



GONDWANA UNIVERSITY, GADCHIROLI

Choice Based Credit System (CBCS)

Syllabus of

B. Sc. III (Geology)

(Semester V and VI)

(Three Years Degree Course)

2019-2020

B.Sc.-III Year
SEMESTER – V
Geology

B. Sc. Geology Semester V

DECIPLENE SPECIFIC ELECTIVE

Paper I: (Economic Geology)

Unit I:

Definition of ore, ore minerals and gangue minerals, grades of ores and non-metallic minerals, assay value and tenor of ore. Broad outline of ideas regarding classification of mineral deposits, Principles and processes of formation of mineral deposits: Magmatic concentration deposits; Pegmatitic deposits; Sublimation deposits; Contact metasomatic deposits; Submarine exhalative volcanogenic deposits; Hydrothermal deposits (Cavity filling and replacement).

Unit II:

Principles and processes of formation of following mineral deposits: Residual concentration deposits; Mechanical concentration deposits (Placers); Sedimentary deposits; Evaporites; Bacteriogenic deposits; Supergene sulphide enrichment deposits; Metamorphic and metamorphosed deposits with suitable Indian examples.

Unit III:

Mineralogy, uses, geological occurrences, origin and geographical distribution of the mineral deposits of - Iron, ^{manganese, copper} Chromium, Tungsten, Lead and Zinc, Gold, Aluminium, ~~Radioactive~~ ^{pyrite, Barytes} minerals, Non-metals related to refractory, fertilizers, cement, chemical, gemstone, (Gypsum, Mica, Graphite, Kyanite, Sillimanite, and Diamond).

Unit IV:

Mineralogy, uses, geological occurrences, origin and geographical distribution in India of the following: ^{Fuels: radioactive minerals,} Manganese, Copper, ^{central India} Natural hydrocarbons; oil and natural gas, ~~Fossil fuel:~~ lignite and coal. Brief account of the geological setting and mineralization of the following: Kolar gold field, Singhbhum copper belt, Malanjkhand copper deposit, Lead zinc deposit of Zawar, Manganese belt of ^{Maharashtra}, Iron ore deposits of Bastar, Bauxite deposits of Maharashtra, Mica deposits of Bihar, and Andhra Pradesh. Gondwana coal deposits, Neyveli lignite deposit, Gypsum deposit of Rajasthan and beach placers of Kerala.

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Practicals

ECONOMIC GEOLOGY

Study of physical properties and identification of the following minerals in handspecimen: Native gold, Native Copper, Chalcopyrite, Bornite, Covellite, Cuprite, Malachite, Azurite, Galena, Anglesite, Cerrusite, Sphalerite, Zincite, Smithsonite, Hematite, Magnetite, Siderite, Pyrite, Marcasite, Pyrrhotite, Chromite, Pyrolusite, Psilomelane, Braunite, Ilmenite, Wolframite, Scheelite, Cassiterite, Molybdenite, Stibnite, Realgar, Orpiment, Cinnabar, Uraninite, Bauxite, Graphite, Asbestos, Barytes, Mica, Talc, Monazite, Beryl, Kyanite, Sillimanite, Gypsum, Clay, Lignite, bituminous coal and Anthracite

Books recommended:

Economic Geology

1. Jensen and Bateman: Economic Mineral Deposits.
2. Sen and Guha: A Handbook of Economic Geology.
3. Banerjee D.K.: Mineral Resources of India.
4. Sharma and Ram: Introduction to India's Economic Minerals.
5. Deb: Industrial Minerals and Rocks of India.
6. Krishnaswamy: India's Mineral Resources.
7. Babu: Tin in India.
T.M.
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8. Babu: Diamonds in India.
9. Radhakrishnan and Curtis: Gold in India.
G.G. and Pitale, V.L.
10. Deshpande: Geology of Maharashtra.
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11. Prasad: Mineral deposits of India CBS Pub.

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B. Sc. Geology Semester V
DECIPLINE SPECIFIC ELECTIVE

Paper II: (Elements of Remote Sensing and Geomorphology)

Unit I:

Definition of Remote Sensing. Scope and aim of Remote Sensing in Geology. Remote Sensing from aerial heights (Aerial photography), Remote Sensing from space heights (Satellite imagery), Aerial photography, Aerial camera, Types of aerial photographs, (black & white, colour and infra-red), Flights for obtaining aerial photos. Methods of studying aerial photos in the form of mosaics and stereopairs. Pocket and Mirror stereoscope.

Unit II:

Recognition elements in the study of aerial photos- tone, texture, pattern, shape, size, form, shadow, drainage, vegetation, and landforms. Photographic expressions of various geological features on aerial photos and factors affecting such expressions (climate, vegetal cover, soil, type of weathering vis-à-vis nature and composition of rocks). Importance of concept of convergence of evidence in photo-interpretation. Guidelines for lithologic, structural and geomorphic interpretation.

Unit III:

Scope and aim of geomorphology. Fundamental concepts, weathering, mass-wasting and related landforms. Fluvial cycle of erosion. Mackin's concept of graded streams. Drainage patterns and their significance.

Unit IV:

Karst topography, Aeolian and glacial cycles, Concept of morphometric regions, Topography developed over folded and faulted structures. Brief idea about applied geomorphology.

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Practical's

Remote Sensing:

Test of stereoscopic vision. Handling of aerial photographs. Aerial photo index. Orientation of stereopairs. Stereoviewing on aerial photos in conjunction with relevant toposheets. Significance of scale and resolution factors. Study of aerial photo expression of structural, geomorphic and lithologic features on stereopairs.

Geomorphology:

Reading of topographic maps. Scheme of numbering of topographic maps. Data provided on topographic maps. Drainage patterns and their relationship to lithology and structure. Computation of gradient of a stream. Contour patterns related to different topographic forms such as valleys, ridges (mesa, cuesta, homoclinal ridge, hogback), scarps, domes, basins, waterfalls, slopes, plains, gorges, plateaus, sand dunes. Contour patterns related to structures such as horizontal, dipping and folded beds, plunging folds. Contour patterns of igneous, sedimentary and metamorphic rock.

Books recommended:

Remote Sensing:

1. Pande: Principles and applications of Photogeology.
2. Sabins: Remote sensing Principles and interpretations.
3. Lillesand and Kiefer: Remote sensing and image interpretation.
4. Drury: Image interpretation in Geology.

Geomorphology:

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B. Sc. Geology Semester V

DECIPLINE SPECIFIC ELECTIVE

Paper III: (EXPLORATION GEOLOGY)

Unit 1:

Mineral Resources; ~~Resource~~ ^{Resource} reserve definitions; Mineral resources in industries – historical perspective and present; A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Unit 2:

Prospecting and Exploration; Principles of mineral exploration, ^{concept of} prospecting and exploration; ~~conceptualization~~ ^{conceptualization}, methodology and stages; Sampling; ^{principles of} subsurface sampling including pitting, trenching and drilling; Geochemical exploration.

Unit 3:

~~Evaluation of data~~ Evaluation of sampling data; Mean, mode, median, standard deviation and variance; Factors affecting reliability of reserve estimation; Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks) Regular and irregular grid patterns, statistics and error estimation

Unit 4:

Drilling and Logging; Core and non-core drilling; Planning of bore holes and location of boreholes on ground; Core-logging and Reserve estimations and Errors; Principles of reserve estimation, density and bulk density

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PRACTICALS:

Preparation of Geological cross-Skill Enhancement Course^{section}. Numerical problem^s of reserve estimation.

Books recommended:

1. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
2. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.
3. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.

1. CLARK, G.B. 1967. ELEMENTS OF MINING. JOHN WILEY & SONS.

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B. Sc. Geology Semester V

DECIPLINE SPECIFIC ELECTIVE:

Paper IV: PETROLIUM GEOLOGY

Unit-I:

Introduction and Aspects of Petroleum Geology, Characteristics of Hydrocarbons (Physical and Chemical properties), Petroleum System, Composition, Origin (Types of Kerogen), Occurrence, Migration and Accumulation of Petroleum; Petroleum traps (Stratigraphic and Structural); Reservoir rocks, conditions & mechanisms.

Unit-II:

Surface indications and direct detection of Hydrocarbons, Surface and Subsurface exploration techniques; ~~Concept~~ Geophysical methods of exploration: Gravity and Seismic methods

Unit-III:

Geo Logging and Well logs (Electric, Radioactive and Acoustic); Formation evaluation and Testing, ~~Geo Logging and Well logs (Electric, Radioactive and Acoustic); Formation evaluation and Testing~~ Well Completion and Stimulation, An outline of the oil belts of the India; ~~Indian~~ geographic and stratigraphic distributions of oil and gas;

Petroleum basins of India

Unit-VI: ~~Recent trends in Petroleum Geology. Recent trends in Petroleum Geology.~~ Functions of Petroleum Geologist; Understanding oil and gas: Exploration, Drilling and ~~Completion~~, Production, ~~Services~~. Types of rigs and its selection; Rotary drilling system and equipment; Drilling sequence: Coring; Casing and Cementation and Drilling fluids;

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Practical:

Plotting of Petroliferous basins on maps ^{of} India. Important Onshore and Offshore Petroliferous basins of India. Problems based on Well log interpretation, Creation of isopachs maps ✓

Books recommended

1. Hyne, N J., (2001) Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, PennWell Corporation.
2. Selley, R.C., (1998) Elements of Petroleum Geology, W.H. Freeman & Company, New York. North, F.K., 1(986) Petroleum Geology, Allen & UnWin, 607p
3. Morris, J., (1985) Practical Petroleum Geology, The University of Texas at Austin - Petroleum Extension Service.
4. Levorsen, A.I., (1967) Geology of Petroleum, W.H. Freeman and Company.

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B. Sc. Geology Semester V
SKILL ENHANCMENT COURSE

Paper I: (Elements of Applied Geology)

Unit-I: Engineering properties of rocks and Soils.

Unit-II: Soil and Soil groups of India.

Unit-III: Elementary idea of mining and Environmental considerations for mining.

Unit-IV: Mineral exploration: Elementary idea of geological prospecting. and

Practicals : ~~Surveying by Plane Table/Theodolite~~; Preparation of geological maps; Engineering properties and identification of building stones.

Books Recommended:

1. Valdiya, K.S., 1987. Environmental Geology – Indian Context. Tata McGraw Hill.
2. Rajendran S., 2007. Mineral Exploration : Recent Strategies.
3. Dobrin, M.B. & Savit, CH., 1988. Introduction to Geophysical Prospecting, McGraw-Hill.
4. Arogyaswamy, R.N.P., 1973. Courses in Mining Geology. Oxford and IBH Publ.
5. Parasins, D.S., 1997. Principles of applied geophysics. Chapman Hall.
6. Krynine D.P. and Judd W.R., 1957. Principles of Engineering Geology & Geotechnics. McGraw-Hill Book
7. Kesavulu, N.C., 2009. A text book of engineering geology. Macmillan P publishing India Ltd.
8. Crozier. M.J., 1989. Landslides: causes, consequences and environment. Academic Press.
9. Readman, J.H., 1979. Techniques in Mineral exploration. Applied Science Publishres.
10. Bell, F.G., 1983. Fundamentals of Engineering Geology. Butterworth and Co

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B. Sc. Geology Semester V
SKILL ENHANCEMENT COURSE

Paper II: (Geochemistry)

Unit-I: Introduction and Principle of geochemistry, Chemical composition and properties of atmosphere, hydrosphere and lithosphere. Elementary idea of Periodic Table: Major, Minor and trace and Rare elements.

Unit-II: Cosmic abundance of elements; Composition of the planets and meteorites; Geochemical evolution of the earth and geochemical cycle.

Unit-III: Geochemical classification of elements; *chemical fundamentals of Geology.* ~~Distribution of major, minor and trace elements in igneous, metamorphic and sedimentary rocks.~~

Unit-IV: Elements of geochemical thermodynamics; Isomorphism, polymorphism and Pseudomorphism; Isotope geochemistry.

Practical's

Determination of LOI of rock samples, Preparation of variation diagrams and plotting of REE data

Books Recommended:

1. Hoefs, J., 1980. Stable Isotope Geochemistry. Springer-Verlag.
2. Klein, C. and Hurlbut, C.S., 1993. Manual of Mineralogy. John Wiley and Sons, New York.
3. Krauskopf, K.B., 1967. Introduction to Geochemistry. McGraw Hill.
4. Mason, B. and Moore, C.B., 1991. Introduction to Geochemistry. Wiley Eastern.
5. Rollinson, H.R., 1993. Using geochemical data: Evaluation, Presentation, and Interpretation. Longman.

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B.Sc.-III Year
SEMESTER – VI
Geology

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B. Sc. Geology Semester VI
DISCIPLINE SPECIFIC ELECTIVE

Paper I: (Structural Geology)

Unit I:

Scope and aim of Structural Geology, Concept of rock deformation: Types of forces, stress and strain. Compass clinometers and its parts, method of using the instrument. Study of outcrops, identification of bedding, data, measurement. Dip, Strike, Rake, Plunge and their measurements.

Unit II

Outcrops and their relationship with topography. Overlap (Offlap and Onlap). Erosional structures: Inlier and Outlier, Klippe and Fenster, Synclinal hill and Anticlinal valley. Unconformities : kinds, geological significance and their recognition. Diapirs (salt domes).

Unit III

Structural elements- planar and linear. Folds: definition, style, orientation, morphology geometric and genetic classification. Effects of folding on outcrops. Joints: Definition, geometric and genetic classification of joints.

Unit IV

Faults: definition, geometric and genetic classification of faults, effects of faulting on outcrops. Recognition of faults in the field. Foliation: descriptive terminology, kinds, origin and relation to major structures. Lineation: descriptive terminology, kinds, origin and relation to major structures. Map symbols for above structural features. Shear zones: ductile and brittle shear zones.

Practicals:

Structural Geology: Reading a geological map and the symbols used. Completion of outcrop/counter maps, problems based on true dip and apparent dip, three point problems, and determination of thickness and depth of the beds. Drawing of geological ^{map} ~~Sketch~~ ~~Enhancement~~ ~~Corrections~~ and interpretation of geology and geological history.

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Books recommended:

1. Billings: Structural Geology.
2. Hills: Outline of Structural Geology.
3. Hobbs, Means and Williams: Outline of Structural Geology.
4. Suppe: Principles of Structural Geology.
5. Park: Fundamentals of Structural Geology.
6. Gokhale: Theory of Structural Geology.
7. Gokhale: A manual of problems of Structural Geology.
8. Mathur: A Guide to Field Geology.
9. Compton: Manual of Field Geology.
10. Lahi: Field Geology.
11. Gokhale: Guide to Field Geology.
12. Butler and Bell: Interpretation of Geological Maps.
13. Phillips: The use of Stereographic projections in Structural Geology.
14. Roberts: Introduction to Geological maps and structures.
15. Ragan: Structural Geology: An introduction to geometric techniques.
16. Bolton: Geological Maps: Their solution and interpretation

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B. Sc. Geology Semester VI

DECIPLINE SPECIFIC ELECTIVE

Paper II: (Elementary Hydrogeology and Environmental Geology)

Unit I

Definition of Precipitation, percolation, runoff, evaporation and transpiration. Hydrologic cycle. Occurrence and distribution of groundwater. Zones of aeration and saturation, water table, cone of depression and recharge. Influent and effluent seepages and springs. Elementary ideas about groundwater flow.

Unit II

Hydrologic properties of rocks. Hydrogeologic characteristics of different types of rocks. Aquifers and their classification. Groundwater provinces of India. Groundwater conditions in different parts of Maharashtra. Concept of watershed management.

Unit III

Definition and concept of Environmental Geology. Natural hazards such as earthquakes, landslides floods, volcanic activity, coastal erosion, desertification and their impact on environment. Soil types, soil degradation and mitigation, soil pollution.

Unit IV

Concepts of natural ecosystems on the earth and their mutual interrelations and interactions (atmosphere, hydrosphere, lithosphere and biosphere). Environmental changes due to human dominated environment over nature dominated system. Environmental considerations in the constructions of large dams, reservoirs, and tunnels. Pollution: its effect on natural ecosystem and anti- pollutional measures (water and air)

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Practical

Hydrogeology: Determination of groundwater flow direction. Interpretation of well inventory data. Pumping test: time-drawdown and time recovery test and evaluation of aquifer parameter in nearby area.

Environmental Geology:

Preparation of map of seismic zone, volcanic hazards zone, flood prone zone and land slide zones of India.

Books recommended: Hydrogeology:

1. Todd: Ground water Hydrology
2. Karanth: Hydrogeology
3. Nagabhushaniah : Groundwater in Hydrosphere (Groundwater hydrology)
4. Karanth: Groundwater Assessment, Development and Management

Environmental Geology:

1. Valdiya: Environmental Geology
2. Miller: Sustaining the Earth
3. Foley, Duncan, McKenzie and Utgard: Investigations in Environmental Geology
4. Keller : Environmental Geology
5. Bell: Geological Hazards.
6. Coats: Environmental Geology

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B. Sc. Geology Semester VI
DECIPLINE SPECIFIC ELECTIVE
Paper III: (SURVEYING and MAPPING)

Unit I

Instrument used in geological mapping and survey. Principle of surveying method , recording, reading and plotting by ~~Prismatic~~ ^{Prismatic} compass, Brunton compass, theodolite and plane table.

Unit II

Leveling and contouring by Hand level, Abney and Dumpy level. Methods of Leveling: Spot, Differential and profile leveling.

Unit III

Fundamental of mine survey, Survey in opencast and underground mines, Geological mapping in opencast and underground mines,

Unit IV

Type of geological map and ^{Sections.} ~~Skill Enhancement Courses~~. General principle of geological mapping, mapping method in Igneous, sedimentary and metamorphic terrain. Toposheet Indexing scheme, Map symbol reading, SOI toposheet map reading Standard Symbols/colour for lithology and symbols.

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Practical

The evaluation is to be based on preparation of portfolio that should include plans drawn using Plane table, a Leveling Exercise.

Books recommended:

- Basak, N N., (2014) Surveying and Levelling, McGraw Hill Education.
- Lisle R., Brabham P and Barnes J., (2011) Basic Geological Mapping (Geological Field Guide), Wiley Blackwell.
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Kang – Tsung – Chang., (2002) Introduction to Geographical Information System, , McGraw Hill.
- Gokhale, N W., (2001) A Guide to Field Geology, CBS Publishers & Distributors.
- Lambert, D A., (1998) Field Guide to Geology, Facts on File Inc.
- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.
- Kanetkar, T P & Kulkarni, S V., (1988) Surveying & Levelling (Part I), Pune VidyarthiGrihaPrakashan.
- Compton, R R., (1985) Geology in the Field, John Wiley & Sons, Inc.
- Compton, R R., (1962) Manual of Field Geology, John Wiley & Sons, Inc.
- Lahee, F H. (1962) Field Geology, McGraw – Hill Book Company, Inc. .

B. Sc. Geology Semester VI

DECIPLINE SPECIFIC ELECTIVE

Paper III: (Marine Geology and Oceanography)

Unit I:

History of development of marine geology; Origin of ocean basins; A brief account of tectonic history of the oceans; Oceanic crust; Deep ocean-floor topography; Morphology of ocean margins; Marine sediments, sources and composition, sediment types and distribution; Oceanic sediments and microfossils; Deep sea sediments and their relation to oceanic processes such as productivity, solution and dilution.

Unit II:

Oceanic circulation - Surface, intermediate and deep ocean circulation; Forces that produce and effect circulation patterns in world oceans; Important phenomena associated with surface circulation; Formation and movement of deep and bottom waters; Sedimentation rates; Calcite and aragonite compensation depth.

Unit III

Methods and instruments for exploring the ocean floor; Deep Sea Drilling Project (DSDP), Ocean Drilling Programme (ODP) and Joint Global Flux Studies (JGOFS) and their major accomplishments; Integrated Ocean Drilling Programme (IODP) and its aims and objectives; Sediment distribution in time and space as related to tectonic models;

Unit IV:

Evolution of oceans through the Cenozoic; Ocean gateways and their role in controlling global climates; Sea level changes during Quaternary with special reference to India; Reconstructing Quaternary climatic and oceanographic history on shorter time scales using marine records; Mineral resources of the ocean including polymetallic nodules;

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Practical:

Sedimentary facies; Bio facies; Depth biotopes and estimation of paleodepth of the ocean using benthic foraminiferal assemblages; Identification of modern and ancient surface water mass with the help of planktic foraminiferal assemblages; Identification of benthic foraminifera characteristic of Low oxygen environment; Identification of planktic foraminifera characteristic of warm and mixed layer.

Books Recommended:

Kennett, J.P. (1982) Laboratory Exercises in Oceanography Marine Geology, Prentice Hall.
Seibold, E. and Berger, W.H. (1982) The Sea Floor, Springer-Verlag.

Field work:

Field work shall be treated as a part of practical examination of semester VI and Marks are assigned on it. Every student should attend field work for a short duration and submit field diary, geological specimen and a report. Field report shall be assessed by teacher and Head of the Department

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B. Sc. Geology Semester VI
SKILL ENHANCMENT COURSE

Paper I: (Urban Geology)

Unit 1:

Geology and Society Necessity of Geology in Urban life. Geology in Urban Constructions
Geotechnical feature and mapping for subsurface in Metropolitan areas Building materials,
Excavation and cutting in urban areas.

Unit 2:

Geology and Urban Agriculture Soil studies, Chemistry and geochemistry of soil in relation to
ground water and fertilizer Effect of pollutants on vegetable contamination

Unit 3:

Urban land use Geotechnical site characterization, Geotechnical and land use mapping, Decision
making in urban landuse, Geological problems in construction of underground structures in
urban areas Urban Tunneling: Tunneling for road and rail in urban areas, Method, Equipments,
Importance of Geology

Unit 4:

Urban water Water lagging in built-up areas, Source of water, Standards for various uses of
water Sources of contamination Waste waters: Sources and its disinfection and treatment,
Ground water surveys and resource development.

PRACTICALS:

1. Map Reading
2. Ground water flow direction estimation
3. Case studies of Urban flood; Flood hydrographs
4. Case studies of urban planning

Books Recommended:

1. Huggenberger, P. and Eptin, J. 2011 Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management. Springer
2. Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

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B. Sc. Geology Semester VI
SKILL ENHANCEMENT COURSE
Paper II: (EARTH RESOURCES)

Unit 1:

Earth Resources reserve definitions; mineral, energy and water resources in industries Historical perspective and present A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies

Unit 2:

Definition of Energy: Primary and Skill Enhancement Course secondary Energy Difference between Energy, Power and Electricity Renewable and Non-Renewable Sources of Energy The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy

Unit 3:

Major Types and Sources of Energy Resources of Natural Oil and Gas Coal and Nuclear Minerals Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy

Unit 4:

Energy Sources and Power Generation: Nuclear, Hydroelectric, Solar, Wind and Wave- General Principles. Ground water resources and its role in economic development of a country Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells.









PRACTICALS:

1. Plotting of major Indian oil fields on map of India
2. Problems related to assessment of possible oil exploration site from geological maps
4. Problems related to energy demand projection of India and possible mitigation pathways
5. Problems related to biofuel

Books Recommended:

1. Energy and the Environment by Fowler, J.M 1984. McGraw-Hill
2. Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.
3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M. A. Prelas. 2009, Springer
4. Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur. 2009, Springer.
5. Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.

~~2. Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.~~

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