

SAMBALPUR UNIVERSITY
SYLLABUS FOR M. Sc. Applied Geology (Semester System) to be effective from the
academic session 2010-11

PART – I

Semester – I

Course- AG. C. 411	Crystallography and Geostatics	4 CH
Course- AG. C. 412	Mineralogy and Optical Mineralogy	4 CH
Course- AG. C. 413	Computer application in Geology and Remote Sensing	4 CH
Course- AG. C. 414	Geomorphology, Environmental Geology and Marine Geology	4 CH
Course- AG. C. 415	(Practical corresponding to AG. C. 411 & 412)	2CH
Course- AG. C. 416	(Practical corresponding to AG. C. 413 & 414)	2CH
Course- AG. C. 417	Seminar	2CH
Grand total		22CH

PART – I

Semester – II

Course- AG. C. 421	Igneous Petrology	4 CH
Course- AG. C. 422	Sedimentary Petrology and Metamorphic Petrology	4 CH
Course- AG. C. 423	Structural Geology and Geotectonics	4 CH
Course- AG. C. 424	Practical corresponding to AG. C. 421 & 422	2CH
Course- AG. C. 425	Practical corresponding to AG. C. 423 & Report on Geological Mapping	2CH
Course- AG. C. 426	Seminar	2CH
Grand total		18CH

PART - II

Semester – III

Course- AG. C. 511	Hydrology and Engineering Geology	4 CH
Course- AG. C. 512	Geochemistry, Theories of Mineral Formation and Mineral Exploration	4 CH
Course- AG. C. 513	Metallic Minerals/ Ores and Industrial Minerals	4 CH
Course- AG. C. 514	Surveying, Mineral Beneficiation, Mineral Economics	4 CH
Course- AG. C. 515	Fossil Fuels and Nuclear Minerals	2CH
Course- AG. C. 516	(Practical corresponding to AG. C. 511 & 512)	2CH
Course- AG. C. 517	(Practical corresponding to AG. C. 513 & 514)	2CH
Course- AG. C. 517	Seminar	2CH
Course- AG. C. 518	Remote Sensing Techniques and Application (Interdisciplinary Course for the students of other departments)	2CH
Grand total		24CH

PART - II

Semester – IV

Course- AG. C. 521	Paleontology	4 CH
Course- AG. C. 522	Stratigraphy	4 CH
Course- AG. C. 523	Elective	4 CH
Course- AG. C. 524	Practical corresponding to AG. C. 521 & 522	2CH
Course- AG. C. 525	Practical corresponding to AG. E. 523 & 523 & Dissertation/ Field Report	2CH
Course- AG. C. 426	Seminar	2CH
Grand total		18 CH

Semester - I	16 CH Theory	4 CH Practical	2 CH Seminar	22 CH
Semester - II	12 CH Theory	4 CH Practical	2 CH Seminar	18 CH
Semester - III	18 CH Theory	4 CH Practical	2 CH Seminar	24 CH
Semester - IV	12 CH Theory	4 CH Practical	2 CH Seminar	18 CH
			Grand total	82 CH

Courses of Studies for M. Sc. Examination in Applied Geology

Course- AG. C. 411 (4CH)

- 80 marks

a) Crystallography

General morphological and mathematical relations in crystals; Symmetry and symmetry elements, crystal projections, Miller Indices, zonal relations, concept of lattice network. Bravais lattices; Twin crystals and laws of twinning, types of twinning in crystal systems; X-ray study of crystals by different methods and its application in identification of minerals and structural states and determination of cell dimension.

a) Geostatistics

Concept of probability. Method of sampling, Frequency distribution and frequency tables. Graphical representation of frequency data (i. e. Histogram, Frequency curve and Cumulative frequency curve), Normal Frequency distribution, population parameters and sample statistics; Mean, Standard deviation, Skewness; Kurtosis, Moment and graphical methods of determining the sample statistics; Testing normality of a frequency distribution, Degree of freedom and level of significance, the t-test the chi-square test, the F-test and analysis variance; correlation coefficient, least square method and regression analysis, Application of statistics to geological problems.

Books recommended :

- 1) Phillips, P. C. : Crystallography.
- 2) Evans, R. C.: An Introduction to Crystallography.
- 3) Dana, E. S. : A Text Book of Mineralogy.
- 4) Kerr, P. F. : Optical Mineralogy.
- 5) Davis, J. C.: Statistical methods in Geology;
- 6) Snedecor, G. W. and Kohrao, W. G.: Statistical method
- 7) Till. R.: Statistical methods for Earth Scientists
- 8) Sharma, D. d. :Geostatistics with application of earth sciences

Course- AG. C. 412 (4CH)

- 80 marks

a) Mineralogy

Silicate structure, Study of important silicate groups: Olivine, Pyroxene, Amphibole, Feldspar, Silica, Garnet, Alumino- silicates, Mica, Feldspathoids and Clay minerals. Study of oxides, sulphides, sulphates, phosphates, carbonates, halides and native elements.

b) Optical mineralogy

Properties of light- reflection, refraction, total internal reflection and double refraction. Nicol Prism. Polarisation of light. Refractive index and its measurement; Birefringence; Extinction angle- types and their determination. Interference colour, Pleochroism, Use of accessory plates; Uniaxial and biaxial Optical indicatrix, Study of anisotropic minerals under microscope orthoscopic (polarized) and conoscopic (convergent light) set-up.

Books recommended :

- 1) Dana, E. S. : A Text Book of Mineralogy.
- 2) Brain and Mason : Mineralogy.
- 3) Rutley : Elements of Mineralogy.
- 4) Barry and Mason : Elements of Mineralogy.
- 5) Deer, W. A., Howaie. R. A. and Zussmann: Rock forming Minerals.
- 8) Kerr, P. F. : Optical Mineralogy.
- 9) Wiachell, A. N. and Wiachell, H. : Elements of Optical Mineralogy (Pt.I-II)

Course- AG. C. 413 (4CH)

- 80 marks

a) Computer Application in Geology

Evolution of computers (generations), computer organization; input and output devices concept of memory (ROM); serial excess memory etc. Discs and their drives; Scan, display and processing unit, interactive graphics. Number system—Binary, octal, hexadecimal and their arithmetic operations (addition, subtraction, multiplication, divisions, two's complement). Elementary idea of truth table and flow chart; WINDOWS operating system, Basic features of computer languages- C and C++; Use of spreadsheet; Basic features of MS word.

b) Remote Sensing

Benefits of Remote Sensing over conventional method of resource survey. Components of Remote Sensing System. Electromagnetic Radiation (EMR), Nature and generation of EMR; Effects of atmosphere on EMR and its interaction with rocks minerals vegetation, water, soil etc. Platform, Role of platform in Remote Sensing, Types of platform with their specific uses. Fundamental properties of sensors and their functions. Basic features of different types of sensors in use, RS data products, Principles of RS data analysis and their application. Aerial photography, Types of aerial photographs. Characteristic features of aerial photography- scale, overlap, sidelap, vertical-exaggeration etc. Photo features - form, shape, texture, tone, drainage pattern etc., Stereoscopic perception, Conditions for stereoscopic vision. Advantages of aerial Photographs. Uses of aerial photographs in different branches of geology.

Books Recommended :

- 1) N. Subramanian : Computers genesis, programming and application.
- 2) N. Subramanian : Introduction to Computers.
- 3) Chandor, A.: The Penguin dictionary of Computers.
- 4) Sanjay Saxena : A first course in Computers
- 5) Bingham; J.: Mastering Data Processing.
- 6) Varalaksmi, P. V. N.: Projects Using C++
- 7) Lillesand, T. M., Kiefer, R. W., Chipman, J. W. : Remote sensing and image Interpretation

- 8) B. C. Panda: Remote Sensing Principles and applications
- 9) Pande, S. N. : Photogeology
- 10) Jenson, J. R. : Remote Sensing of the Environment
- 11) Gibbson, P. J. : Introductory Remote Sensing: Principles and Concepts
- 12) Gupta, R. P. : Remote Sensing Geology
- 13) Drury, S. A. : Image interpretation in Geology
- 14) Anji Reddy, M.: Remote Sensing and Geographical information system

Course- AG. C. 414 (4CH)

- 80 marks

a) Geomorphology

Geomorphic principles and processes; Concept of weathering and weathering and erosion cycle; Concept of fluvial, Aeolian and glacial processes. Types of landform. Methods of analysis of landform and drainage pattern. Major geomorphological divisions of India.

b) Environmental Geology and Marine Geology

Ecology and Ecosystem. Renewable and non renewable natural resources; Role of geology in management of non-renewable natural resources and environmental planning. Natural hazards- Earthquake, volcanic eruptions, landslides, tornado, flood, river and coastal erosion, Environmental problem due to mining activities and their mitigation.

Development of Ocean basins; classification Ocean basins; Morphology of ocean margins; Morphology of the ocean floor, Sources and compositions of marine sediments. Sealevel processes and effects of sea level changes, Mineral resources of the ocean floor.

Books Recommended :

- 1) Thurnbury, W. D.: Principles of Geomorphology
- 2) Holmes, A.: Principles of Physical Geology
- 3) Worcester, P. G.: A test book of Geomorphology
- 4) Valdiya, K. S.: Environmental Geology-Indian context
- 5) Keller E. A.: Environmental Geology
- 6) Odurn, E. P.: Fundamentals of Ecology
- 7) Kuenen, P. M.: Marine Geology
- 8) Shepard, F. P. : Submarine Geology
- 9) Mar, J. L. ; The Mineral Resources of the Sea

Course- AG. C. 415 (2 CH)

- 50 marks

(Practical Corresponding to Course No. AG. C. 411 and AG. C. 412)

Study of symmetry elements and identification of crystal models of 32 classes, Stereographic projections, Determination of axial ratio and face symbol.

Sample statistics, Histogram, frequency curve, Cummulative frequency curve. Application of statistics to geological problems

Viva and Practical record

Megascopic and microscopic identification of rock in minerals; Determination of specific gravity.

Determination of extinction angle, sign of elongation, optical sign and order of interference colours, pleochroic schemes.

Course- AG. C. 416 (2 CH) - 50 marks

(Practical Corresponding to Course No. AG. C.413 and AG. C.414)

Programming in C/ C++; Computer application in solving geological problems.

Visual interpretation of aerial photographs and satellite imageries.

Course- AG. C. 417 (2 CH) Seminar - 50 marks

Semester II

Course- AG. C. 421 (4CH) - 80 marks

a) Igneous Petrology - A (Principles of Igneous rock formation)

Concept of magma and its generation in mantle and crust, Primary and secondary magma, correlation of magma genesis and plate tectonics, introduction to silicate melt equilibria involving forsterite, enstatite, diopside, plagioclase, K- feldspar, leucite and silica minerals, Reaction principles and Bowen's reaction series. Variation diagrams, Magmatic differentiation, assimilation, Global consanguinous association.

b) Igneous Petrology - B (Classification and petrogenesis igneous rocks)

Classification of igneous rocks- mineralogical, chemical and tabular classification with special reference to IUGS classification; Petrology and geotectonic evolution of granites, basalts, andesites and alkaline rocks. Petrology of syenite, ultramafics, anorthosites and carbonatite.

Books Recommended:

- 1) Turner, F. J. and Verhogen ; Igneous and Metamorphic Petrology.
- 2) Best: Igneous and Metamorphic Petrology
- 3) Wahlstrom : Theoretical Igneous Petrology
- 4) Mc Birney, A. R.: Igneous Petrology
- 5) Barth : Theoretical Petrology
- 6) Hall, A. : Igneous Petrology
- 7) Bose, M. K. : Igneous Petrology
- 8) Gupta, A. K. : Igneous Rocks
- 9) Middlemost, E. A. K. : Magmas and Magmatic rocks
- 10) Tyrell, G. W.: The Principles of petrology
- 11) Wilsn, M.: Igneous Petrogenesis

Course- AG. C. 422 (4CH) - 80 marks

a) Sedimentary Petrology :

Processes of formation of sedimentary rocks; Texture and structures (mechanical, chemical and biogenic of sedimentary rocks, Classification and description of Sandstone, Shale and Limestone; Depositional environments - Marine, Estuarine, Lacustrine and Eolian Concept of sedimentary facies.

b) Metamorphic Petrology :

Concept of metamorphism; Types, causes and agents of metamorphism; Metasomatism; Texture and structure of metamorphic rocks, Concept of equilibrium and mineralogical phase rule. Mineral paragenesis, Graphic (ACF, AKF and AFM) diagrams and their application. Classification of metamorphic rocks, concept of zones, grades and facies. Plate tectonics and metamorphism; Important metamorphic rocks of India - Khondalite, Charnockite, Marble.

- 1) Pettijohn, F. J.: Sedimentary rocks
- 2) Potter, P. E. and Pettijohn, F. J. : Paleocurrent and basin Analysis
- 3) Pettijohn, F. J., Potter, P. E. and Siever, R. : Sand & Sandstones
- 4) Krumbein and Pettijohn, F. J. : Principles of Sedimentary Petrography
- 5) Reneick and Singh, I. B.: Depositional Sedimentary environment
- 6) Sengupta, S. M.: Introduction to Sedimentology
- 7) R. C. Lindholm: A practical Approach to sedimentology
- 8) Harker, A.: Metamorphism
- 9) Turner, F. J. and Verhogen ; Igneous and Metamorphic Petrology.
- 10) Best: Igneous and Metamorphic Petrology
- 11) Muller and Saxena : Chemical Geology
- 12) Winkler, H. J. F. : Petrogenesis of Metamorphic rocks
- 13) Miyashiro, A.: Metamorphism & Metamorphic Belts
- 14) Bhaskar Rao, B. : Metamorphic Petrology
- 15) Harker, A. : Metamorphic Petrology

Course- AG. C. 423 (4CH)

- 80 marks

a) Structural Geology

Concept of stress and strain; Elastic, plastic and brittle deformation. Classification and genesis of fold, fault, shearzone, joint, foliation, lineation and unconformities. Recognition of structural features in field. Tectonites.

b) Geotectonics

Earthquake and interior of the earth, Isostasy and gravity anomaly. Concept of sea floor spreading and Mid-oceanic ridges, Continental margins, Concept of geosyncline and different types of basins. Island arcs, Plate tectonics, Orogeny and Epirogeny.

Books Recommended :

- 1) Billings. M. P.: Structural Geology
- 2) Ghosh, S. K.: Structural Geology
- 3) Park, R. G. : Fundamentals of Structural Geology
- 4) Hobbs, B. E., Means, W. D. and Williams. P. F.: An outline of Structural Geology
- 5) De Sitter, L. U.: Elements of Structural Geology
- 6) J. G. Dennis: Structural Geology An introduction
- 7) Davis, G. H. and Reynolds, S. J. : Geology of Rocks and Regions
- 8) Ramsay, J. G. : Folding and Fracturing of Rocks

- 9) Price, N. J. and Casgrove, J. W. : Analysis of Geological structures
- 10) Turner, P. F. and Weiss : Structural analysis of Metamorphic tectonites
- 11) Belousov, V. V. : Basic Problems in Geotectonics
- 12) Valdiya, K. S. : Aspects of Tectonics
- 13) Condie, K. C.: Plate tectonics and Crustal development
- 14) Wyllie. P. J. : The Way the Earth works
- 15) Wyllie, P. J. : The dynamic Earth
- 16) Spencer, E. W. : Introduction to the structure of the earth

Course - AG. C. 424
marks

50

a) Practical corresponding to Course AG. C. 421 and AG. C. 422

Megascopic and microscopic identification of igneous, sedimentary and metamorphic rocks, CIPW normative calculation, Use of ACF, AKF and AFM diagrams for the study of metamorphic rocks. Mechanical analysis of supplied sediment sample. Graphical plotting of given size data and determination of sample statistics. Determination of paleocurrent direction with the help of rose diagram drawn from supplied data.

Practical Record and Viva

Course – AG. C. 425

50 marks

Practical Corresponding to Course AG. C. 423 and Report on geological mapping.

Topographic map study, Measurement of attitude of planar and linear structures, Profile and cross section. from given geological map. Outcrop completion, Three point problem, Geometric and trigonometric methods of calculation of orientation and thickness of beds, Equal area projection of planar and linear structural data. Two dimensional strain analysis from the supplied specimen and data.

Report on geological mapping., Viva and Practical Record

Course- AG. C. 426 (2 CH)

Seminar

- 50 marks

Part –II **Semester -III**

Course- AG. C. 511 (4CH)

- 80 marks

a) Hydrology

Ground water and its importance, Hydrologic properties, Aquifers, Ground water quality analysis, interpretation of analytical data and their use, Ground water exploration and exploitation. Ground water provinces of India, Design and construction of tube wells.

b) Engineering Geology

Engineering properties of rocks and soil. Geological investigation of dam site, reservoir site, tunnels and bridges, Landslides and stability of hill slopes, properties and selection of construction material.

Books Recommended:

- 1) Todd, D. K.: Ground water Hydrology
- 2) Davis, S. N. and Dewiest: Hydrogeology
- 3) Karanth, K. R. : Hydrogeology
- 4) Garg, S. P. : Ground water and Tube wells
- 5) Walston. W. C.: Ground water resource evaluation
- 6) Krynine and Judd : Principles of Engineering Geology.
- 7) Stagg & Zeinkiewics : Rock mechanics in Engineering Practice
- 8) Jager and Cook : Fundamentals of Rock mechanics
- 9) Ries and Watson : Engineering Geology
- 10) Leggeet, R. F.: Geology and Engineering
- 11) Price, D. G. : Engineerig geology- Principals and Practice

Course- AG. C. 512 (4CH)

- 80 marks

a) Geochemistry

Principles of crystal chemistry; Chemical bonds, Coordination principle, Radius ratio, Crystal structure; Polymorphism; Cosmic abundance of elements, Geochemical classification and distribution of elements in the earth; Geochemical cycle, Primary geochemical differentiation of the earth; Composition of the Earth's core, mantle and crust; Composition of hydrosphere and atmosphere.

b) Theories of Mineral Formation and Mineral exploration

Processes of formation of economic minerals; Controls of ore localization; Ores as chemical solutions; Role of Eh-pH in ore formation; Phase rule and its application; Metallogenic provinces and epochs; Geological, geophysical and geochemical methods of prospecting; Principles of sampling, assaying, drilling, core logging.

Books Recommended :

- 1) Mason, B.: Principles of Geochemistry
- 2) Goldschmidt, V. M.: Geochemistry
- 3) Rankama and Sahama, T. G. : Geochemistry
- 4) Krauskopf, K. B. : Introduction to Geochemistry
- 5) Smith, F. G.: Physical Geochemistry
- 6) Bateman, A. M. ; Economic Mineral deposits
- 7) Emmons, W. H. : Principles of Economic Geology
- 8) Park. F. and Mac Diarroid R. A. : Ore Deposits
- 9) Arogyaswamy, R. H. P.; Courses in Mining Geology
- 10) Park. C. F. (Jr) & Mac Diarmid, M. A.: Ore Deposits
- 11) Mukharjee, A.: Ore Genesis
- 12) Stanton : Ore Petrology

Course- AG. C. 513 (4CH)

- 80 marks

b) Metallic Minerals/ Ores

Mineralogy, uses, mode of occurrence, genesis and Indian distribution of ores Iron, Manganese, Aluminium, Copper, Lead, Zinc, Tin, Gold and Chromite; Strategic, critical and essential minerals.

a) Industrial Minerals

Mineralogy, uses, mode of occurrence, genesis and Indian distribution of Limestone and Dolomite, Mica, Gypsum, Asbestos, Graphite, Magnesite, Gemstone, Raw materials for ceramic, cement, refractory, abrasive and fertiliser industry.

Books Recommended:

- 1) Krishnaswamy, S. : Mineral Resources of India
- 2) Banerjee, D. K.: Mineral Resources of India
- 3) Deb, S.: Industrial Minerals and Rocks of India
- 4) Sharma, N. L., and Ram, K. S. V. : Introduction to India's Economic Minerals
- 5) Gokhle, K. V. G. K. and Rao: Ore Deposits of India

Course- AG. C. 514 (4 CH)

- 80 marks

a) Surveying, Mineral Beneficiation and Mineral economics

Chain and Compass, Plane Table and Theodolite survey. GPS survey. Need and methods of mineral/ ore beneficiation. Need and methods of resource evaluation and reserve calculation of economic mineral deposits. National Mineral policy.

b) Fossil Fuels and Nuclear Minerals

Mode of occurrence, genesis and Indian distribution of Coal and Petroleum. Mode of occurrence, genesis and Indian distribution of Nuclear Minerals.

- 1) Krishnaswamy, S. : Mineral Resources of India
- 2) Banerjee, D. K.: Mineral Resources of India
- 3) Deb, S.: Industrial Minerals and Rocks of India
- 4) Chandra, D., Singh, R. M. and Singh, M. P.- Introduction to Coal
- 5) Francis, W.: Coal-its formation and composition
- 6) Levorsen. A, I. : Geology of Petroleum
- 7) North, F. F. : Petroleum Geology
- 8) Hobson, G. D. and Tiratsoo, E. N. : Introduction to Petroleum Geology
- 9) Chandra, D. and Singh, R. M., Petroleum (Indian Context)
- 10) Tissot, B. P. and Welte, D. H.: Petroleum Formation and occurrence
- 11) Chatterjee. K K.: An Introduction to Mineral Economics
- 12) Sinha, R K. and Sharma. N. L.: Mineral Economics
- 13) Mckinstry : Mining Geology
- 14) Arogyaswamy, R. H. P,: Courses in Mining Geology
- 15) Virnave, S. N. Nuclear Geology and Atomic mineral resources
- 16) De Vato, R. H. Uranium Geology and Exploration
- 17) Heinrich, E. Wm.: Mineralogy and Geology of Radioactive raw materials

Course- AG. C. 515 (2CH)

- 50 marks

Practical Corresponding to Course No. AG. C. 511 and AG. C. 512

Determination of pH, Temperature, TDS and other parameters for ground water quality assessment. Graphical representation of supplied ground water quality data. Resistivity survey for ground water.

Engineering geological problems.

Blowpipe analysis of mineral powder, Titration methods to determine the composition of minerals.

Viva and Practical record

Course- AG. C. 516 (2CH) - 50 marks

Practical Corresponding to Course No. AG. C. 513 and AG. C. 514

Megascopic identification of ores and industrial minerals, Block diagram, fence diagram, isopach maps from supplied data, Ore reserve calculation. Calculation of grade/ assay value from the supplied data, identification of common ores (Hematite, magnetite, pyrite, galena, chromite, chalcopyrite, pyrolusite and psilomelane etc.) under reflected light.

Chain and Compass, Plane Table and Theodolite survey. GPS survey

Viva and Practical Record

Course- AG. C. 517 (2 CH) Seminar - 50 marks

**Course- AG. C. 518 (2 CH) Interdisciplinary Course - 50 marks
(Remote Sensing Techniques and Application)**

Definition and Fundamental principles; Advantage of Remote Sensing over conventional method of survey; Components of Remote Sensing System- Electromagnetic Radiation, Platform, Sensor and Target; Classification of EMR), interaction of EMR with vegetation, water, soil, rocks, minerals etc. Types of platform. Classification of sensors; Functioning of whisk broom and push broom type of sensors. RS data products; Principles of RS data analysis and their application in different fields.

- 1) P. K. Guha: Remote Sensing for the Beginner
- 2) B. C. Panda: Remote Sensing Principles and applications
- 3) Pande, S. N. : Photogeology
- 4) Jenson, J. R. : Remote Sensing of the Environment

Semester-IV

Course - AG. C. 521

a) Invertebrate Paleontology

Mode and conditions of preservation of fossils, A review of life through ages. Morphology, classification and evolution of Corals, Trilobites, Brachiopods, Lamellibranchs, Cephalopoda, Gastropods, Echinoids, Graptolites.

b) Paleobotany, Paleopalynology, Vertebrate Paleontology and Micropaleontology

Preservation of plants; classification of plant fossils; Gondwana flora of India, study of Glossopteris, Gangamopteris, Virebraria, Nilsonia and Ptylophyllum.

Basic concepts of paleopalynology.

Evolution history of man, horse and elephant.

Methods of separation and classification microfossils. Morphology and classification of Foraminifera, Elementary idea about radiolaria and ostracoda.

Books Recommended :

- 1) Moore, Lalicker and Fisher : Invertebrate Fossils
- 2) Shrock and Twenhofel: Principles of Invertebrate Paleontology
- 3) Von Zittle. K. A.; A Text Book of Paleontology
- 4) Woods, H.: Invertebrate Paleontology
- 5) Jones. D. J.: Introduction to Microfossils
- 6) Taylor : Paleobotany
- 7) Moore : Vertebrate Paleontology
- 8) Invertebrate paleontology and evolution

Course - AG. C. 522

a) Precambrian Stratigraphy

Principles and code of stratigraphic nomenclature. Standard geological time scale, Stratigraphic correlation; Precambrian stratigraphy of Karnataka, Orissa, Central India, Rajasthan, Eastern Ghats; Stratigraphy of Vindyan basin, Cuddaph basin and Chhattisgarh basin. Proterozoic rocks of Himalayan belt.

b) Phanerozoic Stratigraphy

Cambrians of Peninsular area; Paleozoic rocks of Extra Peninsular area; Triassic rocks of Spiti, Jurassic of Kachh, Cretaceous of Trichinopoly and their equivalents, Deccan Traps, Tertiary rocks of Assam, Siwaliks, Quaternary deposits.

Books Recommended:

- 1) Weber : Principles of Stratigraphy
- 2) Krumbein and Sloss: Stratigraphy and sedimentation
- 3) Dunbar. C. O.: Historical Geology
- 4) Krishnan, M. S.: Geology of India and Burma
- 5) Wadia. D. N.: Geology of India
- 6) Ravindra Kumar : Historical Geology and Stratigraphy of India
- 7) V. J. Gupta : Indian Precambrian Stratigraphy
- 8) Naqvi, S. M.: Precambrian Stratigraphy
- 9) - do - : Indian Paleozoic Stratigraphy
- 10) - do - : Indian Mesozoic Stratigraphy
- 11) - do - : Indian Cenozoic Stratigraphy

Course – AG. E. 523 (4 CH)

Elective (any one)

- i) Geoinformatics
- ii) Digital image processing and Geographic information system
- iii) Coal Geology
- iv) Isotope Geology
- v) Surface and sub-surface water resource management
- vi) Environmental Geology

- vii) Applied Micropaleontology
- viii) Ore Genesis:
- ix) Clay Mineralogy & Soil Geology
- x) Management of Mineral Resources

Course - AG. C. 524 (2 CH)

Practical Corresponding to Course AG. C. 524 and AG. C. 525

Identification and labelling of invertebrate, vertebrate, plant and micro- fossils.
Construction of stratigraphic sequence from given fossils and rock assemblage,
Paleogeographic maps of different geologic periods.
Viva, Practical record

Course - AG. E. 525 (2 CH)

Practical Corresponding to Course AG. E. 523 and dissertation/ field Report.

Course- AG. C. 526 (2 CH) Seminar - 50 marks

Course- AG. E. 523 Elective (any one) - 80 marks

i) Geoinformatics

Concept of resources and reserve and their classification. Mineral resources and National economy- concept and future. Ground and surface water resources of India; Sustainable development of Mineral and water resources; Geostatistical methods for reserve calculation, Computer application in Groundwater studies; Geostatistical methods for the interpretation of geochemical data to study genesis of igneous rocks, ore deposit modeling, quality of water, correlation of borehole data; Mine area planning and environmental management; Geographic Information system and its use in natural resource management.

Practical:

Sampling techniques; Sample statistics; Statistical methods of presentation of analysed sample data. Histogram; frequency curve, Cumulative frequency curve. Application of statistics to geological problems; Programming in C/ C++ for presentation of data; Computer application in solving geological problems. Extraction of statistical data from digital data.

Books recommended:

- 1) Voskuil, W. H.: Minerals in World Industry
- 2) Walston, W. C.: Groundwater resource evaluation
- 3) Maier, F. J. : Water quality and Treatment
- 4) Rao, K. L. ; India's water wealth.
- 5) Dasmann, R. F. : Environmental Conservation
- 6) Agrawal, A, Chopra, R. and Shuhia, K. : The state of India's Environment
- 7) Alien, R. : How to save the world

- 8) Burrough, P. A : Principles of Geographic Information Systems for Land Resources assessment.

ii) Digital image processing and Geographic information system

Image processing system characteristics, CPU, Arithmetic coprocessor, RAM, Operating system and compiler, Basic features of digital images. Image display system; Black and white image display. Video image display; transforming video displays to hard copy displays. Data input, verification, correction and storage data quality and errors, image analysis and pattern recognition image enhancement reduction and magnification, contrast enhancement. Rationing. Spatial filtering, Edge enhancement. Special transformation. Thematic information extraction, Classification scheme. Training site selection; Supervised classification. Map accuracy assessment Introduction of Geographic information system, Advantages of GIS, Data structure of GIS, Raster and vector data for geographical entities. Data encoding, data manipulation, Data analysis and spatial modelling. Data quality, Errors and natural variation and interpretation.

Practical:

Study of the nature and characteristic features of digital images; Methods of digital image collection; Interpretation of digital images; Brightness contrast; Image Analysis; Supervised and unsupervised classification; Preparation of Mosaic; preparation of maps using GIS software.

Books Recommended :

- 1) Rosenfeld, and Kak, A. C.,: Digital picture Processing.
- 2) Jensen, J. R.: Introductory digital Image Processing
- 3) Schowengerdt, R. A.; Techniques of Image Processing and Classification in Remote Sensing.
- 4) Hord, R. M.: Digital Image Processing of Remotely Sensed Data.
- 5) American Soc. of Photogrammetry: Manual of Remote Sensing (Vol. I & II)
- 6) Burrough, P. A : Principles of Geographic Information Systems for Land Resources assessment.
- 7) Ripley, B. : Spatial statistics.
- 8) J. A. Richards and Xiuping Jia: Remote sensing Digital Image analysis: An Introduction
- 9) Anji Reddy, M.: Remote Sensing and Geographical information system

iii) Coal Geology

Origin of coal. Geological and geographical distribution of coal, Geological aspects of strata control and vary methods of coal prospecting and exploration, coal mining methods. Evaluation of coal characteristics, Application of coal petrology. Benification of coal, coal washing, blending, Desulphurization of coal. Carbonisation, gasification of coal. Fertiliser from coal, Environmental problems due to coal mining and its use in different industries, use of fly ash. Future prospect and conservation coal.

Practical:

Megascopic identification of coal; study of coal under reflected light; Proximate analysis of coal. Preparation of maps showing Indian distribution of coal; sketch map of different coal fields of India. Reserve calculation methods for coal.

Books Recommended :

- 1) Francis, W. : Coal-its formation and composition
- 2) Stach, E. et al.,: Text book of Coal Petrology
- 3) Van Krevelen, D. W. and Schuyer: Coal science
- 4) Fettweis, G. B.,: World Coal resources- methods of assessment and results
- 5) Seyler, C. A. - Fuel technology and classification of coal
- 6) Tondon, G. L.: Coal resources of India

iv) Isotope Geology

Internal structure of atoms; Atomic weight, Nuclear stability and abundance; Isotopes; Decay mechanics of radioactive elements - positron decay, electron capture decay, branchel decay. Beta decay, alpha decay. Decay of a radioactive parent to a stable daughter; Principle of mass spectrometry. K-Ar, Sm-Nd, U Pb and C14 method of dating. Sulphur and Oxygen isotopes and their application in geological studies,

Practical:

Study of radioactive minerals under microscope. Theoretical methods of age calculation. Measurement of oxygen and sulphur isotopes.

Books Recommended :

- 1) Hamilton, G. I.: Applied Geochronology.
- 2) Paul, H. : Ages of rocks, Planets and stars
- 3) Paul, H. : Nuclear Geology
- 4) Rankama, K.: Progress in Isotope Geology
- 5) Faure, G.: Isotope Geology.
- 6) Virne, S. N.: Nuclear Geology and Atomic mineral resources.

v) Surface and sub-surface water resource management

Water cycle; measurement of surface run off; infiltration and evaporation; Ground water flow (steady, unsteady and radial); Darcy's Law; Storage equation; Fresh and salt water interaction in coastal and inland areas; Ground water conditions in different parts of India r Design and construction of tube wells; Pumping tests;. Ground water recharge; Quality of ground and surface water. Surface and ground water pollution and their management, Geological and Geophysical prospecting of ground water. Concept of watershed and their management.

Practical:

Sampling of water; Determination of pH, Temperature, TDS and other parameters for ground water quality assessment. Graphical representation of supplied ground water quality data. Resistivity survey for ground water.

Books Recommended :

- 1) Todd, D.K.:: Groundwater Hydrology
- 2) Raghunath, H. M.: Groundwater
- 3) Lewis, G, L. and Harbaugh, T. E. : Introduction to Hydrogeology,
- 4) Davis, S, N. and Dewiest: Hydrogeology
- 5) Karanth, K. R. : Hydrogeology
- 6) Van Te Chow : Applied Hydrology
- 7) Garg, S. P.; Groundwater and Tube wells
- 8) Walston, W. C.: Groundwater resource evaluation
- 9) Maier, F. J. : Water quality and Treatment
- 10) Rao, K. L.; India's water wealth.

vi) Environmental Geology

Ecology and Environment. Anthropogenic changes in Ecosystem; Dynamics of human, Population, Non-renewable natural resources. Mineral consumption. Conservation of mineral resources. Impact of mining activities on environment; Energy resources & their consumption. Energy crisis. Alternative energy resources; Natural hazards. Environmental security and hazard -zoning; Risk assessment analysis; Strategies for hazard mitigation; Seismic hazards; Seismic condition in India; Management of Seismic hazards; Stability of hill slopes and Land Slide; Controlling land slides; Causes of floods; Flood scenario in India; Management of Floods.

Practical:

Sampling of water, soil, dust from environmentally polluted areas; Analysis of water, soil, and dust. Determination of pH, Temperature, TDS and other parameters for ground water quality assessment. Graphical representation of the analysed samples. Resistivity survey for ground water. Determination of heavy metals in the soil and dust samples. Preparation of hazard zonation maps.

Books Recommended,

- 1) Valdiya, K. S. : Environmental Geology- Indian Context
- 2) Keller,E,A.: Environmental-Geology
- 3) Coates, D.R. : Environmental Geology
- 4) Betz, F. Jr (Ed): Environmental Geology
- 5) Davis, S. N. et al.: Geology and our Environment
- 6) Dasmann, R. F. : Environmental Conservation
- 7) Agrawal, A, Chopra, R. and Shuhia, K. : The state of India's Environment
- 8) Alien, R. : How to save the world
- 9) Bolt, B. A. et al. : Geological Hazards
- 10) Down, C. G. and. Stocks, J.: Environmental impact of mining.

vii) Applied Micropaleontology

Morphology, classification, of Foraminiferida, Ostrocooda & radiolaria (upto Super family/family level): Calcareous nanoplanktons; Introduction, definition, concept and

prospects of Palynology; Nature of pollens and their composition; Terminology, concept of taxa, nomenclature, classification, affinity of spore, pollen, diatoms, dinoflagellates and silicoflagellates; Use of microfossils in age determination, polynozboation, polynologing, etc. Procedures in biostratigraphy, ecostratigraphy, paleoclimatology and paleocenography, Biostratigraphic, Zonations in subcrop/ drill core assemblages;; Study of biofacies in delineation of bosin boundaries; Use of microfossils in lignite, coal and silicoflagellates in oil exploration.

Practical:

Collection and washing of microfossil bearing samples; Sepatration of micro fossils from samples. Identification of microfossils. Preparation of paleogeographic maps.

Books reconimended:

- 1) Jones, D. J.: Introduction to Microfossils
- 2) Bignot, G.: Elements of Micropaleontology.

viii) Ore Genesis:

Ore formation as a natural process in the trust; Metallogeny - space-time rationale; Mineralisation in relation to tectonics and crystal evolution; Ores in Mafic ultramafic rock, Classification scheme, immiscible liquid segregation, thermodynamic modelling of partitioning of metals with regard to composition of Cu-Ni- Co-sulfide ores; ores in felsic rocks: end-stage processes during felsic magmatism and their ore genetic significance; Hydrothermal fluids, plurality of sources, fluid inclusions, stable isotope studies, complexing and thermodynamic aspects of solubility and precipitation of minerals. Stratiform and stratabound ores, phase equilibria in simple sulfide systems, Fe-S; Fe-Zn-S, Cu-Fe-S, Fe-Ni-S, their application to natural ores. Ores and metamorphism, cause and effect relations.

Practical:

Study of ore minerals in hand specimen. Study of polished ore minerals under reflected light. Micro hardness testing. Etching study. Paragenetic study from mineral assemblage. Chemical analysis of ore minerals. Reserve calculation methods for estimation of reserve.

Books Recommended :

- 1) Mookherjee, A. ; Ore genesis- a holistic approach
- 2) Spurr, J. E.: The Ore Magmas
- 3) Sawkins, F. J. , : Metal deposits in relation to Plate Tectonics
- 4) Barnes, H. L. and Obmoto, H.: Hydrothermal Process- Application to Ore Genesis
- 5) Stanton : Ore Petrology
- 6) Ramdhor, P.: The Ore Mineral and their growth
- 7) Vaugban, D. J. and Craig, J. R. ; Mineral chemistry of metal sulphide
- 8) Amstutz, G. C.: Sedimentology and Ore genesis
- 9) Wolf, K. H.; Handbook of stratiform and strata bound ore deposits
- 10) Maynacd, J. B.: Geochemistry of Sedimentary Ore Deposits

11) Kostov, I. and Minseva-Stefanova, J. ; Sulphide minerals : crystal chemistry, paragenesis and systematics.

ix) Clay Mineralogy & Soil Geology

Introduction, Classification of clay minerals. Structure of I: I layer silicates (Kaolinite group). Structure of 2 :1 layer silicates, (Smectite group, dioctohedral smectites, trioctahedral smectites). Structure of 2:1:1 layer silicates. (dioctahedral chlorite, trioctahedral chlorite). Mixed-layer clay minerals, ion exchange of clay minerals; X-ray identification and semi quantitative estimation of major clay mineral groups, origin and diagenesis of clay minerals. Formation of Soil, Soil profile, classification of soil. Soil Chemistry, Classification of Soils. Soil type of India, Soil & vegetation. Soil erosion. Soil conservation. Soil pollution and prevention

Practical:

Study of clay minerals in hand specimen. Separation of clay minerals from sedimentary rocks and loose sediments. X-ray , DTA and TGA method of clay mineral analysis. Physical and thermal properties of clay minerals. Classification of soils.

Books Recommended :

- 1) Grim, R. E. ; Clay Mineralogy
- 2) Weaver, C. E. and Pollard, L. D.: The Chemistry of clay minerals
- 3) Velde, B. : Clay and clay minerals in natural and synthetic system
- 4) Hunt, C. B. : Geology of Soil
- 5) Meheta, K. K. : Reclamation of Alkali soils in India
- 6) Olson, G, K.: Soil and the environment
- 7) Retallack, G. J.; Soils of the past-An introduction to Paleopedology
- 8) Sharma, H. S.: Ravine erosion in India

x) Management of Mineral Resources

Prospecting criteria and guides to mineral/ ore search, Review of Geological Geophysical, Geochemical, Geobotanical methods of mineral prospecting, changing concepts, approaches, techniques and planning in regional scale mineral exploration, concept of plate tectonics and mineral location, Remote sensing. Methods of data acquisition and RS techniques in Mineral Exploration, Statistical methods and mineral/ore deposit modelling for prospecting and exploration. Methods of resource evaluation and reserve calculation, property valuation. Treatment and marketing of ores. Demand, supply and substitute. Changing pattern of mineral consumption. Strategic, critical and essential minerals, National mineral policy, Mineral concession rules, Marine mineral resources & Law of Sea, Conservation of strategic mineral resources with special reference to India, Monitoring of land degradation due to mining and natural process.

Practical:

Techniques of survey of mineral deposits. Preparation of block diagram, fence diagram, isopach diagram etc. Reserve calculation methods. Advance method of mineral survey.

Books Recommended:

- 1) Voskuil, W. H.: Minerals in World Industry
- 2) Mc Kinstry : Mining Geology
- 3) Dorbin, M.S.: Introduction to geophysical prospecting.
- 4) Gandir : Principles of Ore dressing
- 5) Hoover : Principles of Mining.
- 6) Young : Mining,