information Systems (GIS) and Mapping: Practices and Standards, Issue 1126, Arnold Ivan Johnson, C. Bernt Pettersson, ASTM International, 01-Jan-1992 - Travel - 346 pages
  29. Introduction to Geographic Information Systems, Kang-tsung Chang, McGraw-Hill Education, 16-Jan-2015 - Science - 448 pages
  30. Fundamentals of Geographical Information Systems, Michael N. DeMers, Wiley, 2009 - Science - 443 pages
  31. Textbook of Remote Sensing and Geographical Information Systems, Kali Charan Sahu, Atlantic Publishers & Dist, 01-Dec-2007 - 512 pages
  32. Geographic Information System, B. Gurugnanam, New India Publishing, 09-Jun-2009 - Geographic information systems - 206 pages
  33. Fundamentals of Geographical Information Systems, Michael N. DeMers, Wiley, 2009 - Science - 443 pages

**PAPER 13 : INDIAN STRATIGRAPHY & SEQUENCE STRATIGRAPHY | LTP / CREDITS = 400/4|**

**UNIT 1: PALEOZOIC ERA:** Introduction, Tethyan Basin, Paleozoic Life, Trace fossils and Stromatolites. Precambrian/Cambrian boundary, pC/C boundary in Himalayan basins. Cambrian – Jammu and Kashmir, Himachal Pradesh, Tal Basins and Uttaranchal. Ordovician and Silurian - Jammu and Kashmir, Himachal Pradesh and Uttaranchal. Devonian - Jammu and Kashmir, Himachal Pradesh and Uttaranchal. Carboniferous - Jammu and Kashmir, Eastern Karakoram, Himachal Pradesh and Uttaranchal. Permian - Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Bhutan Arunachal Pradesh and Peninsular India-Cauvery Basin. Gondwana Supergroup – Introduction, Characteristics, Stratigraphy and Structure, Classification and Age, Life in Gondwana, Coastal Gondwana Basins, Gondwana in Extra-Peninsular India, Environmental of deposition and Economic Significance.

**UNIT 2: MESOZOIC ERA –** Introduction, Life of Mesozoic Era, Triassic - Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Rajasthan and Kutch. Permo-Triassic Boundary. Jurassic – Kutch, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Jharkhand and Bhutan. Cretaceous – Gujarat, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, East Coast, Trichinopoly, Narmada Basin, Lameta Formation, Jharkhand, Assam/Meghalaya, Andaman and Nicobar Islands. Cretaceous/Tertiary Boundary. Deccan Volcanic Province – Introduction, Regional Stratigraphy, Subprovinces, Volcano-Plutonic Complexes, Petrology and Petrogenesis, Inter-Trappean beds, Distribution and its age.

**UNIT 3: CENOZOIC ERA –** Introduction, Distribution, Climate, Correlation, Fauna and Flora, Classification and Stratigraphy. Paleogene – Introduction, Fauna and Flora, Stratigraphy and Distribution. Neogene – Introduction, Fauna and Flora, Stratigraphy and Distribution. Quaternary – Introduction, Distribution, Quaternary climatic changes, Quaternary Sea level changes. Siwalik – Stratigraphy and Sedimentation, Distribution and Fauna of Siwalik. Geology of Offshore Basins. Morphology and Evaluation.

**UNIT 4: SEQUENCE STRATIGRAPHY :** Introduction to Stratigraphy, branches of Stratigraphy. Terms and concepts of Sequence Stratigraphy and its relationship with other branches of Stratigraphy. Sedimentary basin analysis through sequence Stratigraphy. Out crop and subsurface procedures. Global sea level changes/ eustatic sea level. Applications of sequence stratigraphy in petroleum exploration with case studies.



## REFERENCES:

1. Geology of India Vol.1 & 2. M.Ramakrishnan and R Vaidyanathan
2. Geology of India – Wadia, D.N., Mc Millan and Co.
3. Geology of India and Burma – Krishnan M.S. Higginbotham, Madras.
4. A hand book of the Geology of the Mysore State – B. Rama Rao, Bangalore press.
5. Precambrian Stratigraphy and Geochronology of the Peninsular India – Sarkar, S.N. Dhanbad Publishers.
6. Review papers on the Stratigraphy of India –Rec.Geol.Surv.India Vol.101, Part 2.1972Cretaceous Tertiary formations –Geol.Soc. India, seminar Vol. 1958.
7. Paleozoic of Himalayas. HPC publ.Reconnaissance Rb-Sr dating of the Precambrian of Southern Peninsular India- Crawford, A.R., J.G.S.I 1972. 117-126.
8. Sequence stratigraphy- BHP petroleum (America) Inc – Michael Yeaman, Lavy Holcomb, Gill Taylor 1990
9. Sequence stratigraphy – BP Exporation. Stockley Park UK Bridge London, Publ. Blackwell science
10. Sea Level Changes- An Integrated Approach Spl. Pbln.42, Barbara H.Lidz, Editor of Spl. Publ. Oklahoma USA 1998
11. Sequence in Layered Rocks- Blatt Middleton & Humay
12. Sedimentary Petrology- Pettijhon

## **PAPER 14: EXPLORATION GEOLOGY & MINING METHODS [ LTP / CREDITS = 301/4]**

**UNIT 1: Geological Exploration-** Mode of occurrence of commercial-grade deposits of Fe, Mn, An-Ag-(W), Cu,Pb-Zn,Ti,Ni,Mo,Sn,Al,Pt - group. U-Th. Geological criteria for mineral prospecting. Indications of ore. Geological prospecting methods. Small and large scale geological mapping. Methods of geological exploration - exploratory grids, location and documentation of exploratory workings (pits, trenches underground workings), drilling, core logging. Sampling techniques and evaluation of grade. Mining terminology, methods of open cast, underground and alluvial mining.

Definition and scope of mineral processing, communiton, crushers and classifiers. Froth flotation techniques of separation.

**Unit 2: Geochemical Exploration:** Basic principles- Geochemical cycle-Geochemical Environment-Geochemical dispersion-Geochemical mobility and Geochemical reactions-Dispersion of elements under deepseated conditions- Weathering and its products -Mobility under surficial conditions-Association of elements-Patterns of geochemical distribution-Normal back ground values-Geochemical anomaly- geochemical anomaly in residual overburden and geochemical anomalies in transported overburden--Anomalies in gossans and leached outcrops of ores-Epigenetic anomalies-Syngenetic anomalies in residual soil-mode of occurrence of indicator elements in residual soils-Form and magnitude of anomaly-Width of anomalies-Distortion of anomalies-Homogeneity-variation with depth and soil type-Hydromorphic anomalies in residual soil- Anomalies in waters and drainage sediments-Geochemical soil surveys- stability of important minerals -Mode of occurrence of trace elements- Uptake of mineral matter by plants. Biogeochemical anomalies and survey techniques.

**UNIT 3: Geophysical Exploration:** General Principles and classification of Geophysical methods ,Geological applications of Geophysical methods, Geophysical field operations,



Interpretation of geophysical data, Methods and techniques of exploration geophysics and Geophysical anomalies. **Magnetic methods**- Principles and elementary theory, The sources of the Earth's Magnetic field, Instruments, Data processing and interpretation, Magnetic properties of rocks, Case of aeromagnetic surveying for aquifer exploration.

**Resistivity methods**- Electrical prospecting and measurement of resistivity, types of profiling, Equipment for resistivity field work, Electrode layouts and field procedures, interpretations, Resistivity of rocks and Resistivity measurements.

**Seismic methods**: Importance of seismic work, History of seismic exploration, Principles and instrumentation, Reflection and refraction of Seismic waves. Field equipments.

**Gravity methods**: Principles and Field procedures, types, instruments, Interpretation of gravity anomalies, Applications to groundwater exploration.

**Geophysical Borehole logging methods**: Principles and Instrumentation, logging physical parameters, Data processing and interpretation.

**Radiometric methods**: Principles of radioactivity, exploration and its types of instruments, Applications of radiometric methods.

**UNIT 4: PRACTICAL: Geological Exploration**- Delineation of ore deposit based on exploration data. Classification of ore reserves. Economic evaluation of ore deposit. Preparation of technical report.

**Geochemical Exploration**: Geochemical methods in mineral exploration and choice of materials and methods.

Interpretation of Geochemical maps for locating ore mineralization. Preparation of geochemical anomaly maps.

**Geophysical exploration**: Resistivity methods: Curve matching techniques and s-line method.

#### REFERENCE BOOKS

1. Introduction to geophysical prospecting - Milton B Dobrin
2. Exploration geophysics – Jakaosku J J
3. Outlines of geophysical prospecting - A manual for geologists – M B Ramachandra Rao
4. Geophysical Methods in Geology – P V Sharama
5. Exploration Geophysics for geologist and Engineers – Bhimasanakaran and Gaur
6. Principles of Applied Geophysics – D S Paransis
7. Introduction to Geophysics – C H Howel
8. Geochemistry in mineral exploration Rose, A.W Hawkes. H.E & Webb J.S. 1979. Academic press.
9. Principles of geochemical prospecting. Ginzburg. I.I. Petgamon Press, N.Y. London.
10. Biochemical methods of Prospecting - Malyuga, D.P.
11. Principles of Mining Geology, Arokiaswamy.
12. Geological prospecting and exploration – Kreiter, V.M.
13. Rock geochemistry in Mineral Exploration. G.J.S.Govett. Elsevier Publication. 1983.

#### PAPER 15 : HYDROGEOLOGY | LTP / CREDITS = 301/4|

**UNIT 1: VERTICAL DISTRIBUTION OF GROUNDWATER**: Hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient. Classification of aquifers, Concepts of drainage basin. Water table fluctuations – causative factors, Preparation and interpretation of water table contour maps.



Hydro-stratigraphic units, Groundwater provinces of India, Occurrence of groundwater in igneous, sedimentary and metamorphic rocks.

**UNIT 2: THEORY OF GROUNDWATER FLOW:** Darcy's Law and its applications, Determination of permeability in laboratory and in field, Types of wells, Drilling methods, construction, design, development and maintenance of wells, Specific capacity and its determination. Types of groundwater flow-Unconfined, confined, steady, unsteady and radial flow conditions. Aquifer parameter evaluation- Pumps tests- methods, data analysis and interpretation for hydrogeologic boundaries, Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods, Groundwater modeling – numerical approach and electrical resistance capacitance network.

**UNIT 3: GROUNDWATER EXPLORATION:** Geological – lithological and structural mapping, lineament Fracture trace analysis, Hydrogeological – lithological classification with respect of hydrologic properties, Hydrogeomorphic units, Location of springs Interpretation of satellite Data for water resources evaluation. Problems relating to occurrence and distribution of groundwater. Groundwater problems related to foundation work, mining, canals and tunnels, Problems of over exploitation and groundwater mining. Groundwater development in urban and rural area. Artificial recharge methods, Groundwater problems in arid regions and remediation. Groundwater balance and the methods of estimation. Groundwater legislation.

**GROUNDWATER CHEMISTRY,** Hydrogeochemistry physical, chemical and biological properties of water, Quality criteria for different uses, Water quality parameters. Graphical representation of water quality data, Problems of arsenic and fluoride in groundwater, Saline water intrusion in coastal and island aquifers and its prevention.

**UNIT 4: PRACTICAL:** Rainfall patterns of distribution, methods of preparing isohyetal map and Thiessen polygon maps and interpreting volumes of rainfall. Methods of computing runoff volumes- Manning coefficient- flow velocity and discharge calculations, wading method. Analysis water level fluctuation data-Preparation of water level fluctuation data-Preparation of water table contour maps and interpretation. Analysing pumping test data using Jacob's straight line method. Preparation of Iso-resistivity maps and delineating groundwater potential zones. Interpretation of water quality data using numerical and graphical approaches.

**REFERENCE:**

1. Groundwater-C.F.Tolman
2. Groundwater Hydrology-D.K.Todd
3. Hydrology-S.N.Davis and R.J.M Dewiest
4. Groundwater studies-R.H.Brown and others
5. Groundwater Hydrology-Herman Bouver 6 .Hydrology-C.W.Fetter
6. Hand book of Applied hydrology-Van te Chew
7. Groundwater and wells-Hohnson Publications
8. Applied Hydrology-Chow M.Mays.Mac.Graw Hill Publication
9. Hydrology and wetland conservation-Gulam
10. Groundwater survey and investigation-Guatham Mahajan
11. Hydrology-Raghnunath
12. Hydrogeology-Karanth
13. Ecology, Environment and Pollution – A Balasubramanian



**PAPER 16: ENGINEERING GEOLOGY AND SURVEYING [ LTP / CREDITS = 400/4]**

**Unit-1: Surface And Subsurface Geological Investigations:** Field investigations-electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering-Description of discontinuities-bed rock attitudes, thickness, Calculation of True thickness and vertical thickness of bed rock-Geological information for slope stabilization. Rock description and engineering classification of rocks – weathering and its significance in engineering site-Engineering properties of rocks and soils, RMR, RQD methods-determination of engineering properties in field and laboratory.

**Unit 2: Geological Investigations For Dams & Tunnels And Coastal Zones:** Dams - geological investigations- suitability of site, geological profile from catchment area to Dam site- lithology, structures, topography, slope, drainage system- groundwater studies in reservoir sites-reservoir site investigations, siltation analysis-Geological investigations for soft rock and hard rock tunnels construction. Coastal erosion and accretion process and its impact-Geological investigations for harbour construction-Coastal protection structures-Sea walls, bulk heads, groins, jetties.

**Unit 3: Geotechnical Studies Of Landslides And Subsidence:** Landslide - Classification, causative factors, control measures. Land subsidence, factors, causes and remedial measures. Geological considerations for monitoring of landslides. geotechnical problems related to foundation for bridge and building site investigations. Recent trends in geotechnical engineering. Geotechnical case studies of major projects in India.

**Unit 4: Surveying :** Principles and practices of Chain survey, Compass survey, Plane table survey, Dumpy level survey, GPS survey and Total Station Survey

**References:**

- 1.Fundamentals of Engineering Geology – F.G. Bell
- 2.Geology for Engineers – Joseph M.Trfethen
- 3.Geology in Engineers – Schultz Cleaues
- 4.Geology and Engineering - Legget
- 5.Surveying and Levelling – Late T.P. Kanetkar and S.V. Kulkarni.
- 6.Surveying – Punmia.

**PAPER 17: INDUSTRIAL MINERAL RESOURCES [ LTP / CREDITS = 400/4]**  
**OPEN ELECTIVE**

**Unit 1: Mineralogy:** Definition of a Mineral. Classification of Minerals – Rock forming minerals & Ore forming Minerals, Silicate and Non-Silicate minerals. Physical, Chemical and optical properties of Minerals.

**Unit 2: Industrial minerals:** Description of Industrial Minerals: Gold, Silver, Coal, Copper, Diamond, Asbestos, Barite, Calcite, Diatomite, Feldspar, Gypsum, Kaolin, Mica, Silica, Talc, Zeolite and Clay minerals.

**Unit 3:Application of Industrial minerals:** Minerals Used in Paint, Fertilizers, Pesticides,



Abrasives, Refractories, Ceramics, Glass, Pharmaceuticals, Petrochemical and Nuclear Energy.

**Unit 4: Gem Minerals:** (i) Precious varieties 1. Diamond 2. Gem corundum 3. Topaz 4. Emerald (ii) Semi-precious varieties Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems. Minerals Used in Civil work: Sandstones, Marbles, Granites, Sand and Gravel

**References:**

1. Industrial Minerals and Their Uses: a hand book and formulary. Ed. By Peter A Ciullo, Noyes Publications, 1996,
2. India's Mineral Resources by S. Krishnaswamy, Revised by R.K.Sinha, Oxford & IBH Publishing Co.PVT. LTD. Mineral Resources of Karnataka – Geological Society Publication.

**SEMESTER - IV**

**PAPER 18: DISSERTATION [CREDITS – 18]**

The candidate has to carry out independent project work at any state or national Institution/ agency under the supervision of the internal and external supervisors for a period of four months. C1 & C2 evaluation will be assessed as per the University guideline. Candidate has to submit final hard copy of the report in 3 sets to the Chairperson of the department for the evaluation process. C1 & C2 are as per the University regulations.



**Chairman - BOS**

**Centre For Advanced Studies (CAS)  
Department of Studies in Earth Science  
University of Mysore**

**Manasagangothri, MYSORE-570 008**

**Ph. No. 0821-2419724/730/2515256**



Name of the Department: **Department of Studies in Earth Science**  
 Program: **M.Sc., APPLIED GEOLOGY**, Code: **MSAPG**

<b>I Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
1	Advanced Palaeontology	Hard Core	301	4		20
2	Applied Hydrogeology	Hard Core	301	4		
3	Application of Remote Sensing & GIS	Hard Core	400	4		
4	Geology of Fuels and Mineral Economics	Soft Core	400	4		
5	Environmental Geology & Disaster Management	Soft Core	400	4		
<b>II Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
6	Advanced Mineralogy	Hard Core	202	4		24
7	Geo-exploration and Mining Methods	Hard Core	301	4		
8	Stratigraphy of India & Sequence Stratigraphy	Hard Core	400	4		
9	Minor Project (FW & Technical Report)	Soft Core	004	4		
10	Precambrian Crustal Evolution	Soft Core	400	4		
11	Basics of Earth Science	Open Elective	400	4		
<b>III Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
12	Economic Geology	Hard Core	301	4		24
13	Advanced Petrology	Hard Core	301	4		
14	Applied Geomorphology & Geotectonics	Hard Core	301	4		
15	Geochemistry and Geochronology	Hard Core	400	4		
16	Engineering Geology and Surveying	Soft Core	400	4		
17	Industrial Mineral Resources	Open Elective	400	4		
<b>IV Semester</b>	<b>Course</b>	<b>Hard Core/ Soft Core</b>	<b>LTP</b>	<b>Credit Value</b>	<b>Paper Code</b>	<b>Total credits</b>
18	Major Project / Dissertation	Hard Core		08		08
<b>Total Credits</b>						<b>76</b>



## I SEMESTER

### **PAPER 1: ADVANCED PALAEOLOGY [ LTP / CREDITS = 301/4]**

**Unit 1: Micropalaeontology and Palynology:** Organic and mineral walled microfossils. Methods of separation of microfossils from sedimentary matrix. Morphology of Foraminifera, Ostracod. Fossil spores, pollens and dinoflagellates. Fossil shell chemistry and its application for the interpretation of palaeo environment. The role of foraminifera, Ostracod and palynofossils in hydrocarbon exploration. Carbon and oxygen isotope studies of fossil specimens and its applications.

**Unit 2: Invertebrate palaeontology:** Evolution of life through geological time. Pre-burial and post-burial mode of preservation of fossils, concepts of taphonomy. Types of body and ichno fossils, species concept, organic evolution. Ediacara fauna; morphology and time range of Graptolites, Trilobites, Brachiopods, and Mollusca.

**Unit 3: Vertebrate palaeontology and Plant fossils:** Vertebrate life through ages. Evolution in Proscidea, Equidae and Hominidae. Evolution of Siwalik mammals and Mass extinctions episodes, Fishes, amphibians and reptiles. Gondwana plant fossils: Paleozoic, Mesozoic and Cenozoic plants through ages and their significance. Applications of paleontological data in stratigraphy, paleoecology, paleobathymetry, paleo temperature and paleoclimatology.

**Unit 4: Practical:** Description and Identification of invertebrates. Determination of Age based on Index fossil. Demarcation of stratigraphic boundary based on long, short range and index fossils, preparation of fossil proxy studies in Palaeogeography of Gondwana continents. Tethyan fossils. Identification of Siwalik vertebrates to its palaeo environment. Foraminifera and palynofossil separation technique, Methods of Identification of microfossils; foraminifera and Ostracod. M-T-R Trilinear diagram analysis for identification of environment of deposition. Biozones analysis- Bio facies diagrams, biostratigraphy problems. Factor and cluster analysis and interpretation to paleoecology. Biometry of fossils.

#### **References:**

1. Shorrock and Twenhofel: Principles of Invertebrate Palaeontology, IBH New Delhi, 1983
2. Moore, Lalikar and Fisher: Invertebrate Paleontology
3. Pratul Sarwati and Srinivasan, M.S, Micropalaeontology-Principles and applications. Springer International Switzerland, 2016
4. Clarkson, E.N.K., 1998, *Invertebrate Palaeontology and Evolution*, IV edition, publ., Blackwell
5. Stearn, C.W. & Carroll R. L. 1989, *Palaeontology-the record of Life*, Publ. John Wiley.
6. Smith, A.B, 1994, *Systematics and the Fossils Record-Documenting Evolutionary Patterns.*, publ., Blackwell
7. Prothero. D.R., 1998, *Bringing Fossils to Life- An Introduction to Palaeontology.*, publ., Mc Graw Hill
8. D. J. Jones, 1956. *Microfossils*
9. F.T.Banner and A.R, Lord., *Aspects of Micropalaeontology*
10. M.P.Glaessner, *Principles of Micropalaeontology*
11. M.D, Brasier, 1955, *Microfossils*, publ. George allan and Wiley & Sons
12. Romer.A, *Vertebrate Palaeontology*
13. Colbert, *Introduction to Vertebrate Palaeontology*



14. Sukla., A.C & Misra S.P, 1975, *Study of Paleobotany* Vikar Publ. House
15. Sripad.N.Agashe, *Palaeobotany*
16. Maohotra, A K, Ocean Science and Technology
17. Tchernia,P, Descriptive regional oceanography
18. K.Siddhartha, Oceanography- A brief introduction
19. William A Anikouchine and Richard W Stenbegr; the world Ocean- An Introduction to oceanography
20. Cuchlaine A M King, oceanography for Geographers
21. H.V. Thurman, Introduction to Oceanography
22. Treatise on Paleontology
23. R. M. Black : Invertebrate Paleontology

## **PAPER 2: APPLIED HYDROGEOLOGY [LTP /CREDITS = 301/4]**

**Unit 1:** Origin, occurrence and distribution of water on earth; Types of water — meteoric, juvenile, magmatic and sea water; Hydrological Cycle and its components; Water balance; Water-bearing properties of rocks — porosity, permeability, specific yield and specific retention; Vertical distribution of water; Zone of aeration and zone of saturation; Classification of rocks according to their water-bearing properties; Aquifers; Classification of aquifers; Concepts of drainage basins and groundwater basins; Aquifer parameters- transmissivity and storage coefficient; Water table. Fluctuations of water table and piezometric surface; Water table contour maps; Hydrographs; Springs; Geologic and geomorphic controls on groundwater; Hydrostratigraphic units, Groundwater provinces of India. Hydrogeology of arid zones of India, Hydrogeology of wet lands. **Groundwater Management:** Groundwater problems related to foundation work, mining, canals and tunnels; Over-exploitation of groundwater and groundwater mining; Groundwater problems in urban areas; Ground water management in arid and semi arid areas; Concept of sustainable development of groundwater resources; Groundwater management —supply side and demand side management; Rainwater harvesting and managed aquifer recharge; Conjunctive use of surface and groundwater; Groundwater legislation.

**Unit 2:Groundwater Hydraulics:** Theory of groundwater flow; Darcy's law and its applications; Determination of permeability in laboratory and in field; Flow through aquifers; steady, unsteady and radial flow conditions; Evaluation of aquifer parameters of confined, semi-confined and unconfined aquifers -Thiem, Thies, Jacob and Walton's methods; Groundwater modelling.

**Groundwater Exploration and Water Well Construction** Geologic and hydrogeologic methods of exploration; Role of remote sensing in groundwater exploration; Hydro geomorphic and lineament 'napping; Surface geophysical methods — seismic, gravity, geo- electrical and magnetic methods; Types of water wells and methods of construction; Design, development, maintenance and revitalization of wells; Sub-surface geophysical methods; Yield characteristics of wells; Pumping tests- methods, data analysis and interpretation.

**Unit-3: Groundwater Quality:** Physical and chemical properties of water; Quality criteria-for different uses; Graphical presentation of groundwater quality data; Groundwater quality in different provinces in India; Groundwater contamination; natural (geogenic) and anthropogenic contaminants; Saline water intrusion; Radio- isotopes in hydro geological studies.

**Practical-1:** Selection of rain gauge station, Rainfall patterns of distribution, methods of preparing, Arithmetic isohyetal map and Thiessen polygon maps and interpreting volumes of



rainfall, selection of water recharge structures, Preparation of water level fluctuation data, Preparation of water table contour maps and interpretation. Analysing pumping test data using Jacob's straight line method. Delineating groundwater potential zones. Interpretation of water quality data using numerical and graphical approaches.

**Reference:**

1. Groundwater-C.F.Tolman
2. Groundwater Hydrology-D.K.Todd
3. Hydrology-S.N.Davis and R.J.M Dewiest
4. Groundwater studies-R.H.Brown and others
5. Groundwater Hydrology-Herman Bouver
6. Hydrology-C.W.Fetter
7. Hand book of Applied hydrology-Van te Chew
8. Groundwater and wells-Hohnson Publications
9. Applied Hydrology-Chow M.Mays.Mac.Graw Hill Publication
10. Hydrology and wetland conservation-Gulam
11. Groundwater survey and inverstigation-Guatham Mahajan
12. Hydrology-Raghunath
13. Hydrogeology-Karanth
14. Ecology, Environment and Pollution – A Balasubramanian

**PAPER 3: APPLICATION OF REMOTE SENSING AND GIS [ LTP / CREDITS = 202/4]**

**Unit 1: Remote Sensing:** Basic Principles of Remote Sensing. Energy Interactions with the Atmosphere. Radiation and Black Body radiation. Types of Remote Sensing, Sensors. Scanners and their capabilities. Platforms- Types of Platforms, Satellite Remote Sensing. Satellite Data Products-their Characteristics. Resolution and Types of Resolution. Data products and IRS Satellites. Digital Image Processing. Remote Sensing in Indian Scenario. Remote Sensing in Visible, Infrared Rays, Micro Wave and Thermal regions. Application of RS in Geomorphology, Lithological Mapping, Structural mapping, Hydrogeological studies and Mineral Exploration. Remote Sensing for Disaster Management. Global Satellite Data Sources and uses. Hyperspectral Data and their uses.

**Unit 2: GIS:** Definition of Geographic Information System. The nature of geospatial information and data representation. Cartography. Maps and spatial information. Cartographic symbology. GIS and its subsystems. Components of a GIS. Databases used in GIS. Data Structures: Relational, hierarchical and network. RDBMS. Data models used in GIS. Spatial data models. Vector data Model. Raster data Model. DEM. TIN. Vector and raster - advantages and disadvantages. Attribute data models. Topological relationships of spatial data. Data Sources.GPS. Data input techniques. Digitization of maps and imageries; Coordinate transformation; Attribute data generation . Spatial data layers . Data retrieval and querying. Spatial analysis -Spatial overlay operations, buffering, trend surface mapping. Network analysis and proximity analysis; 3D models. GIS Modeling for decision support. Applications of GIS in earth's resources evaluation and management.

**Unit 3: Practical: Remote Sensing:** Visual and Digital interpretation of Reading of Topo maps, Visualization and Interpretation of Satellite Imageries, Interpretation and Demarcation of lithological Units, Interpretation Drainage patterns and water bodies, Interpretation and Measurement of Lineaments, Interpretation of Geological Structures, Interpretation of land use/land cover. Interpretation of vegetation, Interpretation of Mining and Mineralized zones.

**Unit 4: Practical :GIS:** 1. Methods of digitizing geospatial data (toposheet/ satellite image)



2. Methods of creating x,y,z data as database and preparing contour maps, Geo referencing coordinates in scanned toposheets or maps and computing the geometrical properties of digitized zones, Methods of using DEM files, analysing hydrological components, basins, slopes, aspects and other features. Carrying out different kinds of spatial analysis including, buffering, Proximity, split, clip and neighborhood analysis. Application of GIS model for various spatial analysis.

### Reference:

1. Text book of Remote sensing and geographical Information system, 1<sup>st</sup> & 2<sup>nd</sup> Ed. By M. Anjireddy, BS Publications, Hyderabad
2. Remote sensing principles and Interpretations, 3<sup>rd</sup> edition, Floyd. F. Sabins
3. Applications of Remote sensing and GIS by H T Basavarajappa, Et. Al
4. Cartography: Visualization of Geospatial data – Menno-Jan Kraak and Ferjan Ormeling
5. Principles and application of Photogeology – Shiv N Pandey
6. Aerial photographic interpretation, Principles and applications - D.R.Leuder.
7. Photogeology - Miller, J.C.
8. Mannual of colour aerial photography -Ed. Smith, J.T.Jr.
9. Manual of photogrammetry - Ed: Morrie M.Thompson.
10. Manual of Remote sensing - Ed: Robert G Reeves.
11. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
12. Remote sensing in Geology - Parry S. Siegal & Alan. R.Gillespie
13. Manual of photographic interpretation - Ed: Colwell, R.N.
14. Principles of Remote Sensing – Patel Singh; SP publication
15. Digital Remote Sensing – Pritivish Nag M Kudrat ; Concept publication
16. Principles of GIS for land and resources assessment, Burrough, P.A., 1986, Oxford.
17. Introductory cartography, Campbell, 1984, Prentice Hall
18. Map data processing, Freeman and Pieroni, 1980, Academic Press.
19. An introduction to Geographical information systems: Ian Heywood et. al.
20. Geographical information systems and digital image processing – Muralikrishna 1999. Allied Publication
21. Fundamentals of remote sensing and Geoinformatics , by Anjireddy, Hyderabad ed. 1 and 2.
22. Geographic Information Systems: An Introduction, 3rd Ed, Bernhardsen, John Wiley & Sons, 01- Jan-2007 - 444 pages
23. Geographic information systems and science, Paul Longley, Wiley, 13-Jul-2001 - Education - 454 pages
24. Geographic Information Systems for Geoscientists: Modelling with GIS, Graeme F. Bonham-Carter, Elsevier, 18-May-2014 - Science - 416 pages
25. Geographic Information Systems and Science, Paul Longley, John Wiley & Sons, 22- Mar-2005 - Science - 517 pages
26. Handbook on Geographic Information Systems and Digital Mapping, United Nations. Statistical Division, United Nations Publications, 2000 - Census - 197 pages
27. Introductory Readings In Geographic Information Systems, D J Peuquet, D F Marble, CRC Press, 16-Dec-2003 - Technology & Engineering - 371 pages
28. Geographic Information Systems (GIS) and Mapping: Practices and Standards, Issue 1126, Arnold Ivan Johnson, C. Bernt Pettersson, ASTM International, 01-Jan-1992 - Travel - 346 pages
29. Introduction to Geographic Information Systems, Kang-tsung Chang, McGraw-Hill Education, 16-Jan-2015 - Science - 448 pages
30. Fundamentals of Geographical Information Systems, Michael N. DeMers, Wiley, 2009 - Science - 443 pages
31. Textbook of Remote Sensing and Geographical Information Systems, Kali Charan Sahu, Atlantic Publishers & Dist, 01-Dec-2007 - 512 pages
32. Geographic Information System, B. Gurugnanam, New India Publishing, 09-Jun-2009 - Geographic information systems - 206 pages
33. Fundamentals of Geographical Information Systems, Michael N. DeMers, Wiley, 2009 - Science - 443 pages



**PAPER 4: GEOLOGY OF FUELS AND MINERAL ECONOMICS [LTP / CREDITS = 400/4]**

**Unit 1: Coal** - Origin of coal and its type. Coalification. Coal and its properties; proximate and ultimate analysis. Different varieties and rank of coal. Concept of coal maturity, peat, lignite, bituminous and anthracite coal. Lithotype, micro lithotypes and maceral groups of coal, mineral and organic matter in coal. Lithology, stratigraphy and structures of Gondwana coal fields and Tertiary coal fields of India and its properties. **Hydrocarbon** - Fundamental concepts of organic and inorganic theories of hydrocarbon. Sedimentary processes and accumulation of organic matter- diagenesis, catagenesis and metagenesis of organic matter. Generation, migration and accumulation of oil, crude oil types. Oil fields of India. Sedimentary basin analysis to its Petrophysical properties, depositional environment and time line and bathymetry analysis. Seismic method of hydrocarbon reservoir exploration. Seismic reflection patterns and to decipher the depositional and structural features. Well logging techniques, interpretation of logs, geochemical parameters; determination of TOM, TOC, VRO, TTI, and TAMR.

**Unit 2: Nuclear Minerals:** Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods of prospecting and assaying of mineral deposits. Radioactivity in liquid and gaseous phases, Distribution of radioactive minerals in India. Nuclear waste disposal- geological constraints.

**Unit 3:** Introduction and concepts of mineral economics. Peculiarities in mineral deposits. Concepts in mineral exploration and mineral resource estimation. Classification of Indian mineral resources. Role of mineral industry in national economy. Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption.

**Unit 4:** National Mineral Policy. Mineral Concession Rules. Mineral legislation in Karnataka and India. Mining Acts, Mineral production, processing, coproducts and byproducts. Mineral inventory. Consumption and substitution of minerals. Demand Analysis and market survey. Mineral conservation and environment. Mineral information system. Marine mineral resources and Law of Sea.

**Reference Books:**

1. Nuclear geology and Atomic mineral Resources – S.N. Virnave. Published by Bharati Bhawan 1995.
2. Mineral Resources of India – D.K. Banerjee. Published by the world press.
3. Radioactive minerals – R. Dhanaraju –2005 published by Geological Society of India.
4. Hand book of Mineral Exploration and Ore Petrology-R.Dhanaraju-2009-Publ.by Geological Society of India
5. Economic Mineral deposits – A.M. Bateman
6. Geology of Mineral deposits – Smirnov U.G.
7. Indian Mineral Resources – Krishna Swamy.S.
8. Introduction to India Economic Mineral deposits – Sharma, N.L. & Ram, K.S.
9. Basic Petroleum Geology – P.K.Link
10. Petroleum Stratigraphy – R.L.Breuner
11. World Oil Energy Economics – H.A.Kerklelin
12. Jaharia Coal Field – D.Chandra
13. Petroleum Formation and Occurrence – B.P. Tissot
14. Petroleum Geology – Levorsen
15. The world of petroleum- Deshpande B. G.. New Age International, 260p.
16. Geology of Petroleum- Levorsen A. I CBS Publishers and Distributors Pvt Ltd, 260p.
17. Petroleum Geology -North F. K. Allen&Unwin, Boston, 607p.
18. Textbook of Coal (Indian context), Chandra, D., Singh, R.M. Singh, M.P. :, Tara Book Agency, Varanasi,



402p.

19. Coal and coal-bearing strata: Recent Advances and future prospects, Scott, A.C. Geological Society, London, Special Publications, 32p.
20. Coal and Organic Petrology- Singh, M.P. , Hindustan Publishing Corporation, New Delhi, 128p.
21. Stach's Textbook of Coal petrology -Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichmuller, M. and Teichmuller R. GebruderBorntraeger, Stuttgart, 535p.
22. Coal Geology , Thomas L. John Wiley and Sons Ltd., England, 384p.
23. Introduction to the Geology of Coal and Indian Coalfields-.Sharma, N.L. and Ram K.S.V. Dhanbad Publications, Dhanbad, 183p.
24. Coal and Lignite Resources of India-An Overview -Acharyya S.K. . Geol. Soc. of India, 50p.
25. Petroleum formation and Occurrence- Tissot, B.P and Welte, D.H , Springer-Verlag, 699p.
26. Elements of Petroleum Geology- Selley, R.C . Academic press, 470p.
27. Introduction to Geophysical prospecting- Milton B. Dobrin & Carl H. Savit . McGraw-Hill, 867p.
28. Wellsite Geological Techniques and Formation Evaluation: A user's manual -Gupta, P. K. and Nandi, P. K. , Vol. Oil and Natural Gas Corporation, Dehradun.
29. Practical Formation Evaluation -Ransom, R.C. , John Wiley and Sons, 490p.
30. The Geological Interpretation of Well Logs -Rider, M.H. Blackie, London, 280p.
31. Andrew D. M. Geology of stratigraphic sequences Springer Publications, New York 1997.
32. Weimer and Posmentier, Sedimentary Geology, Elsevier Publications, Netherlands 1993.
33. Emery, D., and Myers, K, Sequence Stratigraphy, Blackwell Science, Publ. 1996.
34. Seismic stratigraphy – Applications to hydrocarbon exploration, AAPG Memoir No. 26. 1977.
35. Van Wagonar., P. R. Vail an overview of the fundamentals of sequence stratigraphy and key definitions. Sea level changes – an integrated approach. SEPM Publ. No. 42, 1988.

#### **Reference:**

1. Mineral Economics by Truscot, John Wiley and Sons, Inc, 1987.
2. An introduction to mineral Economics – K.K.Chatterjee. publisher : - Wiley Eastern. 1993.
3. Mineral Economics : - R.K. Sinha and N.L.Sharma. Oxford and IBH publication
4. Five year plan Gezzetier Central government and State government.
5. Central Government weekly employment news.

### **PAPER 5: ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT (LTP = 400/4) SOFT CORE**

**Unit-1 : Environmental Geology** : Fundamental concepts of Environmental Geology - it's scope, objectives, and aims. Earth's thermal environment and Climates. Global warming. Green house effect. Ozone depletion–Ice sheets melting and fluctuation in sea levels. Concepts of ecosystem. Earth's major ecosystems terrestrial and aquatic. Meteorology as environmental science. Air Pollution, sources of pollution, pollution due to dust and waste disposal. National and International standards. Environmental health hazards. Mining, opencast, underground, disposal of industrial and radio-active waste, dumping stacking, rehandling, management, mineral processing, tailing ponds, acid mine drainage, siltation, case studies. Mining below water table, mine water discharges, regional effects on water regime. Noise levels- national standards, mining machinery, ill effects. Air sampling techniques – respirable dust samplers, high volume air samplers, personal sampling pumps, weather monitoring equipments, automatic recorders.

**Unit 2: Environmental Impact Assessment** – impacts, primary, secondary, prediction,



assessment, base-line data generation, physical, biological, cultural, socioeconomic aspects. Carrying capacity based developmental planning – Assimilative capacity – supportive capacity – Resource based planning – Institutional strategies. Sustainable

Developmental Planning. Applications of GIS in Environmental Management. Environmental Legislations in India. Concepts and principles: Natural hazards – preventive/ precautionary measures – floods, landslides, earthquakes, river and coastal erosion. Distribution, magnitude and intensity of earthquakes. Neotectonics and seismic hazard assessment. preparation of seismic hazard maps. Impact of seismic hazards on long and short term environmental conditions. Mechanism of landslides, causes of major floods, cyclones and storms. Deforestation and land degradation. Coastal erosion, its causes and control of Geological hazards and crisis management.

**Unit: 3: Disaster management-** Definition and types of disaster Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunامي, avalanches, global climate extremes. Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires. Study of Important disasters, Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landside and its managements case studies of disasters (e.g) Earthquakes, Landside). Social Economics and Environmental impact of disasters.

**Unit: 4 Disaster Mitigation and Management-** techniques of Disaster Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warning Systems, Building design and construction in highly seismic zones, retrofitting of buildings. Training, awareness program and project on disaster management. Training and drills for disaster preparedness, Awareness generation program, Usages of GIS and Remote sensing techniques in disaster management, Mini project on disaster risk assessment and preparedness for disasters with reference to disasters and its surrounding areas.

#### References:

- 1.Environmental Geology – Peter TP Flawn
- 2.Environmental geosciences – Arthur H Strahler & Alan Strauler
- 3.Geology in Environmental planning- A.D. Howard & I.Ramson
- 4.Focus on Environmental Geology –R Turk
- 5.Environmental Science –S C Santra
- 6.Environmental geology by Waldia K.S
- 7.Climatology: An Atmospheric Science, 2/e, Pearson Education India, 1993 - 423 p.
- 8.Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
- 9.Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
- 10.Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
- 11.Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
- 12.Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

## II SEMESTER

### **PAPER 6: ADVANCED MINERALOGY [ LTP / CREDITS = 202/4]**

**Unit 1: Crystallography:** Form theory of Crystals, Symmetric Operations, Space Lattice, Projections, Bravais Space lattice, Derivation of 32 point groups. Zone and Zone Laws, Atomic



and ionic radii, Bond length and measurements of Radius, Radius ratio and co-ordination polyhedra, Coordination Number, Pauling's Rules, Spheres in Closest packing, Packing Index. Voids in closest packing, Classification & Co-ordination of voids, Derivative Structures. Crystal Defects / Crystal Imperfections. Crystal Structures: AX, AX<sub>2</sub>, A<sub>2</sub>X<sub>3</sub>, ABX<sub>3</sub>, ABX<sub>4</sub> and A<sub>2</sub>BX<sub>4</sub> structures. Crystal forms, Twin crystals, Isomorphism, Polymorphism, Pseudomorphism,

**Unit 2: Mineralogy:** Structure, Chemistry, Paragenesis, optical and physical properties of Olivine group, Garnet group, Epidote group, Pyroxene group, Amphibole group, Feldspar group, Quartz group, Physical Mineralogy: Characters depending upon Cohesion and elasticity, Density and specific gravity, characters depending upon light, heat, electricity and magnetism, . Radioactivity, Surface properties, Chemical mineralogy: Principles of chemistry as applied to Minerals, Examination of minerals by means of wet way and blowpipe.

**Unit 3: Practical 1: Crystallography:** Symmetric projections in Crystals. Isometric, Tetragonal, Orthorhombic, Hexagonal, Monoclinic and Triclinic systems. Calculation of Linear and angular relationship in crystals using Stereonet.

**Unit 4: Practical 2: Mineralogy:** Determination of physical and chemical properties of Olivine, Garnet, Epidote, Pyroxene, Amphibole, Feldspar and Quartz group of minerals, Calculation of mineral formula based on mineral analysis. Calculation of Mineral compositions by plotting in a trilinear diagrams

#### References

1. Modern Mineralogy – Keith Frye
2. Dana's Text book of Mineralogy – W.E Ford
3. Introduction to Rock forming minerals – W.A. Deer, R.A. Howie, J. Zussman
4. Rutley's Elements of Mineralogy – Revised by C.D. Gribble
5. Fundamentals of Optical, Spectroscopic and X-ray Mineralogy
6. A Basic Course in Crystallography – JAK Tareen and TRN Kutty
7. Fundamentals of Crystal Chemistry – JAK Tareen and TRN Kutty
8. Mineralogy A First Course by John Sinkankas
9. Essentials of Crystallography – E. Flint
10. Crystallography and Practical Crystal measurements – A.E.H. Tutton
11. Crystal Structures – Ralph .W. G. Wyckoff
12. Crystal Structure analysis – Martin J Buerger
13. Crystal Chemical Classification of Minerals – A.S. Povarennykh, Vol.1 and Vol.2

#### **PAPER 7: GEOEXPLORATION AND MINING METHODS | LTP / CREDITS = 301/4**

**Unit 1: Geological Exploration:** Prospecting and the Exploration Process: Stages in Prospect Exploration-Target Generation, Target Drilling, Resource Evaluation Drilling, Feasibility Study, Geological Mapping in Exploration: The Nature of a Geological Map, Intelligent Mapping, Choosing the Best Technique, Choosing the Best Scale, Measuring and Recording Structures, Using Satellite Navigation (GPS), Mine Mapping: Mapping in Open Cuts, Mapping Underground Openings, Safety in Mines, Trenching and Underground Development, Importance of Drilling, Rotary Percussion and Auger Drilling, Diamond Drilling, Satellite Imagery, Methods of geological exploration - exploratory grids, location and documentation of exploratory workings (pits, trenches underground workings), drilling, core logging. Sampling techniques and evaluation of grade. Mining terminology, methods of open cast, underground and alluvial mining. Definition and scope of mineral processing, comminution, crushers and classifiers. Froth flotation techniques of separation. Geological criteria for mineral prospecting-Stratigraphic criteria, Structural criteria, Lithological criteria, Magmatogenic criteria, Metamorphogenic criteria, Geomorphological criteria, Paleogeographical criteria, Paleoclimatic criteria, Historical criteria. Indications of ore.



Geological prospecting methods.

**Unit 2: Geochemical Exploration:** Basic principles- Geochemical cycle-Geochemical Environment- Geochemical dispersion-Geochemical mobility and Geochemical reactions-Dispersion of elements under deep seated conditions- Weathering and its products -Mobility under surficial conditions-Association of elements-Patterns of geochemical distribution- geochemical anomaly in residual and transported overburden--Anomalies in gossans and leached outcrops of ores-Epigenetic and Syngenetic anomalies in residual soil-mode of occurrence of indicator elements in residual soils-Form and magnitude of anomaly -Hydromorphic anomalies in residual soil-Anomalies in waters and drainage sediments- stability of important minerals- Geochemical soil surveys- - Geochemistry of ores- major, trace elements, REE and isotopic studies. Biogeochemical anomalies and survey techniques. Vapour geochemistry.

**Unit 3: Geophysical exploration:** Geophysical anomalies, Electrical prospecting: Resistivity method, important electrode arrangements, instruments, interpretation and application of electrical methods in ground water investigation. Principles of electrical logging and its application in petroleum and mineral exploration. Magnetic prospecting: Magnetic properties of rocks and minerals, Earth's magnetic field, instrument and measurements, interpretation of magnetic anomalies. Gravity prospecting: Earth's gravity field, regional and local gravity anomalies, instruments, interpretation of gravity anomalies. Seismic prospecting: Elastic properties of rocks and minerals, refraction and reflection technique time distance relation for horizontal interfaces, seismic instruments and records. Radio metric methods: Radioactivity of rocks and minerals, instruments and measurements of radiation, Well logging: Different techniques of logging. Description of borehole environment.

**Unit 4 Practical:**

**Geological Exploration-** Delineation of ore deposit based on exploration data. Classification of ore reserves. Economic evaluation of ore deposit.

**Geochemical Exploration:** Geochemical methods in mineral exploration and choice of materials and methods. Interpretation of Geochemical maps for locating ore mineralization. Preparation of geochemical anomaly maps.

**Geophysical exploration:** Resistivity methods: Curve matching techniques and s-line method.

**REFERENCE BOOKS**

1. Introduction to geophysical prospecting - Milton B Dobrin
2. Exploration geophysics – Jakaosku J J
3. Outlines of geophysical prospecting - A manual for geologists – M B Ramachandra Rao
4. Geophysical Methods in Geology – P V Sharama
5. Exploration Geophysics for geologist and Engineers – Bhimasanakaran and Gaur
6. Principles of Applied Geophysics – D S Paransis
7. Introduction to Geophysics – C H Howel
8. Geochemistry in mineral exploration Rose, A.W Hawkes. H.E & Webb J.S. 1979. Academic press.
9. Principles of geochemical prospecting. Ginzburg. I.I. Petgamon Press, N.Y. London.
10. Biochemical methods of Prospecting - Malyuga, D.P.
11. Principles of Mining Geology, Arokiaswamy.
12. Geological prospecting and exploration – Kreiter, V.M.
13. Rock geochemistry in Mineral Exploration. G.J.S.Govett. Elsevier Publication. 1983.



## **PAPER 8: STRATIGRAPHY OF INDIA [LTP / CREDITS = 400/4]**

**Unit 1: Principles of Stratigraphy:** Introduction and scope of stratigraphy, Principles of stratigraphy; code of nomenclature of India, litho, bio, chrono and magnetostratigraphy units, principles of stratigraphic correlation, Walther's law. Geological Time Scale. Geological, physical and biological events through geological time.

**Unit 2: Palaeozoic Stratigraphy of India:** Precambrian-Cambrian boundary of India. Cambrian stratigraphy of Tal basins, and Jammu and Kashmir. Spiti Kashmir and Kumanon, and Stratotype sections of Ordovician and Silurian stratigraphy. Carboniferous stratigraphy of India, and its mineral deposits and geological events. Gondwana basin stratigraphy, its classification, age, environment of deposition and plant fossils.

**Unit 3: Mesozoic and Cenozoic Stratigraphy of India:** Triassic stratigraphy of Spiti, Permo-Triassic boundary, Jurassic of Kutch, Cretaceous of India with special reference to Narmada valley and Ariyalur- Pondicherry sub basins (Trichinopoly), Cretaceous-Palaeogene boundary (KTB event), Deccan volcanic province- Inter and Intra trappean beds, age and its distribution. Paleogene, Neogene and Quaternary stratigraphy- Assam, Bengal basin, Garhwal-Shimla Himalayas. Siwaliks. Origin of Himalayas. Quaternary sea-level changes.

**Unit 4: Sequence Stratigraphy:** Introduction to sequence stratigraphy, scope, applications in exploration of hydrocarbons, terminology, facies and sea level cycles. Construction of sequence framework, importance of unconformities, assessing regional and global changes in sea level, hypsometric curves, back stripping, sequence depositional model; Depositional systems and systems tracts, sequence boundaries, Milankovitch processes. Types of stratigraphic cycles, tectono-stratigraphic model, Eustasy, epiorogeny, global cycle chart, tectonic mechanisms.

### **References:**

1. Geology of India Vol.1 & 2. M.Ramakrishnan and R Vaidyanathan
2. Geology of India – Wadia, D.N., Mc Millan and Co.
3. Geology of India and Burma – Krishnan M.S. Higginbotham, Madras.
4. A hand book of the Geology of the Mysore State – B. Rama Rao, Bangalore press.
5. Precambrian Stratigraphy and Geochronology of the Peninsular India – Sarkar, S.N. Dhanbad Publishers.
6. Review papers on the Stratigraphy of India –Rec.Geol.Surv.India Vol.101, Part 2.1972 Cretaceous Tertiary formations –Geol.Soc. India, seminar Vol. 1958.
7. Paleozoic of Himalayas. HPC publ.
8. Reconnaissance Rb-Sr dating of the Precambrian of Southern Peninsular India- Crawford, A.R., J.G.S.I 1972. 117-126.
9. Ramakrishnan, Mand Vaidyanathan Indian Geology, Geological Society of India, 10. Publication, Bangalore, 2007
11. Krishnan, M.S., Geology of India and Burma III Ed. IBH Publishers, New Delhi, 1984
12. Wadia, Geology of India.
13. Ravindra Kumar, Fundamentals of historical Geology and stratigraphy of India,
14. Wiley Eastern Ltd. New Delhi, 1985.
15. Sequence stratigraphy- BHP petroleum (America) Inc – Michael Yeaman, Lavy Holcomb, Gill Tailor 1990
16. Sequence stratigraphy – BP Exporation. Stockley Park UK Bridge London, Publ. Blackwell science
17. Sea Level Changes- An Integrated Approach Spl. Pbln.42, Barbara H.Lidz, Editor of Spl. Publ. Oklahoma USA 1998
18. Sequence in Layered Rocks- Blatt Middleton & Humay
19. Sedimentary Petrology- Pettijhon



**PAPER 9: FIELD WORK AND TECHNICAL REPORT (MINOR PROJECT) [LTP / CREDITS = 004/4]**

**Field work and Technical Report (FW & TR) :** The candidate has to undertake field mapping and preparation of report in a particular terrain for a period of 15 days . C1, C2 & C3 marks will be evaluated as per the university guidelines.

**PAPER 10: PRECAMBRIAN CRUSTAL EVOLUTION [ LTP / CREDITS = 400/4]**

**Unit 1: Geological time span.** Early earth features. Mountain Building activity. Era- Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth. A magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts. Lithosphere and Mantle reactions. Origin of the crust. Lower crust- first continents. early continental crust. growth of crust- Mechanism of continental growth and its growth rate. Growth of Continents.

**Unit 2: Primary Atmosphere.** Secondary Atmosphere. Oxygen in atmosphere- geologic indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory, outgassing. Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian.

**Unit 3: Precambrian Stratigraphy of India:** Archean Granite-Greenstone belts, evolution of Archean Cratons of India, Proterozoic mobile belts- Eastern Ghats Mobile belt, Southern Granulite terrain, Central Indian Tectonic zone, Aravalli-Delhi belt, North Singhbhum Mobile belt. Mineral deposits of Precambrian rocks.

**Unit 4 : Precambrian mineral Deposits.** Proterozoic life. oldest rocks. Continental foundation. Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of laurestia-Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia- grenville orogeny– Proterozoic rifting. Mid-continent rift- snowball earth. Crustal provinces- Precambrian provinces of North America. Cratons of Americ- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of South Africa. Cratons- Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India.

**Reference:**

1. Archaean Geology- C.S. Pichamuthu
2. Early Precambrian supracrustal of southern Karantaka-Memoir 112. Geol.Surv. Ind
3. Geology of Karantaka- B.P Radhakrishna
4. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
5. Geology of India and Burma- M.S Krishnan
6. Geology of India- M. Wadia
7. Crustal Evolution and Metallogeny in India- Sanib Chandra Sarkar and Anupendu Gupta.

**PAPER – 11 OPEN ELECTIVE : BASICS OF EARTH SCIENCE [ LTP / CREDITS = 400/4]**

**Unit 1: Physical Geology** -Introduction to geology. Origin of the Earth. Age of the earth. Interior of the Earth. Geomorphic processes and cycles, Geological action of wind, water, glaciers.



Volcanoes and earthquakes. Morphology of Oceans, Principles of Isostasy and uniformitarianism.

**Unit 2: Structural Geology** - Rock deformation. Earth forces. Folds and Foldings, Fault and Faulting, Joints, Cleavage, Unconformities, Concept of plate tectonics, sea floor spreading and geosynclines.

**Unit 3: Stratigraphy**- Introduction, Definition of Stratigraphy, Branches of Stratigraphy and its relation with other branches of Geology, Principles of Stratigraphy- Law of Uniformitarianism, Law of order of superposition, Law of Faunal Succession. Geological Record and its nature Eon, Era, Period. Geological Time Scale. Classification of Standard Stratigraphic scale. Nomenclature and units-Litho, Bio and Chrono stratigraphic units, Correlation- Lithostratigraphic and Biostratigraphic.

**Unit 4: Palaeontology** -Introduction, Definition of Paleontology, Classification of Plants, Invertebrate and Vertebrate fossils. Fossils-Taphonomy (Burial Law), Types of Fossilization, Mode of preservation- Mummification, Carbonization, Silification, Casts, Moulds, Tracks and Trails. Applications of Fossils. General morphological characters and Geological age of the following Invertebrate and Plant Fossils: Brachiopoda, Cephalopoda, Pelecypoda and Trilobita. Plant fossils: Glossoptrix, Gangamopteris, Ptilophyllum, Calamites and Lepidodendron.

#### References:

1. Physical Geology by Arthur Holmes
2. Structural Geology by Billings
3. General Geology By P.K. Mukerjee
4. Physical Geology By Strahler
5. Stratigraphic Principles and Practice-Weller
6. Stratigraphy-Kumberlein and Sloss
7. Paleontology of the Invertebrates-Tasch Publ. John Wiley and Sons
8. Paleontology- Henry Wood
9. Fossils Plants- Arnold
10. The Elements of Paleontology Black, R.M. Pub. Cambridge university press

### III SEMESTER

#### **PAPER 12: ECONOMIC GEOLOGY [LTP / CREDITS = 301/4]**

**Unit 1: Ore Deposits:** Nature and morphology of the Principal type Ore deposits, Texture and structures of ore and gangue minerals, Fluid inclusions and wall rock alterations, Major theories of ore genesis, Geothermometry, geobarometry paragenetic sequence, zoning and dating of ore deposits, Metallogenic provinces and epochs, Classification of ore deposits, Diamond deposits in kimberlites and lamproites, Carbonatite – alkaline igneous ore environment, Pegmatitic environment, Orthomagmatic deposits of Chromium, platinum, titanium and iron associated with basic and ultrabasic rocks, Orthomagmatic copper – nickel – iron deposits associated with basic and ultrabasic rocks, Greisen deposits, Skarn environment, Disseminated and stockwork deposits associated with plutonic intrusive, stratiform sulphide and oxide deposits of sedimentary and volcanic environments, Vein association and hydrothermal deposits, strata-bound deposits, Sedimentary deposits, Residual deposits and supergene enrichment, metamorphism of ore deposits

**Unit 2: Genesis of Ore Deposits:** Formation of Nickel laterite deposits by the processes of weathering –, Deposits related to clastic sedimentation: Detrital –Sedimentary Concentrations -



placer deposits – Witwatersrand gold and U deposits. Chemical sedimentary concentration – Sedimentary and Syndimentary deposits, phosphate deposits, evaporates, manganese nodules, Ore deposits related to subaerial (Epithermal gold – Au) and submarine volcanism (Kuroko Cu–Zn, Japan, BIFs). Ore deposits related to metamorphism, metallogenic provinces, Epochs and plate Tectonic – classification of ore deposits. Fluid inclusion in ores: Principles, assumptions, limitations and applications.

**Unit 3: Industrial Metallic deposits of India:** Iron, Manganese, Copper, Chromium, Gold, Lead, Zinc and Bauxite deposits, Non-metallic deposits – Minerals used as fertilizers, refractories, abrasives, pigments, ceramic and glass-making materials.

**Unit 4: Practical:** Microscopic Studies of minerals : Vibration direction, Sign of elongation, pleochroic scheme , Ore Microscopy: chromite, ilmenite, Ti-magnetite, hematite, pyrite, sphalerite, galena, chalcopyrite, covellite, Bornite, pyrrhotite, Arsenopyrite, Pyrolusite.

**Reference:**

1. The geology of ore deposits - John M. Guilbert and Charles F. Park, Jr. W.H. Freeman and Co., New York. 1986.
2. Interpretation of ore textures - Bastin, E.S.
3. Economic Mineral deposits by Jenson and Bateman, A.M.
4. Ore microscopy - Cameron, E.N.
5. Textures of the ore minerals - Edwards, A.B.
6. Ore deposits - Park, Jr. C.F.
7. Geology of Mineral deposits - Smirnov, U.J.
8. The ore minerals and their intergrowths - Ramhor, Dr. Paul.
9. Ore Petrology - Stanton, R.L.
10. India's mineral resources – Sinha and Krishnaswamy, S.
11. Metallic and Industrial minerals - Lamey Carl, A.
12. Introduction to India's economic minerals - Sharma, N.L. & Ram . K.S.
13. A treatise on industrial minerals of India-Sinha, R.L.
14. Mineral deposits of India, Mukerjee 1999: Allied publications.

**PAPER 13: ADVANCED PETROLOGY | LTP / CREDITS = 301/4|**

**Unit 1: Igneous Petrology:** Generation and crystallization of magma. classification of Igneous rocks. Classification and petrogenesis of Granites, diorite, Syenite, Gabbro and Layered Igneous Complex, Kimberlite, Anorthosite, Carbonatites and Peridotite, Pegmatite, Aplites, Felsites, Dolerite, Lamprophyre, Basalt, Rhyolite, Rhyodacite, Dacite, Trachyte, Andesite, Concept of concordant and discordant intrusions. Forms and structures of hypabasal rocks. Genetic aspects of structures and textures of igneous rock. Add a note on their economic importance and Indian occurrence

**Unit 2: Sedimentary Petrology:** Weathering and erosion process, products, principles of sedimentation process, scope, applications, classification of sedimentary rocks, sedimentary textures-grain size, roundness, sphericity, shape and fabric, quantitative grain size analysis. Sediment transport and deposition- fluid and sediment gravity flows, lamellar and turbulent flows, Reynold and Froude number, grain entrainment, Hjulstrom diagram, bed and suspension load transport. Primary, penecontemporaneous deformation structures and biogenic structures. Palaeocurrent analysis. Origin and tectonics of sedimentary basins. Sedimentary basins of India. Facies models for marine, fluvial, glacial, and deltaic. Siliciclastic shallow and deep marine environments; carbonate platforms- types and facies models. Sedimentary provenance and



diagenesis of sediments Sandstones, mudstone, carbonate sedimentary rocks, banded iron formation, evaporates, cherts, and Phosphorites; classification, texture, structure, origin, diagenesis and depositional environment.

**Unit 3: Metamorphic Petrology:** Definition, Factors and Limits of Metamorphism (Temperature, Pressure & types). Fabric Changes, Geothermal Gradient, Metamorphic Fluids (recrystallization, pressure, and its type of pressure). Structure and Texture of Metamorphics- Terminology for high strain shear zones related structure and textures. Types of metamorphism based on principal process ( Orogenic, Hydrothermal, Burrial, regional, fault zone, Prograde-Retrograde, progressive Retrograde). Regional and Contact Metamorphism of Peiltic and impure Calcareous rocks. Major metamorphic rocks. Metamorphism of mafic rocks. Protoliths and types- Zones of Metamorphism. Types of Metamorphic Reaction PTX - Conditions-Metamorphic rocks Components and Developments- Development of Metamorphic Mineral Nucleation- Mineral assemblages equilibrium/Reaction. Texture and geo-thermo barometry. Characteristics of different grades and facies of metamorphism. Metasomatism and granitization. Migmatites and migmatization. UHP-UHT metamorphism, Plate tectonics and Metamorphic Zones. Paired metamorphic belts in related to Precambrain metamorphic rocks.

#### **Unit 4: Practical:**

**Igneous:** Identification of Igneous rocks in hand specimens and thin Sections. Identification of microstructures and textures in igneous rocks. Significance of micro- textures in understanding magmatic and tectonic process.

**Sedimentary:** Sieving analysis practices- River, lake and marine sediment grain size analysis, interpretation- CM plotting, histogram, calculation of statistical parameters and interpretation of sediment depositional environment. Determination of sand-silt-clay ratio. Interpretation of XRD data for clay minerals, Description of sedimentary rocks. Identification of sedimentary structures and its interpretations. Interpretation of SEM – recognition of physical, chemical and morphological features and interpretation to transportation and porosity. Identification of heavy minerals and interpretation of provenance history.

Staining and etching technique and identification of carbonate minerals.

**Metamorphic:** Megascopic and Microscopic identification of different types of metamorphic rocks and significance of micro structures and textures in understanding metamorphic reactions and tectonic process.

#### **References:**

1. Petrology of Igneous and Metamorphic rocks by Hyndman
2. Principles of of Igneous and Metamorphic rocks by Anthony R. Philpotts.
3. Igneous petrology by Anthony Hall
4. Petrology of Igneous and Metamorphic rocks by Best.
5. Petrography – An introduction to the study of rocks in thin sections – H Kowell, Williams and Turner.
6. The Study of Rocks in Thin Sections- W.W. Moorhouse
7. Migmatites - Asshworth.
8. Metamorphism - A. Methuen & Co.
9. Migmatites and the origin of granitic rocks - Mehnert K.R. Elsevier & Co.
10. Metamorphism and Metamorphic rocks - Miyashiro, A. George, Allen and Unwin.
11. Sam Boggs, Jr., Principles of Sedimentology and Stratigraphy 4<sup>th</sup> Edition, Pearson, USA, 2006.
12. Petrogenesis of metamorphic rocks- Winkler, H.G.F. Springer, Werly.



**PAPER 14: APPLIED GEOMORPHOLOGY AND GEOTECTONICS | LTP / CREDITS = 301/4**

**Unit 1: Applied Geomorphology:** Natural Hazards due to geomorphic activities: Earthquake, Volcanic eruption, Landslides, Rock slides, Rock fall, fluvial hazard, Role of Geomorphology in Hazard management. Morphometric Analysis: Its geographical significance, Fluvial Morphometry : Linear Aspects, Areal Aspects, Relief Morphometry: Hypsometric analysis, Altimetric analysis, Slope Analysis, Profile Analysis.

**Unit 2: Geotectonics:** Fabric and Structures of the rocks, Rock Tectonics: Brittle, Brittle-ductile and ductile deformations in the rocks, Pure shears, simple shears, transpression, Megascopic and Microscopic strain fields in the rocks, Strain rate, PT conditions of deformation. Deformational structures-Non tectonic and tectonic structures, Extensional (transtensional) structures, Compressional (transpressional) structures, tectonic classifications: S-tectonics, SL-tectonics and L-tectonics, Kinematic analysis, strain and strain analysis, continuous and discontinuous strain, Homogeneous and Heterogeneous strain, Finite strain ellipsoids, techniques of strain analysis, Petrofabric analysis.

**Unit 3: Structural Geology:** Description and classification of folds. Mechanics and causes of folding. Faults: Description and classification of Faults, Criteria for faulting, Breccias and Mylonite. Slickensides's and drag structures, classification: Genetic and Geometrical, types of faults. Recognition of fault in the field, uses of faults. Joints: classification and types of joints, joint sets and system, joint surfaces, relation of joints to other structures origin of joints. Unconformities, Plutons, Cleavage and Schistosity, Foliation: axial plane of foliations, origin of axial plane foliation, preferred orientation of layer silicates. Transposed foliation-Development of transposed foliation, Recognition of transposition. Lineation: slickenside striae, mineral lineations, pebbles, boulders, mullion and boudins, Origin of lineation.

**Unit 4: Practical: Applied Geomorphology:** Morphometric Analysis, Drainage Density & texture analysis, Stream ordering and Bifurcation ratio,

**Geotectonics:** Dip and Strike problems, contour problems, Thickness problems, Bore hole problems, fault problems, Construction of geological cross-section, structural contour maps, Tracing of outcrops, interpretation of geological profile, use of stereographic projection in structural calculation, construction of rose diagram for structural data.

**Reference:**

1. Billings, M.P.(1978) Structural Geology – Prentice – Hall of India Private Ltd. New Delhi.
2. Suppe, J.(1985) – Principles of structural geology – Prentice – Hall.
3. Price, N.J. and Cosgrove, J.W. (1990) Analysis of Geological Structure. Camb. Univ. Press.
4. Hobbs, B.E. Means D and Millions, P.F. (1976) an outline of structural geology. Press.
5. Ramsay, J.G. (1967) – Folding and fracturing of rocks. Mc.Graw Hills New York.
6. Badgley P.C. – Structural Geology for the exploration geologist.
7. Whitten, T- Structural Geology.
8. Ramsay, J.G. Structural Analysis of Metamorphic Tectonites.
9. Thornbury S.D – Principles of Geomorphology
10. Hails – Applied Geomorphology
11. Hamblin – Geomorphology and Geodynamics
12. Chorley, R. J. Spatial Analysis in Geomorphology, Methuen, London.
13. Dury, G. H., The Face of the Earth, Penguin,
14. Fair Bridge, R. W., Encyclopedia of Geomorphology, Reinhildts, New York
15. Gamen,H.F. The Origin of Landscapes-A Synthesis in Geomorphology, Oxfun,1974
16. Pity A.F., Introduction to Geomorphology, Methuen, London,1971
17. Skiman, B.J.and Porter,S.C. The Dynamic Earth, John Willey , NewYor k, 1995



18. Spark, B.W. Geomorphology –Longman, London,1950
19. Sharma, H.S., Perspective in Geomorphology- Concept, New Delhi, 1980.
20. Singh, Savinder Geomorphology, Prayag Publication, Allahabad, 1998.
21. Thornbury, W. Principles of Geomorphology, John Willey, New York, 1960.

**PAPER 15: GEOCHEMISTRY AND GEOCHRONOLOGY | LTP / CREDITS = 301/4|**

**Unit 1: Geochemistry:** Earth in relation to solar system and universe, Cosmic abundance of elements, Geochemical classification of elements, Primary differentiation of the earth. Composition of the planets. Classification, origin and importance of meteorites, Geochemistry of the Earth's crust, mantle and core. Distribution and behaviour of major, trace and Rare Earth Elements (REE's) in igneous, sedimentary and metamorphic environments. Carbon capture and sequestration studies. Role of trace and REE in magmatic processes. Geochemical cycle.

**Unit 2: Geochronology:** Radioactivity and radioactive decay schemes. Radiometric dating, Radiogenic isotope systematics: U-Pb, Rb-Sr, Sm-Nd, K-Ar and  $C^{14}$  systematics. Fission track dating, Preparation of samples for dating. Interpretation of isotope dates. Limitations of isotope dating. Distribution of dates in space and time. Stable isotopes: Carbon, Oxygen, Hydrogen and Sulphur and their geological applications.

**Unit 3: Petrogenesis:** Steady state geotherms, Phase, phase diagram, phase rule, Unary system with examples of water and  $Al_2SiO_5$ , binary (Diop- An System & Fo-Fa system) and ternary system. Physical properties of magma, critical point and super critical fluids, congruent and incongruent melting, eutectic crystallisation, partial melting, miscibility and immiscibility in solids and liquids, peritectic point, perthites and antiperthites. Exsolution phenomena. Eh, pH, limits of Eh and pH in nature. Eh-pH diagrams and their applications.

**Unit-4: Practicals:** P-T calculations and construction of P-T diagrams. Petrochemical calculations- Niggli verte and Niggli base, CIPW norm calculation, Trilinear plots, construction of Variation/Discriminant diagrams using major, trace and REE geochemistry data and interpretation. Isotopic age determination of rocks/minerals. Analysis of important of Ore minerals.

**References:**

1. Geochemistry- William.M.White-Wiley black well publications
2. Mason, Brian, Moore and Carleton, B. (1982), Principles of geochemistry, John Wiley&Sons,
3. New York, 344 p.
4. Introduction to carbon capture and sequestration- Berend Smit, Jeffrey.A. Reimer, CurtisM. Oldenburg and Ian.C.Bourg.
5. Rare earth element Geochemistry by Henderson
6. Petrologic Phase equilibria – W.G.Ernst
7. The Interpretation of Geological Phase diagrams - Ernest G Ehlers
8. Petrogenesis – Wilson
9. Solutions, Minerals and Equilibria – Garrels and Christ, 1966
10. Simulating the Earth- J.R. Holloway and B.J. Wood, 1988
11. Basic analytical Petrography – Ragland, 1989
12. Principles of Igneous and Metamorphic Petrology by Antony R Philpotts, 1979.1.
13. Geochemical Thermodynamics by Darrell Kirk Nordstrom and James L. Munoz
14. Chemical Thermodynamics for earth scientists by Philip Fletcher, 1993
15. Chemical Fundamentals of Geology by Robin Gill.
16. Elementary Thermodynamics by B.J. Wood and D.G. Fraser, 1976
17. Equilibrium Thermodynamics by Roger Powell
18. Geochemistry by Anderson
19. Chemical Thermodynamics by Bruce H Mahan
20. Chemical Fundamentals of Geology -Gill, R., HarperCollins Publishers Ltd, UK, 292p.



21. Geochemistry -Holt, K.H.W, Rinehart and Winston Inc, USA.
22. Geochemistry- Rankama, K. and Sahama, T.H.G. , Univ. Chicago press, 911p.
23. Essentials of Geochemistry- Walther. J.V, Jones and Barlett Publishers, New Delhi. 797p.
24. Geochemistry- Albarede F. - An introduction, Cambridge university press.
25. Geochemistry- Brownlow, A.N., Prentice Hall
26. Chemical fundamentals of geology -Gill, R. Unwin Hyman, London
27. Principles of Isotope Geology -Faure, G., : -John Wiley
28. Stable isotope Geochemistry -Hoefs, J, -Springer Verlag
29. Encyclopaedia of Geochemistry- Marshal, C.P. and Fairbridge, R.W.,: -Kluwer Academic
30. Handbook of Exploration Geochemistry -Govett, G.J.S. (Ed.), : -Elsevier
31. Introduction to Geochemistry- Mason, B. and Moore, C.B., : -Wiley Eastern
32. Geochemical Thermodynamics- Nordstrom, D.K. and Munoz, J.L.,: -Blackwell
33. Inorganic Geochemistry -Henderson, P.,: -Pergamon Press
34. Introduction to Geochemistry- Krauskopf, E.B. , McGraw Hill Book Company, New Delhi.
35. Inorganic Geochemistry- Paul Henderson, , Pergamon Press.
36. Geochemistry -Rankama, K. & Sahama, T.H.C., University of Chicago Press.
37. Progress in Isotope Geology -Rankama, K., Interscience
38. Using geochemical data: Evaluation, presentation, interpretation -Rollinson, H.R.. Longman scientific and Technical, New York.

**PAPER 16: ENGINEERING GEOLOGY AND SURVEYING | LTP / CREDITS = 400/4|**

**Unit-1: Surface and Subsurface Geological Investigations:** Field investigations-electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering-Description of discontinuities-bed rock attitudes, thickness, Calculation of True thickness and vertical thickness of bed rock-Geological information for slope stabilization. Rock description and engineering classification of rocks – weathering and its significance in engineering site-Engineering properties of rocks and soils, RMR, RQD methods-determination of engineering properties in field and laboratory.

**Unit 2: Geological Investigations for Dams & Tunnels and Coastal Zones:** Dams -geological investigations- suitability of site, geological profile from catchment area to Dam site- lithology, structures,

topography, slope, drainage system- groundwater studies in reservoir sites-reservoir site investigations, siltation analysis-Geological investigations for soft rock and hard rock tunnels construction. Coastal erosion and accretion process and its impact-Geological investigations for harbor construction-Coastal protection structures-Sea walls, bulk heads, groins, jetties.

**Unit 3: Geotechnical Studies of Landslides and Subsidence:** Landslide - Classification, causative factors, control measures. Land subsidence, factors, causes and remedial measures. Geological considerations for monitoring of landslides. geotechnical problems related to foundation for bridge and building site investigations. Recent trends in geotechnical engineering. Geotechnical case studies of major projects in India.

**Unit 4: Surveying :** Principles and practices of Chain survey, Compass survey, Plane table survey, Dumpy level survey, GPS survey, Total Station Survey

**References:**

1. Fundamentals of Engineering Geology – F.G. Bell
2. Geology for Engineers – Joseph M.Trfethen
3. Geology in Engineers – Schultz Cleaves



4. Geology and Engineering - Legget
5. Surveying and Levelling – Late T.P. Kanetkar and S.V. Kulkarni.
6. Surveying – Punmia.

**PAPER 17: OPEN ELECTIVE: INDUSTRIAL MINERAL RESOURCES [ LTP / CREDITS = 400/4]**

**Unit 1: Mineralogy:** Definition of a Mineral. Classification of Minerals – Rock forming minerals & Ore forming Minerals, Silicate and Non-Silicate minerals. Physical, Chemical and optical properties of Minerals.

**Unit 2: Industrial Minerals:** Description of Industrial Minerals: Gold, Silver, Coal, Copper, Diamond, Asbestos, Barite, Calcite, Diatomite, Feldspar, Gypsum, Kaolin, Mica, Silica, Talc, Zeolite, Clay minerals.

**Unit 3: Applications of Industrial Minerals:** Minerals Used in Paint, Fertilizers, Pesticides, Abrasives, Refractories, Ceramics, Glass, Pharmaceuticals, Petrochemical and Nuclear Energy.

**Unit 4: Gem Minerals:** (i) Precious varieties 1. Diamond 2. Gem corundum 3. Topaz 4. Emerald (ii) Semi-precious varieties Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems. Minerals Used in Civil work: Sandstones, Marbles, Granites, Sand and Gravel

**References:**

1. Industrial Minerals and Their Uses: a hand book and formulary. Ed. By Peter A Ciullo, Noyes Publications, 1996,
2. India's Mineral Resources by S. Krishnaswamy, Revised by R.K.Sinha, Oxford & IBH Publishing Co.PVT. LTD.
3. Mineral Resources of Karnataka – Geological Society Publication

**IV SEMESTER**

**PAPER 18: DISSERTATION [ LTP / CREDITS = 18]**

The candidate has to carry out independent project work at any state or national Institution/ agency under the supervision of the internal and external supervisors for a period of four months. C1 & C2 evaluation will be assessed as per the University guideline. Candidate has to submit final hard copy of the report in 3 sets to the Chairperson of the department for the evaluation process. C1 & C2 are as per the University regulations.



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