

PALAMURU UNIVERSITY



SCHEME OF INSTRUCTION AND SYLLABUS

GEOLOGY

UNDER CBCS SCHEME

(FROM THE ACADEMIC YEAR 2017-18)



PALAMURU UNIVERSITY

Scheme of Instructions for B.Sc. Regular-GEOLOGY
(as per the CBCS 2017-18)

| Year | Semester | Paper | Paper Code | Title of the paper | Hours Per Week | Exam Duration |
|----------|----------|-------|--------------------|--------------------------------------------------------------|----------------|---------------|
| I Year | I | I | | Physical Geology & Mineralogy | 4 | 3 |
| | II | II | | Crystallography Optical Mineralogy | 4 | 3 |
| II Year | III | III | | Igneous and Metamorphic Petrology | 4 | 3 |
| | IV | IV | | Sedimentary Petrology & Structural Geology | 4 | 3 |
| III Year | V | V | | Indian Geology & Paleontology | 3 | 3 |
| | | VI | Elective Paper-I | Hydrogeology / Environmental Geology | 3 | 3 |
| | VI | VII | | Economic Geology | 3 | 3 |
| | | VIII | Elective Paper- II | Mineral Exploration / Mining Geology & Mineral beneficiation | 3 | 3 |

B.Sc. I - Year - Semester - I**Paper – I - Physical Geology & Mineralogy****Unit - I**

Physical Geology: General aspects, Definition of Geology – Basic assumptions of Geology – Its relationship with other sciences – Branches of Geology – Aim and Applications of Geology. **Earth as a Planet:** Its shape, size, and density – movement and their effects. Origin and age of earth. Geological process – exogenic and endogenic, Definition of weathering – Types of weathering of rocks – physical and chemical; Definition of erosion and denudation, cycle of erosion; erosion, transportation and deposition; agents of erosion. **Rivers:** Erosion, Transportation and deposition of river (fluvial) cycle in different stages – Development of typical land forms by river erosion and deposition. V-shaped valley. Waterfall, alluvial form, meander, ox-bow lake-flood plane, natural plane, peneplain and deltas. Types of rivers.

Unit - II

Glaciers: Definition of a glacier – types of glaciers – development of typical land forms by glacial erosion and deposition – cirque, U-shaped valley – changing valley, Rocks monadnocks. Morains, drum-line - Eskors and Varves, Characteristic features of glaciated regions.

Groundwater – storage, of ground water – porosity, permeability aquifer, water table, zone of saturation, artesian well, spring, geysers development of typical land form by erosion and deposition by groundwater (Karst topography) sinkhole, cavern, stalactites and stalagmites.

Unit - III

Seas: offshore profile – land forms of sea – marine deposits and coral reefs Lacustrine deposits, Atmospheric circulation, weather and climatic changes, land air, interaction. Earth's heat budget and global climatic changes. **Wind:** Development of characteristic features by wind (arid cycle) erosion and deposition – pedestal rock-mushroom topography Incelberg – Ventifacts – locus – sand dunes. Earth movements – definition of diastrophism, epirogenic and orogenic movements – Mountains. Geosynclines. Basic concepts of isostasy, continental drift and plate tectonics. **Earthquakes:** Causes kinds of earthquake waves, and mode of propagation, intensity of earthquakes, Richters scale – seismograph and scismogram. Effects of earthquakes, earthquake zones – Interior of the earth. **Volcanoes:** Origin, products of Volcanoes.

Unit - IV

Mineralogy: Definition of mineral– classification of minerals into rock forming and ore forming minerals. Physical properties of minerals – colour, streak, play of colours, opalescence, asterism, transparency, luster, luminescence, specific gravity, magnetic properties, Electrical properties, pyro and piezo electricity. **Modes of Minerals Formation:** Occurrence and association of Minerals. Chemical properties of minerals – Isomorphism, solid solution, polymorphism, allotrophy, pseudomorphism, radioactivity; silicate structures. **Descriptive Mineralogy:** Study of physical properties, chemical properties and mode of occurrence of the following mineral groups.

Nesosilicate : Olivine, Garnet, Aluminum silicates; **Sorosilicate :** Epidote

Cyclosilicate : Beryl; **Inosilicate :**Pyroxene; Amphibole; **Phyllosilicate :** Mica, Hydrous magnesium silicate; **Tectosilicate :** Feldspars, Feldspathoids and quartz; **Miscellaneous :** Staurolite, Tourmaline, zircon, Calcite, Corundum, Apatite

Practicals

1. Study of physical properties and diagnostic features of the following minerals viz., Quartz, Jasper, Agate, Chalcedony, Amethyst, Orthoclase, Microcline, Albite, Anorthite, Tremolite, Asbestos, Muscovite, Biotite, Phlogopite, Olivine, Epidote, Garnet, Kyanite, Sillimanite, Andalusite, Beryl, Zircon, Apatite, Corundum, Talc, Gypsum Calcite, Fluorspar and Serpentine.
2. Study of important geomorphological models and charts..

Text Books

1. Hollmes Principles of Physical Geology by D.L.Holmes (1978).
2. Physical Geology by A.N.Stracher (1981).
3. Putnam's Geology 4th Edt. By E.E. Larson and P.W. Birkeland (1982).
4. Basic Physical Geology by E.S.Robinson (1982).
5. The evolving Earth: A text in Physical Geology by E.S.Sawkins et al., (1978).
6. Physical Geology by B.F.Mallory and D.N.Gargo (1979).
7. Rutleys elements of mineralogy - H.H.Reed.
8. Manual of mineralogy - C. S.Hurlbut and C.Klein.
9. Mineralogy for students - M.H.Batey.
10. An introduction to rock forming minerals - Deer, Howie, and Zussman.
11. Elements of mineralogy - Mason and Berry.

B.Sc. I - Year - Semester - II
Paper – II - Crystallography and Optical Mineralogy

Unit - I

Crystallography : Definition of a crystal – amorphous and crystalline states, Morphology of Crystals – face, edge, solid angle, interfacial angle. Forms: Simple, combination, closed, and open forms. Symmetry: Plane, axis, centre, crystallographic axes, Parameters, indices; crystallographic notation – parameter system of Weiss, index system of Miller.

Unit - II

Classification of Crystals into 7 Systems. Morphological study of the following classes of symmetry. Cubic system – Normal (Galena type); Tetragonal system – Zircon type; Hexagonal system – Beryl type.

Unit - IV

Trigonal system- Calcite type; Orthorhombic system – Barytes type ; Monoclinic system – Gypsum type; Triclinic system – Axinite type; Twinning in crystals – Definitions of twin plane, twin axis, and composite plane.

Unit - III

Optical Mineralogy: Petrological microscope (polarizing) its mechanical and optical parts behavior of isotropic and anisotropic minerals between crossed nicols – extinction, pleochroism, interference colours. Optical properties of important minerals.

Practicals

1. Study of Symmetry Elements of Seven Crystal Systems
2. Study of optical properties of following minerals.
Quartz, Orthoclase, Microcline, Plagioclase, Augite, Hornblende, Hypersthene, Muscovite, Biotite, Garnet, Olivine, Chlorite, Kyanite, Silliminite, Leucite, Calcite.

Text Books

1. A text book of mineralogy E.S.Dana and W.E.Ford.
2. Elements of Crystallography - F.A..Wade & R.B.Mattox.
3. Elements of Mineralogy - Rutlelys.
4. An introduction to Crystallography - R.C.Phillips.
5. Essential of Crystallography - E.Flint.
6. Rutleys Elements of mineralogy - H.H.Reed.
7. Optical Crytstallography - Wahlstorm.
8. Atlas of rock forming minerals in their sections - machenzic Guford.
9. Manual of optical mineralogy - Shelley.

B.Sc. II - Year - Semester - III
Paper - III - Igneous & Metamorphic Petrology

Unit - I

Nature and scope of petrology – definition of rock, classification of rocks into igneous, sedimentary and metamorphic. Distinguishing features of three types of rocks.

Igneous Rocks:

Classification into plutonic, hypabyssal and volcanic rocks; Forms – Lava flows, Intrusions, sills, laccolith, bysmalith, lopolith, dykes, ring dykes, cone sheets, volcanic necks, phacoliths and batholiths.

Structures – vesicular, amygdaloidal, block lava, ropy lava, pillow, flow, jointing and sheet structures. Plates, columnar and prismatic structures. Textures – Definition of texture, micro-structure, devitrification – allotrimorphic. Hypidiomorphic, panidiomorphic, porphyritic, poikilitic, ophitic, intergranular, intersertal trachytic graphic and micro graphic textures.

Reaction structures – corona, myrmekitic, orbicular, spherulitic, pelitic.

Unit - II

Classification of Igneous rocks - CIPW and Tyrrell tabular classification.

Descriptive Study of following rock types: Granite, Granodiorite, Syenite, Nephelinesyenite, Diorite porphyry, Pegmatite, Aplite, Gabbro, Anorthosite, peridotite, Pyroxenite, Dunite, Dolerite, Rhyolite, Obsidian, Trachyte, Andesite and Basalt.

Composition and constitution of magma – Crystallization of Magma, Uni-component binary system, eutectic and solid solutions.

Origin of igneous rocks – Bowen's reaction principle, differentiation and assimilation.

Unit - III

Metamorphic Rocks: Definition of metamorphism, agents of metamorphism, types of metamorphism, grades and zones of metamorphism. Metamorphic minerals stress and anti-stress minerals. Structures of metamorphic rocks – Cataclastic, maculose, schistose, granulose and gneissose. Textures of metamorphic rocks crystalloblastic, palimpsest, xenoblastic, idioblastic.

Unit - IV

Classification of metamorphic rocks – concept of metamorphic facies. Cataclastic metamorphisms of argillaceous and arenaceous rocks. Thermal metamorphism of argillaceous. Arenaceous and calcareous rocks. Dynamo thermal metamorphism of argillaceous, arenaceous and igneous rocks. Plutonic metamorphism, metasomatism and additive processes. Definition of anatexis and palingenesis. Descriptive study of the following metamorphic rocks. Gneiss, schist, slate, phyllite, quartzite, marble, granulite, eclogite, amphibolites, migmatite – Gondite – Charanockite and Khondalite.

Practicals

1. Megascopic Examination of Igneous Rocks and Metamorphic rocks like Granite, Syenite, Diorite, Gabbro, Dolerite, Rhyolite, Basalt, Pegmatite, Schist, Gneiss, Quartzite, Marble, Charnockite and Khondalite.

2. Microscopic examination of Granite, Syenite, Diorite, Gabbro, Dolerite, Rhyolite, Basalt, Pegmatite, Conglomerate, Breccia, Sandstone, Shale, and Limestone. Schist, Gneiss, Quartzite, Marble, Charnockite and Khondalite.

1. Text Books

2. 1. The Principles of Petrology, G.W. Tyrrell.
3. 2. Petrology - W.T.Huang.

B.Sc. II - Year - Semester - IV
Sedimentary Petrology and Structural Geology

Unit - I

Sedimentary Rocks: Sources of sediments – mechanical and chemical weathering, modes of transportation, stratification. Sedimentary structures, types of bedding, surface marks, deformed bedding solution structures.

Unit - II

Classification of Sedimentary Rocks: clastic – rudaceous, arenaceous, argillaceous, non-clastic calcareous, carbonaceous, ferruginous, phosphatic, evaporites. Descriptive Study of the following sedimentary rocks – conglomerate, Breccia, Sandstone, Grit, Arkose, Greywacke, Shale, limestone, Shelly limestone.

Unit - III

Structural Geology: Definition of Structural geology, Aim and Objectives of the Structural Geology; Importance of study of structures, primary and secondary structures; outcrop, attitude of beds; strike, dip and apparent dip, use of clinometers.

Unit - IV

Primary structures, Folds – description, nomenclature of folds, recognition of folds in the field. Joints – Geometrical and genetic classification of Joints. Faults – Geometrical and genetic classification of faults, recognition of faults in the field, effects of faults on the outcrops. Unconformities – definition of unconformity – types of Unconformities, recognition of Unconformities in the field distinguishing the faults from the Unconformities. Definitions of overlap, of flap, outlier, cleavage, schistosity, foliation and lineation.

Practicals

1. Megascopic and Microscopic examination of Sedimentary rocks like Breccia, Conglomerate, sandstone, limestone, shale, phyllite
2. Study of Topographical maps.
3. Interpretation of simple geological maps with horizontal and inclined beds, unconformity, folds and faults with reference to the topography and structure, geological succession and history. **Section drawing (at least 8 maps)**
4. Problems dealing with true dip and apparent dip.
5. Bore-hole data thickness and width of the outcrop and dip of the beds (At least 8 problems).

Text Books:

1. Structural Geology - Marland. F.Billings.
2. An outline of structural Geology - E.S..Hills.
3. Structural Geology - L.U.De Setter.
4. Elements of Structural Geology - E.S.Hills.
5. Petrology for students - S.R.Nockolds Knox, Chinnar.
6. A Text book of Sedimentary Petrology - Verma & Prasad.
7. Petrology of the Sedimentary Rocks - J.T.Greensmith.
8. Petrology of the Sedimentary Rocks - F.H.Hatch, Wells and Wells.
9. Petrology of the Igneous Rocks - F.H.Hatch, Wells and Wells.

B.Sc. III - Year - Semester - V
Paper V - Indian Geology & Paleontology

Unit - I**Paleontology:**

Definition of Paleontology, conditions of fossilization, modes of preservation and uses of fossils. Phylum echinodermata and Phylum Brachiopod, Phylum Mollusca and Phylum Arthropoda, Phylum Hemichordata, Phylum Coelenterate. Study of the following fossils with respects to their classification, morphology and geological distribution. Cidaris, Micraster, Holaster, Hemiaster, Terebratula, Spirifer, Rhynchonella, Productus, Turritella, Murex, Cypraea, Notica, Voluta, Pecten. Gryphaea, Arca, Cardita, Exogyra, Nautilus, Ammonoids, Bellemnites, Calymene, Paradoxide, Corals and Graptolites.

Plant fossils glossopteris, gangamopteris, ptylophyllum.

Note: Phyla given in Units-I, are studied with respect to their classification morphology, and geological distribution.

Unit - II**Indian Geology:**

Definition of stratigraphy, principles of stratigraphy, lithostratigraphy, standard geological time scale. Physiographic divisions of India with their stratigraphic and structural characteristics. Dharwar system, Cuddapah system, Vindhyan system, Kurnool system and Gondwana system.

UNIT - III

Triassic of spiti, Jurassic of Kutch, Cretaceous of Tiruchirapalli Deccan Traps and their Age, Siwaliks with vertebrate fossils. Geology of Andhra Pradesh. Stratigraphic contacts boundaries between Archaean and Proterozoic and Cretaceous and tertiary boundaries.

Note: Brief study of type area, distribution in India; lithology, fossil content and economic importance of the systems given in Units-II & III.

Practicals

1. Drawing and description of invertebrate fossils
2. Cidaris, Micraster, Holaster, Hemiaster, Terebratula, Spirifer, Rhynchonella, Productus, Turritella, Murex, Cypraea, Notica, Voluta, Pecten. Gryphaea, Arca, Cardita, Exogyra, Nautilus, Ammonoids, Bellemnites, Calymene, Paradoxide, Corals and Graptolites.
3. Drawing and description of plant fossils
4. Plant fossils glossopteris, gangamopteris, ptylophyllum.

Text books

B.Sc. III - Year - Semester - V
Paper - VI Elective - I (Hydrogeology)

Unit - I

Introduction: Definition of Hydrology, Hydrogeology, Scope and application of Hydrogeology. **Hydrological Cycle:** Concept of Hydrological cycle, Evaporation, Condensation, Precipitation, Infiltration, Transpiration, Evapo-transpiration. Groundwater and Runoff, Connate water, Juvenile water, Movement of subsurface water, Discharge of ground. **Ground Water:** Origin, Occurrence, and age of groundwater, vertical distribution of sub-surface water, zone of aeration soil water, vadose water, capillary fringe. Zone of saturation – water table. Perched water table. Recharge and discharge areas. Drainage basins and their physical characteristics.

Unit - II

Aquifers : Definition of aquifer, Aquitard, Aquiclude, Aquifuge. Properties of Aquifer– Porosity, retention of water in rocks, yield of water from rocks (specific yield and specific retention), Darcy law, permeability, hydraulic conductivity, velocity of groundwater flow. Transmissivity, Storage Co-efficient and Storativity. Types of aquifers, confined, semi-confined, unconfined, semi-unconfined, Homogeneous, Heterogeneous, Isotropic and Anisotropic aquifers. Igneous, Sedimentary and metamorphic rocks as aquifers. **Quality of Groundwater:** Physical, Chemical and Bacteriological characteristics of groundwater. Suitability of groundwater for drinking (with special reference to fluoride content), Irrigation and Industrial purposes. **Pollution of Groundwater:** Pollution in relation to water use urban, industrial and Agricultural sources and causes of pollution. Brief account of saline water intrusion.

Unit - III

Groundwater Investigations: Scope of investigations, Methods of groundwater explorations, Brief account of Geologic, hydrogeologic, Geo-botanical investigations, Introduction to Remote Sensing techniques.

Geophysical Exploration: Basic principles of Geophysical exploration methods, Electrical methods–Schlumberger & Wenner configuration, Resistivity profiling and Vertical Electrical Sounding.

Management of Groundwater: Groundwater balance, recharge, (natural and artificial) and discharge, static and dynamic reserves, Safe substantial and mining yields and over draft. Conjunctive use of surface and groundwater. Utilization of groundwater. Groundwater resource evaluation water table fluctuation method and rainfall infiltration method. Groundwater provinces of India. Concept of water shed management.

Practicals

1. Calculation of porosity and permeability.
2. Grain size analysis - uniformity co-efficient.
3. Ph Electrical conductivity and total dissolved solids.
4. Well inventory data collection.
5. Preparation of water table contour map and depth to water level map;.
6. Electrical Resistivity - Schlumberger method and VES.
7. Observation Satellite imagery for Geological Information

Field work: 3 periods per week (Batch strength 12) field training.

Camp: - One week during vacation

Text books

1. Groundwater hydrology by Todd.
2. Hydrogeology by Davis and Dewiest.
3. Hydrogeology by Karanth.
4. Groundwater Assessment - Development and Management by Karanth.
5. Applied Hydrogeology by Fetter.
6. Applied principles of Hydrogeology by Mannings.

B.Sc. III - Year - Semester - V
Paper - VI Elective – II - Environmental Geology

Unit - I

Fundamental concepts of Environmental Geology-Environmental geoscience-its scope, objectives, and aims. Environmental Awareness - Role of Geologist in Environmental Protection and Planning. Earth's thermal environment and Climates. Global warming. Green house effect. Ozone depletion - Ice sheets and fluctuation in sea levels. Concepts of ecosystem. Earth's major ecosystems terrestrial and aquatic. Meteorology as environmental science. Earth resources - Air, Pollution, sources, and Pollution due to dust, waste disposal. National and International standards. Constructions and urbanization. Waste disposal - Environmental effects - Waste recycling - recycling of resources. Land Cover-Application of remote sensing, mapping soil cover, forest cover, degraded land, surface water reservoirs.

Unit - II

Mining, opencast, underground, solid waste, generation, dumping stacking, rehandling, management, mineral processing, tailing ponds, acid mine drainage, siltation, case studies. Noise levels - national standards, mining machinery. Fundamental concepts - of geological hazards and crisis management. Mining impact on the environment - Health Hazards - Minerals resource depletion. Environmental considerations in location and construction of dams, reservoirs and tunnels.

Unit - III

Geological Hazards - Fundamental concepts - of geological hazards and crisis management. Mining impact on the environment - Environmental Health Hazards -floods - landslides - earthquakes - Man- made Hazards. Beach erosion - sedimentation - coastal zone protection & Management - coastal engineering constructions - their effects remedial measures. Mass wasting - land scarification - Migration of dunes - stabilization.

Practicals

Soil testing- Grain size analysis - Mineralogy
Beach cycles - Measurement of beach profiles - Estimation of erosion
Sedimentation. Chemical analysis of water & sediments.

Text books

1. K.S. Valdiya - Text book of Environmental Geology
2. Strahler - Environmental Geology
3. Lindgren - Environmental Geology
4. Keller - Environmental Geology.

B.Sc. III - Year - Semester - VI
Paper - VII - Economic Geology

Unit-I

Definition of Economic Geology, Global tectonics and metallogeny - mineral resources and mineral deposits importance of economic minerals and rocks, ore minerals, gangue minerals (gangue). Ore, industrial minerals, tenor and grade; syngenetic deposits, epigenetic deposits. Classification of mineral deposits - Bateman's classification modified by Jensen. Processes of formation of mineral deposits; endogenetic and exogenetic processes.

Unit-II

Study of Ore deposits of gold, copper, lead, zinc, aluminum, Iron, manganese, chromium, uranium and thorium, with respect to their mineralogy, uses mode of occurrence, origin and distribution in India.

Distribution of Industrial Minerals in India for the following industries; Abrasives, cement, Ceramic, Glass, Fertilizers & Chemicals, Insulators)

Unit-III

Fossil fuels: Coal, origin and types of coal - coal deposits of India.

Oil and Natural Gas: Origin, migration and entrapment - and distribution in India, use of micropaleontology in oil exploration. Gem Stones and Dimension Stones. **Atomic Minerals:** Uranite, Pitchblende, Coffenite - Beach sands: Monazite, Ilmenite, Rutile and Zircon and their use Mineral resources of Andhra Pradesh.

Practicals :

1. Drawing and description invertebrate and plant fossils as per the list mentioned in the theory syllabus.
2. Megascopic study, mode of occurrence, distribution in India and uses of the following economic minerals, haematite, magnetite, pyrite, Pyrolusite, Psilomelane, Chalcopyrite, malachite, Azurite, Bauxite, Chromite, Galena Sphalerite, Magnesite, Gypsum, Asbestos, Steatite, Graphite, Monazite, Illemnite, Zircon, Fluorite, Barytes, Corundum, Topaz, Calcite, Kaolinite, Kyanite, Sillimanite, Garnet, Mica.
3. Study of Toposheets and fieldwork in the neighbouring areas.
4. Field Geology practical's of 3 periods per week over and above the normal workload.

Text Books:

1. Indian mineral resources - S. Krishna swamy.
2. Introduction of India's economic Minerals - N. L. Sharma, K. S. V. Ram.
3. Geology & Mineral resources of Andhra Pradesh - N.V.B.S.Dutt.
4. Mineral Resource of Andhra Pradesh - Dr.P. K. Ramam.
5. Indian mineral year book (1997) Indian Bureau of Mines.
6. Fuel Minerals - A.K.Brown & Dey.

B.Sc. III - Year - Semester - VI
Paper - VIII - Elective I - Mineral Exploration

Unit - I

Definition and scope of mineral prospecting and exploration Prospecting criteria and guides. Physiographic guides and lithological structural, stratigraphic, Geochemical, Geophysical aerial and remote sensing techniques in mineral exploration.

Geochemical prospecting - Primary and secondary dispersion Geochemical association and pathfinders. Geophysical exploration brief description and application of gravity, magnetic seism electrical and radioactive methods.

Unit - II

Estimation of Ore reserves - classification - chip sampling, group sampling, pitting, trenching and bore-hole logging and sampling Calculation of Reserves. Mining methods - Classification of mining methods, criteria selection of mining method; Brief description of alluvial mining quarrying, open cast mining and underground mining methods.

Unit - I

Mineral processing - necessity and advantages of concentrate, Principles of Minerals, economics, Strategic, critical and Essen minerals, National mineral policy.

Practicals

1. Coning and quartering.
2. Estimation of ore reserves
 - a. bedded type; b. vein type (included area and extended area problems).
3. Field work: 3 periods per week.

Field training camp : Ten days (compulsory) during vacation

Text Books

1. Courses in mining geology - R.N.P.Arogya Swamy.
2. Geological Prospecting and exploration- V.M.Kneiter.
3. Mineral Economics - R. K.Sinha & N.L.Sharma.
4. Mining Geology - Mc.Kinstry.

B.Sc. III - Year - Semester - VI**Paper - VIII - Elective II Mining Geology & Mineral Beneficiation****Unit - I**

Mining Terminology. Types of Mining Methods-Alluvial Mining – pan and Beta. Long Tom, Sluicing (Ground Sluicing) Derricks and Cable Way, Hydraulic Drift Mining. Fore poling and Dredging. Open Cast Mining –Bench Mining- Glory Hole Mining, Kaolin Mining, Strip Mining.

Unit - II

Underground Mining- Gophering, Breast, Stopping, Open Overhand stopping, Underground Glory Hole Mining. Pillar and Chamber Method, Sub-Level Stopping Method. Coal Mining Method – Panel System, Board and Pillar Method, Long wall Mining, Advance and Retreat, Horizon.

Unit - III

Mining, Strip Mining, Mine Supports, Lighting Ventilation. Crushing- Jaw Crushers, Gyratory Crushers, Cone Crushers, Sledging Rolls, Hammer Mill or Pulveriser, Stamping, Spring Rolls, Manual Crushing. Grinding-Sizing by Screening, Flotation, Magnetic Separation, Electro-static Separation.

Text books

1. Courses in Mining Geology - Arogyaswamy
2. Principles of Mineral Dressing - Gaudin
3. Mining Policy Initiatives- Dhar, Gautam
4. Mineral Processing Technology - Wills