

# KARNATAK UNIVERSITY, DHARWAD



P.G. Department of Studies in Geology

SYLLABUS

For

GEOLOGY-M.SC. APPLIED GEOLOGY

Under CBCS (New Scheme)

With effect from 2011-12

KARNATAK UNIVERSITY, DHARWAD



SYLLABUS

For

P.G. DEPARTMENT OF STUDIES IN

Geology

M.Sc. APPLIED GEOLOGY

Choice Based Credit System (CBCS)

(New Scheme)

With effect from

2011-12

**Theory Question Paper pattern for Semester Examinations of 2011-12 onwards**

M.Sc. \_\_\_\_\_ Semester Examination

Subject \_\_\_\_\_

Paper Title \_\_\_\_\_

Time : 3 hours

Max. Marks : 75

**SECTION – A**

4 X 4 = 16 marks

- QUE. 1 (a) \_\_\_\_\_ (Unit I)  
(b) \_\_\_\_\_ (Unit II)  
(c) \_\_\_\_\_ (Unit III)  
(d) \_\_\_\_\_ (Unit IV)

**SECTION – B**

6 X 4 = 24 marks

- QUE. 2 (a) \_\_\_\_\_ (Unit I)  
(b) \_\_\_\_\_ (Unit II)  
(c) \_\_\_\_\_ (Unit III)  
(d) \_\_\_\_\_ (Unit IV)

**SECTION – C**

- QUE. 3 (a) 

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 OR 

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 } (Unit I) 09 marks
- (b) 

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 OR 

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 } (Unit II) 09 marks
- (c) 

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 OR 

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 } (Unit III) 09 marks
- (d) 

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 OR 

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 } (Unit IV) 08 marks

**KARNATAK UNIVERSITY, DHARWAD**  
**POST-GRADUATE DEPARTMENT OF STUDIES IN GEOLOGY**  
**Course Structure and Scheme of Examination**

**PROGRAM OUTLINES**

**FIRST SEMESTER**

Description of Papers	Credits	No. of Hrs/ Week Theory / Practical	Duration of exam in Hrs Theory / Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
<b>Theory</b>						
CT AG.1.1 : Stratigraphy and Palaeontology	4	4	3	25	75	100
CTAG.1.2 : Mineralogy	4	4	3	25	75	100
CTAG.1.3:Geodynamics and Structural Geology	4	4	3	25	75	100
CTAG.1.4: Gemstones and Industrial Minerals	4	4	3	25	75	100
<b>Practical's</b>						
CPAG.1.5: Palaeontology (35) and Viva (05)	2	4	4	10	40	50
CPAG.1.6: Mineralogy (35) and Viva (05)	2	4	4	10	40	50
CPAG.1.7: Structural Geology (35) and Viva (05)	2	4	4	10	40	50
	<b>22</b>	<b>28</b>	<b>24</b>	<b>130</b>	<b>420</b>	<b>550</b>

## SECOND SEMESTER

Description of Papers	Credits	No. of Hrs/ Week Theory / Practical	Duration of exam in Hrs Theory / Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
<b>Theory</b>						
CTAG.2.1: Petrology	4	4	3	25	75	100
CTAG.2.2: Mining Geology	4	4	3	25	75	100
CTAG.2.3: Ore Geology, Indian Mineral Deposits and Energy Resources	4	4	3	25	75	100
ETAG.2.4: Earth Science – I (Elective)	4	4	3	25	75	100
<b>Practical's</b>						
CPAG.2.5: Petrology (35) and Viva (05)	2	4	4	10	40	50
CPAG.2.6: Ore Geology (35) and Viva (05)	2	4	4	10	40	50
CPAG.2.7 : Ore Reserve Estimation (35) and Viva (05)	2	4	4	10	40	50
	<b>22</b>	<b>28</b>	<b>24</b>	<b>130</b>	<b>420</b>	<b>550</b>

### THIRD SEMESTER

Description of Papers	Credits	No. of Hrs/ Week Theory / Practical	Duration of exam in Hrs Theory / Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
<b>Theory</b>						
CTAG.3.1: Geochemistry	4	4	3	25	75	100
CTAG.3.2:Hydrogeology	4	4	3	25	75	100
CTAG.3.3:Mineral Economics and Engineering Geology	4	4	3	25	75	100
ETAG.3.4: Earth Science-II (Elective)	4	4	3	25	75	100
<b>Practical's</b>						
CPAG.3.5: Geochemistry (35) and Viva (05)	2	4	4	10	40	50
CPAG.3.6:Hydrogeology (35) and Viva (05)	2	4	4	10	40	50
CPAG.3.7: Geostatistics and Computer Application (35) and Viva (05)	2	4	4	10	40	50
	<b>22</b>	<b>28</b>	<b>24</b>	<b>130</b>	<b>420</b>	<b>550</b>

## FOURTH SEMESTER

Description of Papers	Credits	No. of Hrs/ Week Theory / Practical	Duration of exam in Hrs Theory / Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
<b>Theory</b>						
CTAG.4.1: Mineral Beneficiation and Environmental Geology	4	4	3	25	75	100
CTAG.4.2: Geochemical Exploration (40) and Geophysical Exploration (40)	4	4	3	25	75	100
CTAG.4.3: Photogeology and Remote Sensing	4	4	3	25	75	100
CTAGP.4.4: Project Work	6	4	Dissertation Evaluation 75 Marks	25	* Viva Voce 50 marks	150
<b>Practical's</b>						
CPAG.4.5: Mineral Beneficiation (35) and Viva (05)	2	4	4	10	40	50
CPAG.4.6: Exploration Geophysics (35) and Viva (05)	2	4	4	10	40	50
CPAG.4.7: Photogeology and Remote Sensing (35) and Viva (05)	2	4	4	10	40	50
	<b>26</b>	<b>28</b>	<b>21</b>	<b>130</b>	<b>395</b>	<b>600</b>



## **PROGRAMME SPECIFIC OUTCOMES (PSOS)**

After completion of this programme, the student will be able to:

1. Understand the different branches, concepts and its application in the field of Geology.
2. Learn the practical skills to work in the field as a professional Geologist, Hydrogeologist and Geophysicist.
3. Understand the needs and requirements of different agencies/stakeholder in the field of mineral development and water technology.
4. Effectively use Information and Communication Technology (ICT) in the study of remote sensing and geographic information systems and work as a GIS Analyst.

**KARNATAK UNIVERSITY, DHARWAD  
POST-GRADUATE DEPARTMENT OF STUDIES IN GEOLOGY  
SYLLABUS FOR M.SC. APPLIED GEOLOGY**

**CHOICE BASED CREDIT SYSTEM  
(CBCS)**

**M.Sc. I Semester  
THEORY**

<b>Paper Code and Name</b>	<b>CTAG:1.1 STRATIGRAPHY AND PALAEONTOLOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Student will understand the principle of chronological information
Unit-II	Student will understand the different lithologies
Unit-III	Student will be able to reconstruct taphanomic history of fossil assemblage
Unit-IV	Student will be able to understand the various morphological features, ages and their depositional environment

**CTAG-1.1. STRATIGRAPHY AND PALAEONTOLOGY**

**UNIT I**

Definitions of Craton, Shield, Basement and Supracrustals. Archeans of Aravallis, Extra Peninsular, Central India and Karnataka craton.

**12 hrs.**

**UNIT II**

Proterozoic successions – Cuddapah, Kaladgi and Vindhyan basins. Gondwana Formations of India – their tectonic relations, origin and distribution. Cretaceous Formations of Tiruchirapally. Deccan Traps – Classification, distribution and age. Siwalik Formations.

**12 hrs.**

**UNIT III**

Principles and procedures in paleontology, Nature and methods of preservation of fossils, Importance and use of fossils, Origin and evolution of life, Life zones in the ocean..

**12 hrs.**

**UNIT IV**

Taxonomic classification, Morphological features, Evolutionary trends and geological distribution of Principle groups of invertebrates - Corals, Brachiopods, Pelcypods, Cephalopods, Trilobites and echinoids. Plant life through ages, Gondwana flora.

Micropalaeontological studies – study of shell morphology, Classification and the geological distribution of foraminifera, Pollen and Spores.

**12 hrs.**

**Total 48 hrs**

### **Books Recommended :**

1. Geology of India D. N. Wadia Tata Mac Graw Hill Co 1975.
2. Pre-Cambrian Geology of India : S.M. Naqvi & JJW Rogers, Oxford University, Press London.
3. Pre-Cambrian of South India : S.M. Naqvi & JJW Rogers, Memoir No. 7, Geol.Soc.of India 1988
4. Geology of Karnataka: B.P. Radhakrishna & R. Vaidyanadhan 1994.
5. Purana Basis of Peninsular India – middle & late Proterozoic: B.P. Radhakrishna (Ed) Memoir no.6, Geol.Soc.of India.
6. Purana Basins of Peninsular India Memoir 6, Geol. Soc. Of India.
7. Precambrian of the eastern Indian Shield Memoir 8, Geol. Soc. Of India.
8. Precambrian of the Eastern Aravalli Mountain Memoir 7, Geol. Soc. Of India.
9. Decan volcanisim memoir 3, Geol. Soc. Of. India.
10. Cretaceous Stratigraph and Palaeoenvironments, Memoir 73, Geol. Soc. Of. India.
11. Elements of Palaeontology Claude Babin John Witney & Sons 1980.
12. Hand Book of Palaeontological Technique: B. Kummel Freeman Co., 1965.
13. Introduction to Micro Fossils : D. Jones Harper, 1956.
14. Out lines of Palaeontology: H.H. Swinnerton Edward Homold 1965.
15. Palaeontology: Invertebrates Henry woods Cambridge University Press 1982.
16. Invertebrate Palaeontology and Evolution.. IV Ed. Blackwell: Clarkson, E.N.K. 1998
17. Brinting Fossils to Life- An introduction to Palaeobiology: MC Graw Hill : Prothero. D.R. 1998.
18. Plant Life through the ages: A.C. Seward Hafner Publication 1959.
19. Principles of Micropalaeontology: M.F. Glaesser Hafner Publication 1972.
20. Microfossils : M.D. Brassier George Allan 1981.
21. Applications of Micropalaeontology : P.K. Kathal.

<b>Paper Code and Name</b>	<b>CTAG:1.2 MINERALOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Student will be able to clearly understand and differentiate Physical and Optical properties of different groups of minerals.
Unit-II	Students will be able to understand the crystal structures, different types of silicate structures along with the role of Isomorphism and Polymorphism.
Unit-III	Students will be able to understand the role of light in the optical mineralogy and behaviour of light in Isotropic and Anisotropic substances.
Unit-IV	Students will be able to understand the crystal structures developed in the different minerals with their symmetric classes, classification and twinning structures.

## **CTAG -1.2. MINERALOGY**

### **UNIT I**

General introduction to subject mineralogy, Physical and optical properties of minerals. General study of the following groups of minerals: Native elements- Gold, Silver, Copper and platinum

Sulphides- Stibnite group, Oxides–Carbonates (Calcite and aragonite), Silicates-Mica , feldspar & Feldspathoids, pyroxenes, amphibolites, Garnet and olivine

**12 hrs.**

### **UNIT II**

Crystal structure in general, Silicate structure (Types of silicate structures), Isomorphism and polymorphism

**12 hrs.**

### **UNIT III**

Conception of Optics (nature of light, simple harmonic motion, wave motion and wave surface). A general study of isotropic and anisotropic substances. Reflection, refraction, index of refraction, critical angle birefringence, pleochroism and extinction angle

**12 hrs.**

### **UNIT IV**

Elementary concept of crystallography

Classification of crystals into six crystal systems. A brief study of 32 symmetry classes of crystals. Hermann Mauguan and Schoenflies symbols. Crystal formation and irregularities (both internal & external) in crystals. Twinning in crystals

12 hrs.

Total 48 hrs.

### Books Recommended :

1. Introduction to Rock forming Minerals Vol. 1 to 4: Deer, Howie & Zussman, Longmans, 1966.
2. Dan's manual of Mineralogy : Hurlbut, C.S. Hohn Wiley 1959.
3. Mineralogy of Students : Belady Mill Oliver & Boyd, 1972.
4. Optical Crystallography : Earnst E. Wahlstrom, John Wiley & Sons.
5. Elements of Optical Mineralogy : Winchel & Winchel, Wiley Eastern 1968.
6. Optical Mineralogy, Roger, S.R.F. & Kerr. P.G. Mc. Graw Hill 1960.
7. Elementary Crystallography : Burger. M.
8. Essentials of Crystallography : Flint Peace Publi.
9. Elements of X-ray Crystallography : Azaroff.
10. A text book of Mineralogy : E.S. Dana.
11. Elements of crystallography by Phillips.

<b>Paper Code and Name</b>	<b>CTAG:1.3 GEODYNAMICS AND STRUCTURAL GEOLOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Major divisions of the Earth and concepts of Plate Tectonics
Unit-II	Understand different Orogenic Belts of India and Global tectonics
Unit-III	Understand the basic concept of Structural Geology-stress & strain
Unit-IV	Understand the concepts of Shear Zones, Faults, Unconformities & Joints

## CTAG.1.3. - GEODYNAMICS AND STRUCTURAL GEOLOGY

### UNIT I

Introduction to Major divisions/layers of the earth. Continental and Oceanic crusts. Plate tectonics. Seafloor spreading, Mid oceanic ridges

12 hrs.

### UNIT II

Island Arcs, Oceanic Trenches, Continental Margins, Hot spots, Orogenic Mountain Belts, Orogenic Belts of India, Global tectonics in relation to Plate Tectonics.

12 hrs.

### UNIT III

Concept of Stress and Strain. Strain analysis using deformed objects. Geometric Classification of Folds. Mechanics of folding. Foliations and Lineation.

12 hrs.

#### UNIT IV

Shear Zones – Geometry and Mechanics, Large scale thrusts and their significance in tectonics Classification of unconformities. Faults – Mechanics, classification and their recognition in the field Joints- Mechanics and classification

12 hrs.  
Total 48 hrs

#### Books Recommended :

1. Principles of Physical Geology : A Holmes, Nelson, London 1965
2. Basic concepts of physical Geology : E.W. Spencer, Oxford & I.B. 1971.
3. Physical Geology : Strahler Wiley & Sons. 1974.
4. Dynamic Earth : H. Leep, Mc Graw Hill 1973
5. Changing Earth : B. Meers Reinhold N.Y. 1973.
6. The Dynamic Earth System: A.M. Patvardhan, Prentice Hall of India Pvt. Ltd., 1999
7. Plate Tectonics & Crustal Evolution: K.C. Condie, Pergamon Press, 1986.
8. Palaeomagnetism & Plate tectonics : M.M. Elhimony, Cambridge Univ. Press.
9. Understanding Earth by Traak Press, Raymond Seiver Treeman & Co.,
10. Tectonics by E.M. Moores, R.J. Twiss, Freeman & Co.,

Paper Code and Name	CTAG:1.4 GEMSTONES AND INDUSTRIAL MINERALS
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the basics of gemstones and able to identify originality and qualities of different types of gemstones.
Unit-II	differentiate the Inorganic and organic Gemstones, further able to identify natural and synthetic gemstones.
Unit-III	identify suitable industrial Mineral for Abrasive, Chemical and Refractory industries
Unit-IV	identify specified industrial Mineral for Fertilizer Glass and building materials

#### CTAG.1.4. – GEMSTONES AND INDUSTRIAL MINERALS

##### UNIT I

Introduction to precious and semi-precious stones. Gem Industry in India, Qualities of Gemstones. Classification of Gemstones. Study of the following gemstones: Diamond, Topaz, Ruby, Sapphire, Emerald, Aquamarine, Tourmaline, Alexandrite, Lazurite and Turquoise.

12 hrs.

## **UNIT II**

Quartz varieties of gemstones, Pearl, Coral and Amber, Zodiacal and astrological gemstones, Distribution of gemstones in India.

**12 hrs.**

## **UNIT III**

Characters of different materials used in following industries with respects to their specification and preparations. Ceramic, Abrasives, Chemical and Refractory industries.

**12 hrs.**

## **UNIT IV**

Fertilizers, Paints, Glass, and Cement industries, Building materials.

**12hrs.**

**Total 48 hrs.**

## **Books Recommended :**

1. The geology of ore deposits – John, M. Guilbert and Chartes, F. Park. Jr. W.H. Freeman and Co., New York 1986.
2. Interpretation of ore textures – Bastin E.S.
3. Economic Mineral Deposits – Bastin A.H.
4. Ore Microscopy – Cameron E.N.
5. Ore Deposits – Park Jr. C.G.
6. Geology of Mineral Deposits Smirnor U.J.
7. The Ore Minerals and their intergrowths – Raibor
8. India's Mineral resources – Krishna Swamy S.
9. Metallic and Industrial Minerals Lamey Carl. A.
10. Introduction to India's Economic Minerals – Sharma N.L. and Ram K.S.
11. A treatise an Industrial Minerals of India – Sinha R.L.
12. Non Fuel Mineral Deposits of India – Mukarjee 1999 – Allied publications.
13. Minerals in world affairs – Iovring
14. Minerals in worlds and Industry – Vorkii
15. Mineral Economics – Sinha R.K. and Sharma N.L. Oxford I.B.H. Publications Co.,
16. Concerning Mineral Sesouran – Allen
17. An introduction to Mineral Economics by K.K. Chatterjee New Age International Ltd., 2004
18. Granite Industry : Emerging Trends and Developments by N.C. Ghose, A.N. Trivedy and S.N. Virhave 2000.

## PRACTICALS

<b>Paper Code and Name</b>	<b>CRAG:1.5 PALAEONTOLOGY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Student will be able to interpret the modes of life of fossil organism and evolutionary relationships of invertebrates.	

### CRAG. 1.5. -PALAEONTOLOGY AND VIVA

Illustration and identification of important taxa of mega and micro fossils belonging to the following groups :- Brachiopoda, Pelecypoda, Gastropoda, Cephalopoda, Trilobita, Foraminifera, Gondwana Flora.

<b>Paper Code and Name</b>	<b>CRAG:1.6 MINERALOGY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Students will be able to identify and spot the different physical properties of various minerals in the lab as well as in the field; identify different minerals under petrological microscope by understanding the optical properties of various minerals; identify the crystal forms and the crystal system of the various minerals; calculate the axial ratio of different crystal systems using stereonet.	

### CRAG. 1.6. -MINERALOGY AND VIVA

Study of minerals belonging to major groups and their identification with aid of megascopic characters and optical properties. Identification of crystals and crystals systems. Calculation of axial ratios of minerals of tetragonal, orthorhombic and monoclinic systems by stereographic methods.

<b>Paper Code and Name</b>	<b>CRAG:1.7 STRUCTURAL GEOLOGY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Measure strike and dip in the field; prepare base map and geological map and construct cross-sectional map



## **CRAG. 1.7. – STRUCTURAL GEOLOGY AND VIVA**

Study of Geological maps, tracing of outcrops, construction of geological cross sections. Dip and strike problems. Interpretation of underground structure from borehole data.

### **M.Sc. II Semester** **THEORY**

<b>Paper Code and Name</b>	<b>CTAG:2.1 PETROLOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the basics concepts of magma, its composition and classification
Unit-II	Understand different systems of magma
Unit-III	Understand the concepts of Metamorphic rocks
Unit-IV	Understand the concepts of Sedimentary rocks

## **CTAG.2.1: PETROLOGY**

### **UNIT I**

Petrography and composition of Magmatic rocks (Fabric, rock forming minerals and classification). The Origin and evolution of magma.

A brief study of the following groups of rocks:

1. Calc- alkali volcanic rock body
2. Calc-alkali plutonic rock body
3. Basaltic and Ultramafic rock bodies
4. Alkali rock bodies

**12 hrs.**

### **UNIT II**

A general study of the composition of magma, crystal-liquid-vapor equilibrium in magma system and magma generation and diversion

**12 hrs.**

### **UNIT III**

A general study of metamorphic bodies and systems. Petrography and compositional aspects of metamorphic rock bodies. Metamorphic facies, types of metamorphism. Role of temperature and pressure in metamorphism. General metamorphic rock bodies: schists, gneisses, amphibolites, granulites and eclogites.

**12 hrs.**

#### UNIT IV

Origin of sediments and formation of sedimentary rocks. Weathering, transportation and deposition. Lithification and diagenesis. Structures and textures of sedimentary rocks. A general study of the following sedimentary rocks. Sandstone, limestone and argillaceous rocks. Important sedimentary basins of India.

12 hrs.

Total 48 hrs.

#### Books Recommended :

1. Igneous and Metamorphic Petrology, Turner & Verhoogen, Mc Graw Hill.
2. Principles of Petrology : G.W. Tyrell, Asia Publ. House.
3. Metamorphic Petrology : H.G.F. Winkler.
4. Igneous & Metamorphic rocks: Antony.
5. Interpretation of Igneous rocks : K.G. Cox & Others.
6. Metamorphic Petrology : Bhaskar Rao.
7. Metamorphic Petrology : Miyashiro
8. Sedimentary Petrology : Petti John CBS Publ.
9. Principles of Sedimentation : Twenhofel.
10. Procedures of Sedimentary Petrology : R.E. Carver.
11. Introduction to Sedimentology : S.M. Sena Gupta, Oxfore IBH.
12. Principles of Sedimentary Basin Analysis : Miall, A.D. Springer Verlag, 2000
13. Analysis of Sedimentary Successions : Bhattacharya, A & Chakraborti, C. Oxford IBH 2000.
14. Petrography : William Turner & Martin Frey, CBS Public
15. Sedimentary Rocks : Pettijohn, F.J. Harper & Row 1975.
16. Principles of Sedimentary Basin Analysis : G.M. Freeman & Others, John Wiley 1978.
17. Methods of Sedimentary Petrology : Garmon Muller, Hafner Public.
18. Igneous and Metamorphic petrology : MYRON.G. BEST, Brigham young University.

Paper Code and Name	CTAG:2.2 MINING GEOLOGY
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand different concepts and method involved in mining
Unit-II	Understand how to develop mines (open and underground) and sampling techniques
Unit-III	Understand different types and methods of drilling
Unit-IV	Understand different concepts involved in Coal Mining

## **CTAG 2.2. MINING GEOLOGY**

### **UNIT I**

Introduction of Mining and mining technologies. Methods of mining: Alluvial, Opencast and Underground mining methods.

**12 hrs.**

### **UNIT II**

Shaft sinking and Development of mines. Mine sampling. Guides to ore search – Mineralogic, Stratigraphic, Lithologic and Structural guides.

**12 hrs.**

### **UNIT III**

Geological parameters for mine planning and designing. Drilling: Methods and types of drills their uses. Type and specification of drilling methods in various geological formations.

**12 hrs.**

### **UNIT IV**

Coal mining: A comparative study of room and pillar with Long and wall method of mining

**12 hrs.**

**Total 48 hrs.**

### **Books Recommended :**

1. Elements of Mining Geology C.J. Young Mc Graw Hill.
2. Courses in Mining Geology Arogyaswami Oxfords & IBH
3. Mining Geology W.C. Peter
4. Mining Geology MC Kinstry
5. Mining Geology C.S. Fox
6. Exploration and Mining Geology. W.C. Peter

<b>Paper Code and Name</b>	<b>CTAG:2.3 ORE GEOLOGY, INDIAN MINERAL DEPOSITS AND ENERGY RESOURCES</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Introduce students to various processes of mineral formation
Unit-II	Students understands why certain parts of the Earth are mineralized by introducing mineralization
Unit-III	Students will know occurrence, origin and economic importance of metallic and non-metallic deposits
Unit-IV	Students will understand various energy resources and distribution of coal and petroleum in India

## **CTAG.2.3: ORE GEOLOGY, INDIAN MINERAL DEPOSITS AND ENERGY RESOURCES**

### **UNIT I**

Introduction. Geological processes of formation of economic mineral deposits, Magmatic, Hydrothermal, Residual and Mechanical concentration, Oxidation and supergene enrichment.

**12 hrs.**

### **UNIT II**

Sedimentation and Evaporation, Metamorphism and Metasomatism. Geothermometry, Metallogenic Provinces and Epochs, Global metallogeny as related to plate tectonics.

**12 hrs.**

### **UNIT III**

Study of important metallic and non-metallic deposits of India with reference to Geology, Mode of occurrence, Mineralogy and Indian distribution of the following:- **Metallic deposits:** Iron, Manganese, Copper, Lead, Zinc, Gold, Silver and Aluminum. **Non metallic deposits:** Asbestos, Barites, Magnesite, Mica, Clay, Phosphorite, Sillimanite, Kyanite and Andalusite.

**12 hrs.**

### **UNIT IV**

**Non-Renewable – Petroleum :**Types of hydrocarbons, Origin, migration and entrapment of petroleum. Properties of source and reservoir rocks.**Structural traps:** Anticlinal traps, Fault traps, Diapiric traps, Combination traps and Hydrodynamic traps. **Techniques of exploration:** oil exploration, exploration methods and elements of a petroleum prospect, Reserves and resources. Petroliferous basins of India – Assam Kutch Gujarat, Bombay High, Cauvery, Godavari and Krishna Basins. **Coal:** Origin of Peat, Lignite, Bitumenous and Anthracite. Important coal measures of India – Gondwana, Tertiary. **Renewable Energy Resources:** Solar, Wind and Water.

**12 hrs.**

**Total 48 hrs.**

### **Books Recommended :**

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 – Bateman A.H.
4. Ore Microscope – Cameron E.N.
5. Ore Deposits – Park Jr. C.F.
6. Geology of Mineral Deposits – Smirhor U.J.
7. The Ore Minerals and their intergrowths – Raibor
8. India's Mineral resources – Krishna Swamy S.
9. Metallic and Industrial Minerals Lamey Carl. A.
10. Introduction to India's Economic Minerals – Sharma N.L. and Ram K.S.
11. A treatise on Industrial Minerals of India – Sinha R.L.

12. Non Fuel Mineral Deposits of India – Kukarjee 1999 - Allied publications.
13. Minerals in world affairs –Loverning
14. Minerals in worlds and Industry – Vorkii
15. Mineral Economics – Sinha R.K. and Sharma N.L. Oxford I.B.H. Publication co.,
16. Concerning Mineral Sesouran – Allen
17. An introduction to Mineral Economics by K.K. Chatterjee New Age International Ltd., 2004
18. Granite Industry : Eerging Trends and Developments by N.C. Chose , A.N. Trivedy and S.N. Virhave 2000.

<b>Paper Code and Name</b>	<b>ETAG:2.4 EARTH SCIENCE-I (ELECTIVE)</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the origin and divisions of the Earth
Unit-II	Understand different types of Igneous, Sedimentary and Metamorphic Rocks
Unit-III	Understand concepts of weathering and erosion
Unit-IV	Understand concepts of Hydrologic Cycle

## **ETAG 2.4 : EARTH SCIENCE - I (ELECTIVE)**

### **UNIT I**

Origin of the Earth. Four subsystems of the Earth : lithosphere, biosphere, atmosphere, hydrosphere, Uniformitarianism. Importance of Earth science. Materials of Lithosphere.

**12hrs.**

### **UNIT II**

Rock cycle, Igneous rocks, Sedimentary rocks and Metamorphic rocks. Resources from rocks and minerals

**12hrs.**

### **UNIT III**

Weathering: Definition, Mechanical and Chemical weathering. Rates of weathering, Soil formations, Soil types and erosion.

**12hrs.**

### **UNIT IV**

Hydrologic cycle, Running Water: Work of streams, stream valleys and floods. Drainage basins and pattern. Groundwater: Distribution and movement of groundwater, Hot springs, Geysers

**12hrs.**

**Total 48 hrs.**

**Books Recommended :**

1. Principles of Physical Geology : A Holmes, Nelson, London 1965
2. Basic concepts of physical Geology : E.W. Spencer, Oxford & I.B. 1971
3. Physical Geology : Strahler Wiley & Sons. 1974
4. Dynamic Earth : H Leep Mc. Graw Hill 1973
5. Changing Earth : B. Meers Rein hold N.Y. 1973
6. The Dynamic Earth System : A.M. Patvardhan, Prentice Hall of India Pvt. Ltd., 1999
7. Plate Tectonics & Crustal Evolution : K.C. Condie, Pergamon Press, 1986
8. Palaeomagnetism & Plate tectonics : M.M.Mc. Elhimony, Cambridge Univ. Press
9. Understanding Earth by Traak Press, Raymond Seiver Treeman & Co.,
10. Tectonics by E.M. Moores, R.J. Twiss, Freeman & Co.,

**PRACTICALS**

<b>Paper Code and Name</b>	<b>CRAG:2.5 PETROGRAPHY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Identify and classify megascopically and microscopically different igneous, sedimentary and metamorphic rocks	

**CRAG. 2.5 – PETROGRAPHY AND VIVA**

Classification, identification and petrographic study of the following groups / families based on megascopic, microscopic and structural studies of Igneous rocks ; Granites, granodiorites, gabbros-ultramafics, lamprophyres, andesites, dacites, rhyolites and volcanic glasses, Sedimentary rocks- megascopic and microscopic identification of common sedimentary rocks : sandstones, greywackes, siltstones, shales, limestone, dolomite, conglomerate, Heavy mineral analysis. Metamorphic rocks – megascopic and microscopic identification of schists, amphibolites, gneisses, granulites, eclogites and hornfelses.

<b>Paper Code and Name</b>	<b>CRAG:2.6 ORE GEOLOGY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Students will be able to interpret various properties exhibited by the different ores	

## **CRAG. 2.6 – ORE GEOLOGY AND VIVA**

Megascopic and microscopic identification of important ore minerals, study of typical structures / textures and their genetic significance.

<b>Paper Code and Name</b>	<b>CTAG:2.7 ORE RESERVE ESTIMATION AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand concepts of estimation and calculation of Ore reserves and generate different cross-sectional and contour maps

## **CRAG. 2.7 ORE RESERVE ESTIMATION AND VIVA**

Estimation and calculation of ore reserves. Regular and irregular samples, Underground mine samples. Ore deposits with over burden. Hidden ore bodies, use of trigonometric functions in estimation of ore reserve. Preparation of cross section of underground mine data and calculation of ore reserves. Preparation of contour maps to represent depth to ore body and concentration specific metals.

**M.Sc. III Semester**  
**THEORY**

<b>Paper Code and Name</b>	<b>CTAG:3.1 GEOCHEMISTRY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand different geochemical classification of the Earth
Unit-II	Understand different geochemical processes involved in sedimentation and metamorphism
Unit-III	Understand Thermodynamics of magmatic crystallization and introduction to concepts of meteorites
Unit-IV	Thermodynamics of metamorphism, Metamorphic phase rule and diagrams

**CTAG. 3.1. GEOCHEMISTRY**

**UNIT I**

Geochemical classification of elements: Lithophile, Siderophile, Chalcophile and Atmophile elements with examples. Structure of the earth : composition of crust, Mantle and core. Lattice energy of crystals: Ions, Atoms and Energy, Lattice energy estimated using Born – Haber Cycle. Gibb’s Free Energy : Thermodynamic system, Thermodynamic potential, State function, STP and Rule of thumb and Derivation of Gibbs free energy. Oxygen Fugacity: Definitions, concepts and geology. Godich’s stability series.

**12 hrs.**

**UNIT II**

Physico-chemical factors in sedimentation: Ionic potential, Redox potential and Hydrogen ion concentration. Colloids and Colloidal processes: Collidal stability system, Classification of colloids. Metamorphism as geochemical processes.

**12 hrs.**

**UNIT III**

Thermodynamics of magmatic crystallization, Introduction of magma : Composition of the magma, Partial melting Geochemical implications of partial melting, Effect of composition on physical properties of magmas, Fractional melting, Fractional Crystallization, assimilation and magma mixing. Introduction to Meteorites, origin and their composition and classification and mineral constituents of meteorites.

**12 hrs.**

**UNIT IV**

Mineralogy of metamorphic rocks and stability of minerals. Thermodynamics of metamorphism, Metamorphic phase rule: Illustration of phase rule, Metamorphic phases and phase diagrams. Principal types of phase diagrams (ACF, AKF and AFM Diagrams) Geochemical cycle, the Earth as a physico chemical system, Crust as a separate system.

**12 hrs.**

**Total 48 hrs.**



## Books Recommended :

1. Principles of Geochemistry B. Mason John Wiley & Sons.
2. Principles of Geochemistry B. Mason John Wiley & Sons.
3. Handbook of Geochemistry Vol I K.H. Wodephol
4. Principles of Agrochemical Prospecting Ginsberg & Sokol.
5. Geochemistry in Mineral Exploration M.S. Balasundarm
6. Geobotany and Biogeochemistry in Mineral Exploration. A.R. Brooks Harper & Row, 1972
7. Inorganic Geochemistry P.K. Anderson.
8. Geochemistry in Mineral Exploration A.W. Rose, H.E. Howkers and J.A. Webb Academic Press. 1979.

<b>Paper Code and Name</b>	<b>CTAG:3.2 HYDROGEOLOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the origin of water and Hydrological Cycle
Unit-II	Understand the concept of Vertical distribution of Water; Hydrogeological Properties of Rocks.
Unit-III	Understand the concepts of Springs, Aquifer, Pumping Tests, Water Quality for different purposes and Well technology
Unit-IV	Understand the concepts of Rain Water Harvesting, Artificial Recharge & Conjunctive Use of SW & GW; Concepts of Sea Water Intrusion; Groundwater Provinces of India; Groundwater Exploration by various methods.

## CTAG.3.2 : HYDROGEOLOGY

### UNIT I

Definition of hydrology, hydrogeology and groundwater hydrology, Importance of water, Worldwide water resources. Different states of water. Comparison of surface water and groundwater. Origin and types of water. Hydrological cycle : Definition and components of hydrological cycle. Precipitation – types of precipitation raingauge, spacing of raingange stations, Factors controlling evaporation, evapotraspiration, surface runoff, infiltration influent and effluent situations. Water budgeting, water balance studies. Impact of hydrological cycle.

**10 hrs.**

### UNIT II

Subsurface distribution of water: Zone of aeration soil zone, intermediate zone (pellicular & gravitational water), zone of saturation, water table, ground water. Factors influencing seepage of water in different ways. Occurrence of groundwater: Agencies that produce and destory openings Hydrogeological properties of rocks : porosity, permeability, specific yield, specific retention, specific absorption, Transmissivity, storativity, hydraulic

conductivity specific capacity, void ratio, specific storage, hydraulic diffusivity, hydraulic resistivity, leakage coefficient, leakage factor, drainage factor, storativity ratio. Laws governing porosity. Groundwater in fractured formations. Factors influencing porosity and permeability. Yield in different rocks. Classification of rocks based on degree of permeability. Classification of rocks with respect to hydrogeological characters.

**10 hrs.**

### **UNIT III**

Springs: Definition, origin, types of springs: Causes for water table fluctuations: Groundwater flow, equation of continuity, properties of water in relation to flow. Laminar (viscous) and turbulent (non viscous) flow, flow nets, flow lines Definitions of aquifer, aquiclude, aquitard, aquifuge. Types of aquifers: unconfined, confined, perched, semi unconfined and semi confined. Darcy's law and its application. Pumping Tests: Definition, purpose of pumping test, Well and aquifer tests Precautions before pumping tests, Assumptions in analytical methods, Selection of observation well, Water level measurements, Discharge measurements: Volumetric, Orifice weir, Rectangular and triangular V notch, Jet methods, Estimation of storativity and transmissivity. Water Quality: Physical and chemical characters, Major, Secondary, minor and trace constituents, Criteria for different uses, Graphical representations of chemical data, Determination of agricultural suitability, Role of rocks and minerals in water quality Well technology : Classification of wells – vertical, horizontal, ghannels, Well development, sterilization, stimulation, Pump and power units, Deterioration and maintenance of wells, Incrustations in wells, Corrosion and its protection in wells, Abandoned wells

**12 hrs.**

### **UNIT IV**

Hydrogeology of arid and wet lands: Occurrence of Groundwater and its characters. Artificial recharge of groundwater: Criteria to adopt, Feasibility, Pre-study, Different methods: basin, ditch – furrow, channel, pit flooding, irrigation and agricultural practices, induced recharge, recharge well method, subsurface dams, recharge of urban storms. Rain water harvesting: Definition, Requirement of harvesting (essential and solution). Methods of rainwater harvesting. Direct storing and recharge of rainwater, roof top harvesting, open space harvesting, Rainwater harvesting structures. Conjunctive use of surface and groundwater: Definition, basic studies, advantages of storing water on surface or groundwater, Restrictions in exploration of groundwater, Beneficial effects of conjunctive use in canal commands. Disadvantages in implementing conjunctive use programmes. Surface water harvesting management techniques. Groundwater provinces of India: Precambrian crystalline and sedimentary, Gondwana, Deccan Trap, Cenozoic sedimentary and fault basin, Ganges – Brahmaputra Alluvial Himalayan high lands. Sea water intrusion in coastal aquifers: Definition, interface, different situation during sea water intrusion, Ghyben – Herzberg relation, Identification of saline zones and interface, prevention and control of sea water intrusion. Occurrence of water in consolidated, semi consolidated and unconsolidated rocks. Consolidated rocks: fracture systems, weathering, groundwater occurrence and movement, aquifer characters and well yield. Yield in igneous metamorphic and volcanic rocks. Semi consolidated rocks: Aquifer characters and well yield in sandstones shales and limestones, Unconsolidated rocks: Aquifer characters in alluvial fans, piedmont deposits, valley fills, flood plain deposits, coastal deposits, glacial deposits, aeolian deposits. Groundwater Exploration: Definitions, Study of features related to

geomorphology, climate, geology, aquifer characters, hydrogeochemistry, Land and water use, Remote Sensing application (land use and land formations), Study of toposheets, Water dowsing and Electrical resistivity method. Radio isotopes in hydrogeological studies. Paleohydrological studies.

**16 hrs.**

**Total 48 hrs.**

**Books Recommended :**

1. Groundwater Hydrogeology – D.K. Todd
2. Hydrogeology – S.N. Davis and R.J.M. Dewiest
3. Groundwater Studies – R.H. Brown & Others
4. Groundwater Hydrology – Hermand Bouver
5. Groundwater resources Evaluation – W.C. Walton
6. Hydrogeology – C.W. Fetter
7. Hand book of Applied Hydrology – Ven Te Chew
8. Groundwater and wells - Hohnson Publication.
9. Physical dn Chemical Hydrogeology – Patrick A. Dominics
10. Applied hydrogeology – chow M.Mays Mac. Graw Hil Publications.
11. Hydrogeology and Wethoused conservation – Gulman – Wiley publications.
12. Groundwater Survey and Investigation – Gautham Mahajan ApH Puls.
13. Hydrology – Raghunath
14. Hydrogeology – Karanth
15. Groundwater Assessment Development and Management – Karanth
16. Groundwater – S. Ramakrishnan
17. Palehydrology and Environmental change by wiley, chichester, Bemite, V.R. Baber and K.J. Gregong
18. Global Environmental changes, the context of paleolydrology, wiley Chichester, J Brauson, A.G. Brown, K.S. Gregory.

<b>Paper Code and Name</b>	<b>CTAG:3.3 MINERAL ECONOMICS AND ENGINEERING GEOLOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Present status of availability of metallic minerals in India and other countries, its production and its market value/economy.
Unit-II	availability of Energy minerals in India and other countries, its production and its market value/economy and further administrative aspects.
Unit-III	select the suitable locations and materials for construction of major and minor projects like Dam, Reservoir, Bridges, Tunnel etc
Unit-IV	anticipate the geological problems occurring during and post construction of major geotechnical projects

## **CTAG. 3.3. MINERAL ECONOMICS AND ENGINEERING GEOLOGY**

### **UNIT I**

Role of India in the world market of the following minerals: Iron, Manganese, Barytes, Asbestos, Lead and zinc, Copper, Mica, Role of India in the world market of following minerals

**12 hrs.**

### **UNIT II**

Coal, Petroleum, Atomic Minerals, Strategic, Critical and Essential minerals: Definition, Production and Reserves, Listing of various minerals of India into the above categories Exclusive economic zones of India and their strategic importance in the production of marine minerals, National mineral policy of India and Mineral Legislation.

**12 hrs.**

### **UNIT III**

Mechanical properties of rocks and soils, Geological investigations of river valley projects Dams and Reservoirs, Tunnels – types methods and problems. Bridges – types and foundation problems

**12 hrs.**

### **UNIT IV**

Shore line engineering, Concrete aggregate – Sources, alkali aggregate reaction, A seismic designing – Seismicity in India, Earthquake resistant structures, Groundwater problems related to foundation work, mining canals and tunnels, Geotechnical case studies of major projects in India, Role of minerals in National economy and development of indigenous production

**12 hrs.**

**Total 48 hrs.**

### **Books Recommended :**

1. Introduction to India's Economic Minerals – Sharma N.L. and Ram K.S.
2. A treatise on Industrial Minerals of India – Sinha R.L.
3. Non Fuel Mineral Deposits of India – Mukarjee 1999 – Allied publications.
4. Minerals in world affairs – Lovering
5. Minerals in worlds and Industry – Vorkii
6. Mineral Economics – Sinha R.K. and Sharma N.L. Oxford I.B.H. Publication co.,
7. Concerning Mineral Resources – Allen
8. An introduction to Mineral Economics by K.K. Chatterjee New Age International Ltd., 2004
9. Granite Industry : Emerging Trends and Developments by N.c. Chose, A.N. Trivedy and S.N. Virhava 2000
10. Principles of Engineering Geology and Geotectonics – Krymimine
11. Geology in Engineering – Schulz and Cleaves, John Wiley and Sons.
12. Eng. Geology – Fox, C.S. Technical Press, London.
13. Applications of Geology to engineering practice (Berkly vol.)

14. Engineering Geology – Roice H & Watson, Jhon Wiley & Sons.
15. Geology in Engineering – Legget. F.R. McGraw Hill Co.,
16. Elements of engineering Geology – Raichey E.E. Pitman 1964
17. Engineering Geology & Hydrology – Danisev
18. Foundation Engineering – Peak, Hanson & Thornburn.
19. Rock Mechanics – Fairhurst, C. Pergamon Press.
20. Dam Geology – Walters. R.c. Butterworth & Co., Ltd., London.
21. Geology for Engineers – Blyth, F.c. H. Edward Arnold Ltd.,
22. Engineering Geology – Parbin Singh, CBS Publication.

<b>Paper Code and Name</b>	<b>ETAG:3.4 EARTH SCIENCE-II (ELECTIVE)</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the concepts of Glaciers and Earthquakes
Unit-II	Understand the concepts of Major layers of the Earth and Theory of Plate Tectonics
Unit-III	Understand the concept of Geological Time Scale which describes the major events happening
Unit-IV	Concepts of oceans, Renewable and non-renewable resources and Natural Hazards

### **ETA.G. 3.4. EARTH SCIENCE – II (ELECTIVE)**

#### **UNIT I**

Glaciers, Deserts and wind: Glacier erosion and deposits. Geologic process in arid climates. Wind erosion and deposits. Earthquakes and Earth interior: Earthquake waves, epicenters, intensity and magnitude of Earthquakes. Prediction of Earthquakes.

**12hrs.**

#### **UNIT II**

Major layers of the Earth. Plate Tectonics: Plate boundaries, Sea floor spreading, continental margins, ocean ridges, Island arcs, hotspots, mountain building activities. Volcanoes: Magma and its composition, Lava flows, Types of volcanoes.

**12hrs.**

#### **UNIT III**

Geologic Time Scale: Evolution of Earth's atmosphere, Precambrian time, Paleozoic era, Mesozoic era, Cenozoic era and introduction to Paleontology.

**12hrs.**

#### **UNIT IV**

Oceans: Composition of sea water, Ocean's layered structure. Earth Resources: Renewable and non renewable resources. Natural Hazards.

**12hrs.**

**Total 48 hrs.**

**Books Recommended :**

1. Principles of Physical Geology : A Holmes, Nelson, London 1965
2. Basic concepts of Physical Geology : E.W. Spencer, Oxford & I.B. 1971
3. Physical Geology : Strahler Wiley & Sons 1974
4. Dynamic Earth : H Leep, Mc Graw Hill 1973
5. Changing Earth : B. Meers Rein hold N.Y. 1973
6. The Dynamic Earth System : A.M. Patvardhan, Prentice Hall of India Pvt. Ltd., 1999
7. Plate Tectonics & Crustal Evolution : K.C. Condie, Pergamon Press 1986
8. Palaeomagnetism & plate tectonics : M.M. Mc Elhimony, Cambridge Univ., press.
9. Understanding Earth by Traak Press, Raymond Seiver Treeman & Co.,
10. Tectonics by E.M. Moores, R.J Twiss, Freeman & Co.,

**PRACTICALS**

<b>Paper Code and Name</b>	<b>CRAG:3.5 GEOCHEMISTRY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Understand and analyse various geochemical parameters using titration method and using instruments such as AAS, Spectrophotometer etc	

**CRG. 3.5: GEOCHEMISTRY AND VIVA**

Analysis of Iron Manganese, Copper ores. Analysis of Limestones and dolomites, Demonstration of working AAS, IR, Spectrometer, Flame Photometer, pH meter, Conductivity meter and other related analytical instruments.

<b>Paper Code and Name</b>	<b>CRAG:3.6 HYDROGEOLOGY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Understand the concept of Drainage basin analysis, Rain gauge and Rainfall data analysis, collection and analysis of different water samples for different purposes; prepare contour maps etc	

**CRAG. 3.6 : HYDROGEOLOGY AND VIVA**

Morphometric analysis of basins Calculation of mean areal annual Rainfall, Preparation of water table contours and their interpretation. Study of Depth and yield of bore wells. Analysis of water samples and their interpretation.

<b>Paper Code and Name</b>	<b>CTAG:3.7 GEOSTATISTICS AND COMPUTER APPLICATION IN GEOLOGY AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Understand and interpret the data using statistical approach; Further, learn to use different geological, hydrological and geophysical softwares and its interpretation.	

### **CRA. 3.7: GEOSTATISTICS AND COMPUTER APPLICATION IN GEOLOGY AND VIVA**

#### **GEOSTATISTICS**

1. Frequency distribution table and graphical representation of data
2. Measures of Central Tendency
3. Measures of Dispersion
4. Correlation studies – simple and bivariate
5. Regression Analysis
6. Principal Components Analysis (PCA)
7. Hierarchical Cluster Analysis

#### **COMPUTER APPLICATION IN GEOLOGY**

1. Executing of HYCHEM Programme- Analysis of hydrogeochemical data
2. Executing of GW\_CHART-Plotting on Piper's diagram
3. Executing of PLOCHEM – Plotting on Piper;s Stiff diagrams
4. Executing of GWW (Ground Water for Windows) software
5. Calculation of Saturation Indices (SI) of mineral species using WATEQ4F programme
6. Analysis of electrical resistivity data using RESIST software
7. Analysis of electrical resistivity data sing IGIS VES software
8. Analysis of electrical resistivity data using IPI2 WIN software
9. Principal Component analysis using PCA software
10. Preparation of Rose Diagram using ROZETA software – for plotting structural data related to joints and faults.

**M.Sc. IV SEMESTER APPLIED GEOLOGY  
THEORY**

<b>Paper Code and Name</b>	<b>CTAG:4.1 MINERAL BENEFICIATION AND ENVIRONMENTAL GEOLOGY</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the concept of Mineral processing
Unit-II	Understand the processes involved and Flowsheet of different metallic and non-metallic minerals
Unit-III	Understand the different concepts involved in Environmental Geology
Unit-IV	Understand the concepts of Volcanoes, Earthquakes and Pollution

**CTAG.4.1: MINERAL BENEFICIATION AND ENVIRONMENTAL GEOLOGY**

**UNIT I**

Principles and scope of mineral processing. Properties of ores and minerals applied to mineral beneficiation. Size reduction – Crushing, Rittinger law, Kick’s law, Bond’s theory Crushers and grinding mills. Sizing and screening. Principles of concentration processes. Gravity concentration. Jigging, Bring’s test. Operation of Wilfley Table, comparison of jigging and tabling.

**12 hrs.**

**UNIT II**

Magnetic separators primary magnet type and secondary magnet type; Flotation principles, types and functions of reagents used. Heavy media separation. Flow sheets of metallic ores; gold, copper, lead, zinc. Flow sheets of non-metallics; barite and Coal.

**12 hrs.**

**UNIT III**

Definition of Environmental Geology, Scope and objectives of environmental Geology Ecosystem, concepts of ecosystem: Energy transformation, Food chain, Stratification of biotic communities. Atmosphere: Clean air, major layers of atmosphere, Global temperature, Greenhouse effect, Greenhouse gases and their characters, Ozone depletion, CFC’s emission, Sources of Air pollution, Overview of the global warming problems, Landslides : Definition, Roles of gravity and slope, water earth quake in landslides, slides, flows and creeps, Rockslides and snow slides, Debris slides Talus and Talus creep, Mud slides, earth flows, Recognizing areas, Prone to slope instability, Ways to reduce incidence and severity of landslides Floods: Origin of streams, stream discharge, stream velocity, stream load, Flash floods, occurrence of floods, flood frequency, Urbanization and flooding, Anticipating and controlling of floods, Flood control : channelization; building levees, along streams building dams across rivers. Water quality and Pollution: Definition of pure water, water quality of different uses, Point and non point sources of pollution. Types of pollution sources, Sources



of groundwater quality deterioration. Degree and extent of pollution heavy metal pollution, Pesticide pollution. Trace metals in waste water, DO, BOD, COD, Problems of As and F in water. Restoration of groundwater.

**12 hrs.**

#### **UNIT IV**

Earth quakes: Definition, magnitude and intensity of earthquakes, Forecasting of earthquake : Animal Sense, Science of forecasting paleoquakes, Protecting from earthquakes: building construction, personal preparation, Official forecasts and public response, Earthquake hazards and Tsunamis. Volcanoes: Definition, Occurrence of volcanoes, Types of volcanoes, Forecasting eruption, volcanic hazards and benefits. Mining and Environment : Problems and issues as a result of mining industry, Geomorphological changes, Geohydrological changes, Biological changes, Cultural changes, Climatological changes, Effect air quality, Noise pollution and vibrations

**12 hrs.**

**Total 48 hrs.**

#### **Books Recommended :**

1. Principles of Mineral Dressing A.M. Gaudin Mc. Graw Hill
2. Elements of Ore Dressing. A.F. Taggart, John Wiley
3. Principles of Mineral Beneficiation Wells & Wells.
4. Mineral Processing. Pray Elsevier
5. Ore Processing S.K. Jain Prayor Elsuvier
6. Environmental Geology, L.L. Lundgren
7. Environmental Geology, C.W. Montgomery
8. Environmental Geology, Keller Bell and Howell, USA 1978
9. Environmental Geology, Indian Context K.S. Valdiya Tata MacGraw Hill 1987
10. Environmental Geology, P. Flawn
11. Environmental Geoscience, Strahler
12. Our Physical Environment, S.N. Davis
13. The Earth and its Environment Hesse and Macdonald
14. Geological Hazards, Bvell, F.G. Routledge, London, 1999
15. Natrual Hazarrds, Bryant E., Cambridge University, Press 1985
16. Text Book in Environmental Science V. Subramaniam, Sarosa International 2001.
17. Environment Impact of Mining Down and Stokes.

<b>Paper Code and Name</b>	<b>CTAG:4.2 GEOCHEMICAL EXPLORATION AND GEOPHYSICAL EXPLORATION</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	understand the Geochemical principles and its cycle, further in turn leads to find new favourable locations of mineral deposits.
Unit-II	understand the how the chemical analysis of different geological material and flora will help find new favourable locations of mineral deposits.
Unit-III	Get acquainted with the basic principles, instrumentation and interpretation of different geophysical methods (Gravity and Magnetic) and further to find new favourable locations of mineral deposits.
Unit-IV	acquainted with the basic principles, instrumentation and interpretation of different geophysical methods (Electrical and Seismic method) and further to find new favourable locations of mineral deposits.

## **CTAG.4.2:GEOCHEMICAL EXPLORATION AND GEOPHYSICAL EXPLORATION**

### **UNIT I**

Geochemical cycle, Principles of geochemical exploration, Geochemical environment, Dispersion, Mobility of the elements and tracers, Patterns of geochemical distribution and geochemical anomalies.

**12 hrs.**

### **UNIT II**

Primary and Secondary dispersions and classifications, Geochemical soil surveys, Soil profiles in drainage sediments, Geochemical drainage survey, Biogeochemical anomalies, Biogeochemical survey techniques. Geobotanical indicators in mineral exploration.

**12 hrs.**

### **UNIT III**

Variation of gravity over the surface of the earth. Principles of gravimeters, Eotvos, Torsion balance, Thyssen and Worden gravimeters, Field procedure, various corrections applied to gravity data, Interpretation of the data in terms of slope, Shape, size and depth. Magnetic properties of the rocks, Working principles of Schmidt, Fluxgate, Proton, Precision and alkali, vapor magnetometers, Field procedure, Data reductions, Removal of regional effects, Interpretation of the data, Introduction to aero magnetic surveys,

**12 hrs.**

### **UNIT IV**

Classification of electrical methods, Resistivity method, Basic principles and various types of electrode configurations, field procedures of profiling and VES. Seismic methods - fundamental principles of wave propagation, general field procedures of reflection and refraction surveys, shooting patterns, Instruments used in seismic surveys. Radioactivity methods - principle, instruments used, interpretation of the data well logging methods.

**12 hrs.**

**Total 48 hrs.**

**Books Recommended :**

1. Geochemistry in Mineral exploration – Awkes H & Wobb J.S. Harper and Row New York.
2. Principles of Geochemical procepecting Ginzburg I.I. Pergaman Press. N.Y. London.
3. Geochmistry of rare and dispersed chemical elements in Society – Vimogroudev
4. Biochemical Methods of prospecting – Malyuga D.P.
5. Geochemistry of epigeneis – Faibidge
6. Principles of Mining Geology – Arogyswamy
7. Geochemistry of epigenesist – Farbidge

<b>Paper Code and Name</b>	<b>CTAG:4.3 PHOTO GEOLOGY, REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Unit-I	Understand the concept and scope of Photo Geology
Unit-II	Learn the interpretation techniques of photo interpretation
Unit-III	Understand the concept and scope of Remote sensing & different satellites
Unit-IV	Learn the physics behind concept of remote sensing data and techniques of interpretation of digitally processed image

**CTAG. 4.3: PHOTO GEOLOGY, REMOTE SENSING AND GIS PHOTO GEOLOGY****Unit I**

Definition and Scope of Photo Geology. Advantages and limitations of photo geology. Flight lines and over lap and side laps, tilt and tip, drift and crab. Scale of Photographs and its significance. Types of aerial photographs: vertical, low oblique, high oblique, black and white, colour, infra red, colour infrared (FCC), Multiband spectra (MSS), Thermal infra red, Radar imagery, Spectra zonal. Geometrical properties of vertical and oblique Photographs. Instruments for interpretation: Viewing instruments- lens and mirror stereoscopes. Measuring instruments-stereo meter, parallax bar. Plotting instruments- sketch master and stereo sketch.

**12 hrs.****Unit II**

Criteria for photo interpretation: Photographic tone, photographic texture and scale, shape and size of the objects, drainage pattern. Interpretation of Geological structures: Linear features, faults, folds, dip slopes, unconformities, dikes and sills, domal structures. Interpretation of rocks and types and land forms: Igneous rocks- Intrusive and extrusive igneous rocks. Sedimentary rocks-conglomerates, shales, sandstones, gravels, limestones. Metamorphic rocks- Gneisses, schist's.

**12 hrs.**

## REMOTE SENSING

### Unit III

Definition and Scope of Remote Sensing. History and development of Remote Sensing: Remote Sensing satellites, Evolution of Indian remote sensing satellites. Electromagnetic spectrum and its parts. Spectral reflectance properties of common earth surface features: vegetation, soil, water and rock. Radiation Laws (Thermal emission laws): Kirchhoff's law, Planck's law, Wein's law and Stefan-Boltzmann's law. Atmospheric effects and scattering, atmospheric window and atmospheric absorption scattering. Sensing Sensors: Active and Passive. Multi band cameras, multi band video cameras, opto mechanical scanners, modular multispectral scanners, land sat multispectral scanners, thermal mapper, linear imaging self scanning sensors (LISS sensors).

**12 hrs.**

### Unit IV

Earth Stations: Main reflector, servo system, feed, Low noise amplifier, down converter, tracking receiver, data demodulator, bit synchroniser. Processing of Remote sensed data: (A) Geometric corrections: Earth rotation correction, line – length correction, detector offsets, band to band offsets, altitude variation, velocity change. (B) Radiometric corrections and Atmospheric effects. Principles of Microwave remote sensing and Digital Image processing technique. Application of Remote Sensing: Spectral signature of rocks, significance of drainage analysis. Application for Lithologic discrimination: igneous, sedimentary and metamorphic rocks. Criteria for structural mapping: attitude of beds, folds, linear features, unconformities. Application for land use and land cover: land sat thematic mapper spectral bands, classification of land use and land cover systems, and classification for use with remote sensor data.

**12 hrs.**

**Total 48 hrs.**

### Books Recommended :

1. Photogeology, Millder, V.C. Mc. Graw Hill
2. Manual of Photogrammetry M.M. Thomposn
3. Remote Sensing Principles and application. A.N. Patel and Surendra Singh.
4. Manual of Remote Sensing Robert G. Reevers.
5. Remote Sensing Principles and applications Sabbins, F.F. Free man 1985
6. Image interpretation in Geology, Drury, S.A. Allen and Unwin 1987.
7. Photogrammetry Moffit F.H. and Mikhail. E.M. Harper and Row 1980
8. Aerial Photography and Image Interpretation for Resource Management. Paine, D.P.Jhn Wiley, 1981
9. Remote Sensing Geology, Gupta, M.R.P. Springer, Verlag, 1990
10. Principles and Applications of Photogeology. Pandely, S.N. wiley Eastern, New Delhi 1987
11. Aerial Photographs in Geological Interpretation and Mapping Ray, R.G. Usgs Prof. papers.

12. Geographic Information Systems, Author – Pratap, Rana, Year 2006 Geographical Information Systems an Spatial Analysis in Veterinary Science, Author –Durr, P. & A Gatrell Year 2004.
13. Geoinformatics for Environmental Management, Author Reddy, M. Anji, Year 2004, Rs. 895/-
14. GIS Applications for water waste water and Stormwater Systems, Author – Shamsi, U.M. Year 2005
15. GPS Principles and Applications, Author – Ganesh. A. & R. Narayanakumar, year 2006.
16. Remote Sensing and Geographical Information Systems : An introduction : Author – Reddy, M Anji year 2000.
17. The Science of Earth, author Bonney T.g. Year 2004
18. Sensors and Environmental Applications of Remote Sensing, Author – Askne, Jan Year 2005
19. The Social Implications of Geographic Information Systems, Author Pickles, John Year 2006
20. Textbook of Remote Sensing and Geographic Information Systems 3<sup>rd</sup> edn. Author – reddy, M Anji, year 2006
21. Trends in Geological Remote Sensing / Ramaswamy S M Year 1996
22. Remote Sensing and Urban analysis : Edited by Jean Paul Donny, Mike J Barsley & Paul Alongley. Pub : Taylo and Frances : ISBN : 0748408606
23. Introduction of Environmental Remote Sensing 4<sup>th</sup> ed. Eric Chales Barrelt and Leonard F Curtis.
24. Waste land mapping in India, Goutam N.C. and L.R.a. Narayan, pink publishing house.
25. Geo-Interpretation Model for Land – cover / Land – Use classification Jiancheng, Z.C.L. and H. Lin, 1999.
26. Suggested land use / land cover classification system for Indian sing remote sensing technique : Gautam N. C. and Narayan L.R.A..Pink publishing house, Mathura.
27. Remote Sensing and Urban Analysis : Edited by Tem – Paul Donnay Taylor and Frances.
28. Introduction of Environmental remote sensing – Eric Charles Barelt Rontledge 4<sup>th</sup> edn.
29. Remote Sensing in hydrology and water management by Schultz.
30. Hydrological application of GIS by Gurnell.
31. Remote sensing in hydrology & water management by Schultz.
32. Introduction to remote sensing – Jams B Campbell. 3<sup>rd</sup> ed.
33. Remote sensing and Urban analysis / edited by Jean – Paul Donny Michael J. Barnsley Paul A Logley. London
34. Remote sensing for sustainable forest management / Steven E. Franklin, Boca Raton
35. Fundamentals of Remote Sensing and airphoto > interpretation / Thomas Eugene Avery
36. Remote sensing for soil survey / L.P. White
37. Manual of aerial photography / Ron Graham, Roger E Read
38. Remote sensing and Geographical information system Author Chandra A.M. Year 2006
39. Introduction Digital Image Processing – A Remote Sensing Perspective Author – Jensen Prentice Hal Publication

40. Remote Sensing in Water Resources Author Ramaswamy S.M. Rawat Publishers
41. Remote Sensing of the Environment : An Earth Resources Perspective (2rd Edition)  
Author by John R Jense Publishers Prentice Hall \$ 113.33
42. Introduction to Remote Sensing, 3<sup>rd</sup> Edition Author – james B Campbell Year 2002
43. Remote Sensing and Urban Analysis : GISDATA, Author – J.P. Donnay, Mike Barnsley and Paul Longle Publishers John Wiley \$119.95
44. Physical Principles of Remote Sensing (Topics in Remote Sensing), Author W.G. Rees
45. Urban Remote Sensing, Author –Qihao Weng and Dale A Quattrochi year 2006
46. Manual of Remote Sensing, Remote Sensing for Natural Resource Management and Environmental Monitorian (Manual of Remote Sensing – 3<sup>rd</sup> edition), Author – Susan Ustin
47. Introduction to Remote Sensing 2rd edition Year 2007 author – Arthur P. Cracknell and Ladson Hayes
48. Handbook of Aerial Photography and Interpretation year Jun 1999, Author K.K. Rampal
49. Aerial Photography (Teachers Gudie) Jan 2002, Author Laurel Tilbury and Mike Corbishley
50. Digital Photogrammetry : A Practical Course, Author Wilfried Linder year Mar 8, 2006

<b>Paper Code and Name</b>	<b>CRAG:4.4 PROJECT WORK</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Work on different projects in the field of Geological, Mining, Structural and Hydrogeology which requires field work, laboratory work, interpretation and drafting of thesis	

#### PRACTICALS

<b>Paper Code and Name</b>	<b>CRAG:4.5 MINERAL BENEFICIATION AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Understand the working principle of Jaw crushers, ball mill, rod mill and roll crusher	

#### **CRAG. 4.5 : MINERAL BENEFICIATION AND VIVA**

Size reduction :Jaw crushers, Roll crushers, Ball mill ad Rod mills. Study of reduction samples using, Roll crusher : angle of nip and ratio between size of feed and size of product, Ball and rod mills. Size analysis of ground material and their graphical representation. Study

of settling rate of solids with reference to Stoke's law and Rittinger's law using clay sample. Gravity concentration experiments using hydro cyclone. Froth flotation experiments using Denver flotation. Calculation of ratio of concentration and recovery percentages.

<b>Paper Code and Name</b>	<b>CTAG:4.6 EXPLORATION GEOPHYSICS AND VIVA</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
The students able handle the different geophysical instruments and data acquisition	

**CRAG. 4.6: EXPLORATION GEOPHYSICS AND VIVA**

Computation of gravity anomaly, gravity gradient and gravity curvature due to buried ore body. Case study of gravity anomalies. Computation of magnetic intensity due to buried magnetic ore bodies. Case study of magnetic anomalies. Computation of thickness / depth of beds and velocity of seismic waves by refraction and reflection methods for single and two layer horizontal discontinuity. Electrical resistivity technique – determination of resistivity and thickness of subsurface layers (VES) – Preparation of geoelectrical cross sections and their interpretation.

<b>Paper Code and Name</b>	<b>CTAG:4.7 PHOTO GEOLOGY AND REMOTE SENSING</b>
<b>COURSE OUTCOMES (COs)</b>	
After completing this paper, the students will be able to:	
Learn how to use photogeologic instruments to interpret photogeology data and criterion to interpret remote sensing data (satellite images)	

**CRAG. 4.7 : PHOTO GEOLOGY AND REMOTE SENSING**

Equipments used in Photogeology and Remote Sensing. Stereoscopic study of aerial photographs. Interpretation of aerial Photographs, (Geomorphological, structural and lithological). Study of Satellite Imageries and their Visual Interpretation (Geomorphological structural and lithological).

