Savitribai Phule Pune University
T. Y. B. Sc. Geology Syllabus

(To be implemented from Academic Year 2021-22)

Semester V (Total Credits 22)

Discipline Specific Electives (DSE) Theory Papers

Paper No.	Title of the paper	Credits
GL 311	Geology of India I	2
GL 312	Mineral Resources	2
GL 313	Marine Geology	2
GL 314	Engineering Geology	2
GL 315	Hydrogeology	2
GL 316	Applied Geophysics	2

Practical related to DSE

Paper No.	Title of the paper	Credits
GL 317	Practical's related to GL311and GL312	2
GL 318	Practical's related to GL313and GL314	2
GL 319	Practical's related to GL315and GL316	2

Skill Enhancement Courses (SEC)

Paper No.	Title of the paper	Credits
SEC I	Geotechnology	2
SEC II	Gemmology and Gem Testing	2

Semester VI (Total Credits 22)

Discipline Specific Electives (DSE) Theory Papers

Paper No.	Title of the paper	Credits
GL 321	Geology of India II	2
GL 322	Mining and Mineral Exploration	2
GL 323	Oceanography	2
GL 324	Petroleum Geology	2
GL 325	Climate Change: Past, Present, and Future	2
GL 326	Geological Field Methods and Mapping	2

Practical related to DSE

Paper No.	Title of the paper	Credits
GL 327	Practical's related to GL321and GL322	2
GL 328	Practical's related to GL323and GL324	2
GL 329	Practical's related to GL325and GL326+ (Fieldwork component)	2

Skill Enhancement Courses (SEC) (Any two)

Paper No.	Title of the paper (Any two)	Credits
SEC III	Applications of Remote Sensing in Geosciences	2
SEC IV	Oil Field Services	2
SEC V	Watershed Development	2

T.Y.B.Sc. Geology (SEMESTER - V)

Paper I: GL 311 Geology of India – I
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

The Indian sub-continent exposes a wide range of lithologies that span from 3.6 billion years to present. The geology of India is synonymous with the geology of the world and its ancient rock types from the Indian Peninsula, Cretaceous Deccan volcanism and Tethyan sediments exposed in the mighty Himalayas is noteworthy. The student will gain knowledge about the stratigraphy and geology of India with emphasis on the Stratigraphy of India with respect to Paleozoic, Mesozoic and Cenozoic Era which will help in understanding the different episodes on the earth during the geologic past.

(ii) Broad contents of the course:

The course intends to introduce students to important geological formations of India, from Precambrian to Recent times.

(iii) Skills to be learned:

At the end of the course, the students will acquire skills that will enable to recognise different geological formation, their age and economic potential. They will also learn to correlate International Geological Time Scale with Indian Stratigraphic Time Scale.
TYBSc Geology.

Title and Contents	No. of Lectures
Credit I: Precambrian Stratigraphy of Peninsular India - I	**18**
A) **Precambrian Stratigraphic framework of India**	2
B) **Brief account of distribution, Geographical location, classification, lithological succession, structure and economic importance, with a broad range stratigraphic correlation.**	
a. Dharwar Craton.	3
b. Singhbhum – Odisha Iron Ore Craton	3
c. Central Indian Craton/ Bastar Craton	3
d. Aravalli Craton	3
e. Bundelkhand Craton	2
f. Eastern Ghat mobile belt	2
Credit II: Precambrian Stratigraphy of Peninsular India - II	**18**
A) The Archaean – Proterozoic boundary	2
B) Stratigraphy, tectonics, depositional environment and correlation of the following Proterozoic Basins of India:	
a. Vindhyan Supergroup	3

b. Cuddapah Supergroup	3
c. Pranhita-Godavari Supergroup	3
d. Bhima Supergroup	3
e. Kaladgi Supergroup	2
f. Chhattisgarh Supergroup	2

REFERENCE BOOKS -

1. G.G. Deshpande (2002): Geological of Maharashtra- Geological Society of India – Special Publication.
2. Wadia, D. (1973) Geology of India. McGraw Hill Book co.
3. Krishnan, M.S. (1982) Geology of India and Burma, 6th Edition. CBS Publ.
4. Ramakrishnan M, and Vaidynadhan, R (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. I
5. Valdiya, K. S. (2010) The Making of India: Geodynamic Evolution, Springer
6. Valdiya, K.S. (1984) Aspects of tectonics, Tata Mcgrath Hill.
7. Sinha Singhum - Orissa Iron Ore Craton: Geological Society of India – Special Publication
8. Naqvi, S.M., 2005. Geological Evolution of the Indian Plate (From Haedean to Holocene -4Ga to 4Ka)

T.Y.B.Sc. Geology (SEMESTER V)
Paper II: GL 312 Mineral Resources
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

The course provides the student essential and basic concepts of mineral expiration techniques and the art and science of mining mineral resources.

(ii) Broad contents of the course:

The curse envisages to expose the students to the topics such as geology in mining industry, methods of exploration, Sampling Principle, Methods, estimation of reserves, Ore Dressing and Beneficiation.

(iii) Skills to be learned:

This course tries to impart skills related to Geology in mining and enable him/her to perform duties of a geologist at the mining site.

Title and Contents	No. of Lectures
Credit I: Mineral forming processes -I	**18**
A) Introduction: a) Definition of ore minerals, gangue, tenor, overburden, country rock, syngenetic & epigenetic deposits. b) Classification of economically important metalliferous & non metalliferous mineral deposits.	2
B) Magmatic Concentration: a) Early magmatic deposits b) Late magmatic deposits	3
C) Hydrothermal processes: a) Principles of hydrothermal processes, characters of solutions, types of openings in rocks, factors affecting deposition from hydrothermal solution, wall rock alternations. b) Types of hydrothermal deposits 1. Cavity filling deposits: • Processes & characteristic features • Types of cavity filling deposits: Fissure veins & its types (in brief), stock work, saddle reefs, ladder veins, pitches and flats, breccias filling deposits, solution cavity fillings, pore space fillings & vesicular fillings 2. Metasomatic replacement: Definition, Criteria of replacement& resulting mineral deposits	7
D) Oxidation & Supergene enrichment: a. Oxidation& solution in the zone of oxidation b. Gossans & Cappings, the role of iron in gossans, indigenous& transported limonite, false gossans & gossans as guides to the hidden deposits. c. Ore deposition in the zone of oxidation & their method of precipitation d. Supergene Sulphide Enrichment: 1. Requirements for supergene enrichment 2. Factors influencing supergene enrichment 3. Recognition of supergene enrichment	6

Credit II : Mineral forming processes -II	**18**
A) Evaporation, Residual concentration & Mechanical concentration: a. Evaporation: 1. Process of mineral formation by evaporation 2. Evaporation deposits: Brief account of deposits of oceanic water, lake water, ground water & hot springs b. Residual concentration (residual deposits): 1. Conditions favouring of residual deposits 2. Brief account of residual deposits: Bauxite, clay & iron formation c. Mechanical concentration (placer deposits): 1. Principles involved in the process of mechanical concentration 2. Study of placer deposits: Eluvial, Alluvial, Beach &Aeolia	4
B) Study of following metallic deposits with reference to mineralogy, properties, uses & their geological & geographical distribution a. Precious metals: Gold, Silver. b. Non-ferrous metals: Copper, Lead, Zinc & Aluminium c. Iron & Ferro alloy metals – Iron, Manganese, Nickel & Chromium	6
C) Study of following non-metallic deposits with reference to mineralogy, properties, uses & their geological & geographical distribution Muscovite, Gypsum, Baryte, Calcite/Dolomite, Asbestos, Fluorsopar,Wollastonite, Kyanite, Coal.	2
D) Radioactive minerals: a. Study of Uranium & Thorium deposits of India with reference to mineralogy, mode of occurrence, properties, uses & their geological & geographical distribution	1
E) Introduction to Geophysical and Geochemical methods for mineral exploration	3
F) Environmental and social issues related to mineral resource extraction	2

Reference Books-

1. Jeason and Bateman (1981) Economic mineral deposits, John Wiley and Sons
2. Gokhale &Rao (1978) Ore deposits of India, Thomson press (India) limited.
3. Krishnaswamy, Subbier (1979) *India's mineral resources*, 2d edition: New Delhi, Oxford and IBH Publishing
4. D. N.Wadia (1966) India's Minerals, National Book Trust
5. Robert L. Bates (1969) Geology of the industrial rocks & minerals, Dover Publications
6. Umeshwar Prasad (2003) Economic Geology, Satish Kumar Jain, CBS Publishers and Distributers.
7. Umate (IBM) : Economic mineral deposits of India
8. Park & Mc-dermitt (1997): Economic Ore Deposits
9. Tiwari, S.K (2010): Ore Geology, Economic Minerals and Mineral Economics
10. Aswathanarayana, U. (2005): Mineral Resources Management and The Environment
11. Guilbert, John M. and Charles Frederick Park (2007): The Geology of Ore Deposits
12. Arogyaswamy R.N.P (2017): Courses in Mining Geology

T.Y.B.Sc. Geology (SEMESTER V)
Paper III: GL 313 Marine Geology
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

A student will understand and learn about the basic concepts of oceanography and marine geology with respect to geology as to enable them to work as a marine researcher.

(ii) Broad contents of the course:

To provide essential concepts of marine geology and to study the tectonics, geology, exclusive economic zones & marine pollution with respect to the oceans.

(iii) Skills to be learned:

The students will equip himself with knowledge and skills related to dealing with the physical and chemical components and phenomena related to marine geology.

Title and Contents	No. of Lectures
Credit I: Study of Ocean floor	**18**
A) Physiographic divisions of oceans (the Continental Shelf, the Continental Slope, the Deep Sea Plain & the Oceanic Deeps)	5
B) Ocean floor rocks - Ultramafic rocks, Gabbroic rocks & Basalts Marine sediments.	2
C) Origin, structure and evolution of Indian Ocean shelf and margins (estuaries, deltas, tidal flats)	5
D) Applications of Geophysical Techniques for Exploration of the Sea Floor (Introduction, Explosion seismology, Reflections: echo-sounding and seismic-profiling)	6
Credit II: Marine Sediments and Pollution	**18**
A) Marine Sediments (Introduction, Sources, Composition, distribution & Classification of marine sediment)	6
B) Marine Pollution (Introduction, Marine Environmental Problems Associated with Petroleum Pollution - Two major case studies, Marine Environmental Problems Associated with Non-Petroleum Chemical Pollution - Sewage Sludge, DDT and PCBs, Mercury and Minamata Disease & Other Types of Chemical Pollutants)	6
C) Exclusive economic zones (EEZ) and their economic potential (Introduction, Origin, Disputes, EEZ of India)	6

REFERENCE BOOKS

1. Brown E., Coiling A., Park D., Phillips J., Rothery D., Wright J. (1998) The Ocean Basins: Their Structure and Evolution

2. Einsele, G. (1982) Sedimentary basins-evolution, facies and sediment budget. Springer-Verlag.

3. Fowler, C.M.R. (1993) The Solid Earth, Cambridge Press University.

4. Heklnlan R. (1982) Petrology of The Ocean Floor

5. Keen M. J. (1968) An Introduction to Marine Geology

6. Kenneth, J. (1982) Marine Geology and Geophysics.

7. Nittrouer, C.A., Austin, J. A., Field M. E., Kravitz J. H., SyvitskiJ. P. M., Wiberg P.L. (2007) Continental margin, sedimentation from sediment transport to sequence stratigraphy, Wiley Blackwell.

8. Trujillo A. P., Thurman H. V. (2018) Essentials of Oceanography

9. Turcotte, D.L. and Schubert, G (1992) Geodynamics, Wiley and Sons.

T.Y.B.Sc. Geology (SEMESTER V)
Paper IV: GL 314 Engineering Geology
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

Upon completion of the course the student will become aware of the importance of geological studies and its applicability to various engineering problems.

(ii) Broad contents of the course:

To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.

(iii) Skills to be learned:

The student will be educated on geological site investigations for engineering structures and will provide skills in geological mapping and making geotechnical measurements.

Title and Contents	No of Lectures
Credit I: Engineering Properties of Construction Material	**18**
A) Introduction: i. Introduction to Engineering Geology ii. Significance of Geology in Engineering and Environment projects	2
B) Rocks as Construction Material: i. Building stone, Facing stone, and Foundation material. ii. Factors influencing engineering usefulness of the rocks (Durability of rock).	4
C) Engineering properties of rocks: i. Factors controlling the engineering properties of the rock. Specific gravity, porosity, sorption, strength of rocks (Compressive, shear & tensile), elasticity of rocks, residual and shear stresses in rocks. ii. Importance of weathering and clay formations.	6
D) Use of rocks as an aggregate: i. Use of rocks as an aggregate in different types of constructions, source of different grades of aggregates ii. Types of aggregates iii. Physical and Engineering properties of aggregates	6
Credit II: Site investigations	**18**
A) Study of foundation rocks: i. With reference to tunnelling, dams, reservoirs and bridges, ii. Scale factor and insitu measurements, Quantitative measurements of discontinuities	3
B) Tunnels: i. Types of tunnels and Site selection for tunnel construction ii. Tunnelling in various terrains like tunnel in bedded rocks and folded rocks, influence of divisional planes, effects of faults and crushed zones. iii. Tunnels in the vicinity of slopes iv. Role of groundwater in tunnelling.	6

v. Tunnels in the Deccan Traps. Names and locations of at least six very important tunnels in India, Case study: Jawahar Tunnel	
C) Dams and Reservoirs: i. Types of Dams and reservoirs ii. Site selection for dam and reservoir construction iii. Location with type of all the important dams and hydroelectric projects in India. Case study: Sardar Sarovar Dam	6
D) Bridges: i. Types of bridges and Site selection for bridge construction ii. Names and locations of at least six very important bridges in India. Case study: Mumbai Sea-Link	3

Reference Books:

1. Blyth, F.G.H. and M. H. de Freitas (1984) Geology for Engineers, Butterworth - Heinemann Title
2. Krynine, D.P and Judd, W.R (2005) Principles of Engineering Geology and Geotechniques, CBS Publishers & Distributors
3. Ries, H. and T. L. Watson, (1949) Elements of Engineering Geology, New York, John Wiley & Sons, Inc.
4. Tony Waltham (2009) Foundations of Engineering Geology, Taylor and Francis.
5. Chenna Keshvallu (2018) Text book of Engineering Geology, Laxmi Publications.
6. Gokhale, K.V.G. (2006) Principles of engineering geology, BS publications.

T.Y.B.Sc. Geology (SEMESTER V)
Paper V: GL 315 Hydrogeology
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

On completion of the course, the student will have gained an understanding of hydrogeological concepts, exploration, exploitation and recharge of groundwater and methods of monitoring groundwater quality and sources of pollution

(ii) Broad contents of the course:

To impart knowledge about groundwater, its movement, methods of its exploration, the criteria of its quality, methods of its conservation, recharge of groundwater monitoring of groundwater quantity and quality.

(iii)Skills to be learned:

Students will be able to acquire skills of systematic hydrogeological surveys and water quality monitoring

Title and Contents	No. of lectures
Credit I: Basic concepts in Hydrogeology	**18**
A) Definitions- Hydrology, Geo-hydrology, Hydrogeology	1
B) Water bearing properties of rocks – a. Interstices and porosity, permeability, specific yield and specific retention, storativity, transmisivity and Hydraulic conductivity b. Aquifers,Geologic formations as aquifers- Aquicludes, Aquitard and Aquifuge. c. Vertical distribution of subsurface water-zone of saturation and zone of aeration. d. Types of aquifers – unconfined, confined, Perched.	6
C) Groundwater Flow- a. Darcy's law and its validity b. Aquifer parameters-transmissivity, storage coefficient, hydraulic conductivity, Intrinsic permeability c. Groundwater flow rates and flow direction d. Laminar and turbulent groundwater flow	4
D) Field and laboratory methods used to characterize aquifer properties and hydrogeology of rocks **a) Field methods**: **Pumping tests and slug test** a. Principles – types of pumping tests, procedures, b. Determination of aquifer properties and well characteristics by Methods of Theim's equilibrium method.	2
b) Laboratory methods:	1

a. Grain size Analysis method (GSA) consolidated and unconsolidated sediments b. Permeameter method	2
a) Well inventory Water Well Construction – Selection of suitable site for well construction, Water well design criteria and specifications, maintenance of production wells and types of well.	2
b) Hydrogeology of rocks	

Credit II: Groundwater chemistry and Groundwater Resources of India	**18**
A) Groundwater chemistry: a. chemical standards for drinking, and irrigational water b. major ion and isotope analyses, chemical tracers in groundwater c. Physical and chemical properties of water and water quality. BIS, WHO standard; d. Groundwater contamination; natural (geogenic) and anthropogenic contaminants; e. Saline water intrusion in coastal aquifers-Hymen Herzberg relation	9
B) Groundwater Resources i.e. aquifers of India a. Unconsolidated sedimentary b. Consolidated sedimentary c. Sedimentary Aquitards d. Folded metamorphic e. Jointed Crystalline f. Fractured Crystalline	5
C) Groundwater quality hotspots in India a. Hydrogeology in Maharashtra b. Groundwater quality hotspots in India- TDS, F, Ar, U, Fe	4

Reference Books:

1. Todd, D.K. and Mays, L.W. (2004) Groundwater Hydrology, John Wiley & Sons.

2. Raghunath, H.M. (1987) Groundwater,New Age International

3. Brassington, R. (2017) Field Hydrogeology, Wiley Blackwell

4. Freeze, R. A. and Cherry, J. A. (1979) Groundwater, Prentice Hall

5. Pawar N.J, Das, S. And Duraiswami R.A (2012) Hydrogeology of Deccan Traps and associated Formations in Peninsular India, Geol. Soc. India, Bangalore

6. Hiscock, K. M. (2005) Hydrogeology: Principles and Practice, Blackwell Publishing

T.Y.B.Sc. Geology (SEMESTER V)
Paper VI: GL 316 Applied Geophysics
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

This course deals with methodologies for extracting geological information out of geophysical datasets generated from different petrophysical properties. In Geophysical exploration the student will gain first-hand knowledge dealing with the principles and their significance

(ii) Broad contents of the course:

The course is centered on the topics of Applied Geophysics and use of GPS in mapping the subsurface. The geophysical techniques include seismic, gravity, magnetic and electrical resistivity methods and their various applications.

(iii) Skills to be learned:

The students will acquire skills to use GPS, Electrical Resistivity and other methods for exploration. These have wide application in mineral exploration, groundwater studies, petroleum geology, etc.

Title and Contents	No of Lectures
Credit I: Geophysical Methods I	**18**
A) Gravity Method: a. Introduction, Principles, Types of Gravimeters, Concept of Bouguer b. Anomaly- Generalized interpretation of Gravity data- Case Study. **B) Magnetic Method:** a. Introduction, Principles, Types of magnetometers- Magnetic anomalies and their interpretation. b. Air borne surveys in Gravity and Magnetic Methods c. Gravity and magnetics for the exploration of the minerals, oil /gas and groundwater d. Processing and interpretation. **C) Seismic Method:** a. Introduction and Principles b. Seismic Reflection Method and Seismic Refraction Method c. Seismic instruments and Field procedures d. Processing of Seismic data and Case Study	6 6 6
Credit II: Geophysical Methods II	**18**
A) Electrical Method: Introduction, Principles and Anomalies **B) Resistivity Method:** Introduction, Principles and Interpretation of resistivity data **C) Self-potential Method:** Origin of self-potential instrumentation and field procedure **D) Induced polarization Method:** Electrolytic and Electrode polarization- Instruments and field procedure **E) Electromagnetic Method:** Principles, Instruments and Case Study.	4 4 3 3 4

Reference Books:

1. Dobrin, M B and Savit C H. (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
2. Ramachandra Rao and Prasaranga, M B. (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.
3. Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
4. Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (vol. 1). Cambridge University Press.
5. Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press
6. Parasnis D. S. (1986): Well Logging in Oil Fields, In: Principles of Applied Geophysics, Springer

T.Y.B.Sc. Geology (SEMESTER V)

Paper SEC-I: Geotechnology
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

The student will gain detail knowledge about the concepts, methods and hands on determination of soil and rock properties which will strength their knowledge of Engineering Geology. It also provides basic knowledge of surveying techniques.

(ii) Broad contents of the course:

This course deals with the Geotechnical lab measurements used in Engineering Geology. It also includes surveying and levelling methods.

(iii) Skills to be learned:

The course provides vital skills in geotechnical lab work and skills related to surveying and levelling techniques in the field.

Title and Contents	No of Lectures
Credit I: Geotechnical Studies	**18**
A) Geotechnical Studies:	
a. Drilling in geotechnical field and Drilling Equipments	1
b. Rock Quality Designation (RQD) and Core Recovery (CR) Core logging and bore logging	2
c. RMR(Rock Mass Rating) (Bienawiski, 1989)	1
d. Types of foundations and Safe Bearing Capacity	1
	2
B) Laboratory and Field Geotechnical Tests	
a. Introduction to Piling Packer Permeability Test (P.P.T)., Standard Penetration Test and its types. (S.P.T.)	1
b. Sieve analysis of Soil	1
c. Specific Gravity by Pycnometer	
d. Determination of Field Density by Core cutter method and Sand Replacement method	3
e. Determination of Consistency limit: Liquid Limit by Casagrande's Apparatus (Plastic Limit, Shrinkage Limit	2
f. Direct Shear Test and Vane Shear Test, Triaxial Test, Determination of Compaction properties of Soil by standard proctor Test, Differential Free Swell Test	3
g. Uses of oven	1
Credit II: Surveying and Levelling	**18**
A) Surveying:	
a. Definitions of Surveying and Levelling and Objectives of Survey	2
b. Measurement of horizontal and vertical angle by 1' Theodolite Measurement of distance, angle by using Total Station.	4
B) Levelling:	
a. Definitions of Terms used in Levelling, Characteristics of a Dumpy Level and a Levelling Staff, Bench Marks, Change Points.	4

b. Levelling operations and steps in Levelling: Demonstration with an exercise in the field	4
c. Principles of Levelling: Simple and Differential, Reduction of Levels: The Collimation, and Rise and Fall systems of Computation	4

Reference Books:

1. Braja M. Das (2005) Fundamentals of Geotechnical Engineering, Thomson Asia Pvt. Ltd., Singapore
2. Gopal Ranjan and Rao, P. (2002) Basic and Applied Soil Mechanics, New Age International Pvt. Limited, New Delhi
3. Kanetkar T.P. and Kulkarni S.V. (1973) Surveying & Levelling (Part I) 23rd ed.
4. Duggal, S.K. (2004) Surveying Vol. I and II, Tata McGraw Hill.
5. Punmia, B.C. (1994) Surveying Vol. I and II, Standard Publishers.
6. Arora, K. R. (1996) Surveying Vol. I and II, Standard Book House.

T.Y.B.Sc. Geology (SEMESTER V)
Paper SEC-II: Gemmology and Gem Testing
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

The basic idea is to make students well versed with the different terminologies used in the gem industry and to provide skills to become a successful gemmologist.

(ii) Broad contents of the course:

The course covers the various aspects of gem testing using both theoretical as well as lab work by dealing with basics to the advanced techniques of gemstone identification. Further, it deals with the methods employed by diamond industry in cutting a rough diamond into a sparkling gem and how diamonds are graded internationally. Why synthetic gemstones have flooded the market and how they are manufactured is then next topic, including their detection.

(iii) Skills to be learned

The students will acquire skills which will be useful to them in the gem industry.

Title and Contents	No of Lectures
Credit I: Gemmology	**18**
a. Introduction to Gems- Basic properties of gems- Formation of gem stones.	3
b. Description of following gem species with respect to their varieties (colour wise), Chemical composition, Crystal system, Physical and optical properties, Characteristic inclusions and Geographical Occurrences.	10
c. Corundum, Beryl, Garnet, Felspar, Silica, Tourmaline, Topaz, Spinel and Chrysoberyl Diamonds	1 2
d. Opaque gem varieties.	1
e. Rare Gemstones (Peridot, kyanite, iolite, sphene, zircon, apatite etc)	
f. Gem synthesis and distinction between Synthetic and Natural gem stones.	1
g. Organic Gemstone	
Credit II: Use of Gem Testing Instruments	**18**
a. Gem instruments and their use in gem stone identification (hand lens (10x), Detection of double refraction, by observing pleochroic colours with the Dichroscope, Identification of gemstones on the basis of pleochroic colours)	4
b. Use of refractometers, Polariscope, Dichroscope	2
c. Causes of colours in gem stones.	2
d. Treatments of gem stones and their detection (Methods of Specific Gravity determination, Detection of double refraction, interference figures and internal strain with the Polariscope, study of the fluorescent colours exhibited by various gemstones under Ultraviolet (long wave and short wave) light, Measurement of refractive indices and birefringence tests using a gem-testing Refractometer).	10

Reference Books:

1. Karanth R.V. (2000) Gems and Gem Industry in India, Geological society of India
2. Read, P. G. (1991) Gemmology, Butterworth-Heinemann Ltd.
3. Webster, R. and edited by Anderson, B.W. (1983) Gems: Their Sources, Descriptions and Identification, Butterworth-Heinemann Ltd.
4. Sinkankas, J. (1969) Mineralogy: A First Course, Van Nostrand Reinhold Company.
5. Karanth R.V (2008) Gemstones Enchanting Gifts of Nature, Geological society of India
6. Fareeduddin & R. H. Mitchell (2012) Diamonds and their Source rocks in India, Geological society of India
7. Babu T.M (1998) Diamonds in India, Geological Society of India

T.Y.B.Sc. Geology (SEMESTER V)

Practical I: GL 317 Practicals related to GL 311 and GL 312

(Total Credits: 2)

(Total No. of Practicals: 10)

Practicals Related to GL 311

Sr. No.	Title and Contents	No of Practicals
1	Study of typical hand specimens of rocks from different lithological units of Precambrians of India: Dharwar Craton, Bastar Craton, Aravalli Craton, Orissa-Singhbhum Craton, Bundelkhand Craton, Eastern Ghat mobile belt, Vindhyan, Cuddapah, Kaladgi, Chattisgarh Supergroups	2
2	Study of paleogeographical maps of different periods of Precambrians of India.	1
3	Geographic distribution of various geological formations of Precambrians of India.	1
4	Interpretation of geological map of India.	1

Practicals Related to GL 312

Sr. No.	Title and Contents	No of Practicals
1	Study of ore minerals in hand specimen (at least 8). Haematite, Magnetite, Galena, Sphalerite, Chromite, Pyrolusite, Malachite & Bauxite.	1
2	Study of industrial minerals in hand specimen (at least 8). Muscovite, Gypsum, Baryte, Calcite/Dolomite, Asbestos, Fluorsopar, Wollastonite, Kyanite, Coal.	1
3	Preparation of mineral maps of India showing occurrences of Ore and industrial minerals.	1
4	Mineralogical & textural study of common Ore minerals/industrial minerals under microscope.	1
5	Preparation of charts showing specifications of materials required for different industries.	1

T.Y.B.Sc. Geology (SEMESTER V)

Practical II: GL 318 Practicals related to GL 313 and GL 314

(Total Credits: 2)

(Total No. of Practicals: 10)

Practicals Related to GL 313

Sr. No.	Title and Contents	No of Practicals
1	Study of rocks of ocean floor	1
2	Plotting of distribution of major bathymetric and tectonic features in the global oceans	1
3	Identification of oozes and authigenic sediments	1
4	Distribution and plotting of carbonate and siliceous oozes, glacio-marine, pelagic clay and volcanogenic sediments in global oceans	1
5	Grain-size analysis using pipette method	1

Practicals Related to GL 314

Sr. No.	Title and Contents	No of Practicals
1	Preparation of section along mentioned directions and interpretation for construction of dam, tunnel and bridge	3
2	Study of physical and engineering properties of aggregates and building stone	2

T.Y.B.Sc. Geology (SEMESTER V)
Practical III: GL 319 Practicals related to GL 315 and GL 316
(Total Credits: 2)
(Total No. of Practicals: 10)

Practicals Related to GL 315

Sr. no.	Title and Contents	No. of practicals
1	Preparation and interpretations of hydrographs from given water level data.	1
2	Preparation of water table contour maps from given water level data.	1
3	Estimation of aquifer properties as porosity and permeability, hydraulic conductivity. Storage coefficient and Transmissivity.	1
4	Groundwater quality analysis using Piper's plot.	1
5	Morphomertric analysis.	1

Practicals Related to GL 316

Sr. no.	Title and Contents	No of Practicals
1	Study of patterns of geophysical responses from various geological media.	1
2	Study of maps related to Gravity and Magnetic anomalies	1
3	Interpretation of Seismic Data	1
4	Plotting and interpretation of resistivity data.	1
5	Analysis of self-potential data.	1

T.Y.B.Sc. Geology (SEMESTER VI)
Paper I: GL 321 Geology of India – II
(Total Credits: 2)
(Total No. of Lectures: 36)

(iv) Course learning outcome:

The Indian sub-continent exposes a wide range of lithologies that span from 3.6 billion years to present. The geology of India is synonymous with the geology of the world and its ancient rock types from the Indian Peninsula, Cretaceous Deccan volcanism and Tethyan sediments exposed in the mighty Himalayas is noteworthy. The student will gain knowledge about the stratigraphy and geology of India with emphasis on the Stratigraphy of India with respect to Paleozoic, Mesozoic and Cenozoic Era which will help in understanding the different episodes on the earth during the geologic past.

(v) Broad contents of the course:

The course intends to introduce students to important geological formations of India, from Precambrian to Recent times.

(vi) Skills to be learned:

At the end of the course, the students will acquire skills that will enable to recognise different geological formation, their age and economic potential. They will also learn to correlate International Geological Time Scale with Indian Stratigraphic Time Scale.
TYBSc Geology

Title and Contents	No. of Lectures
Credit I: Phanerozoic Stratigraphy of the Peninsular Region	**18**
A) Stratigraphic Boundaries in India – Archean- Proterozoic, Precambrian- Cambrian, Permo- Triassic, K-T **B) Study of following Geological systems with reference to their type area, broad lithology, fossils content:** Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous & Tertiary	2 2
C) Palaeozoic and Mesozoic Stratigraphy: Brief account of their distribution, Geographical location, classification lithological succession, structure and economic importance, with a broad range stratigraphic correlation.	
a. Gondwana Super group	2
b. Jurassic of Kachchh and Jurassic of Rajasthan	2
c. Cretaceous of Narmada valley/ Bagh Beds,	1
d. Cretaceous of Trichinopoly	1
e. Mesozoic of Extra Peninsular region Spiti	1
D) Cenozoic Stratigraphy	
a. Deccan Volcanic Province.	2
b. Krishna-Godavari Basin and Assam, Andaman- Nicobar Arc	2

c. Cenozoic of Kachchh	1
d. Tertiary formations along the West Coast	1
e. Quaternaries of Peninsular India	1
Credit II: Stratigraphic framework of the Himalayas and Geology of Maharashtra	**18**
A) **The Phanerozoic Stratigraphy of Extra-Peninsular India**	
a. Introduction to Himalayas: Physiographic divisions and tectono-magmatic evolution	4
b. Stratigraphy and tectonics of the Siwaliks.	4
c. Karewas of Kashmir	3
d. The Trans-Himalayan and Karakoram Granite Batholith.	3
B) State related Geology: The Geology and Stratigraphy of Maharashtra	4

Reference Books:

1) G.G. Deshpande (2002): Geological of Maharashtra- Geological Society of India – Special Publication.
2) Wadia, D. (1973) Geology of India. McGraw Hill Book co.
3) Krishnan, M.S. (1982) Geology of India and Burma, 6th Edition. CBS Publ.
4) Ramakrishnan M, and Vaidynadhan, R (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. II.
5) Valdiya K.S. (2010) The Making of India: Geodynamic Evolution, Springer
6) Valdiya K.S. (1984) Aspects of tectonics, Tata Mcgrath Hill.
7) Sinha Singhum - Orissa Iron Ore Craton: Geological Society of India – Special Publication
8) Naqvi, S.M., 2005. Geological Evolution of the Indian Plate (From Haedean to Holocene -4 Ga to 4Ka)

T.Y.B.Sc. Geology (SEMESTER VI)
Paper II: GL 322 Mining and Mineral Exploration
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

The course provides the student essential and basic concepts of mineral expiration techniques and the art and science of mining mineral resources.

(ii) Broad contents of the course:

Thecurseenvisagestoexposethestudentstothetopicssuchasgeologyinmining industry, methods of exploration, Sampling Principle, Methods, estimation of reserves, Ore Dressing and Beneficiation.

(iii) Skills to be learned:

This course tries to impart skills related to Geology in mining and enable him/her to perform duties of a geologist at the mining site.

Title and Contents	No of Lectures
Credit II: Mineral exploration	**18**
A) Introduction of mining: Geology in mining industry, **Definition of ore minerals** Gangue, Tenor, Overburden, Country rock, and Grade, Float ores and In situ ores, Gossan	1 1
B) Mineral exploration: a. Introduction to mineral exploration, Surface and sub-surface exploration methods. b. prospecting for economic minerals – drilling, sampling and assaying, c. Geophysical techniques d. Geomorphological and remote sensing techniques e. Geobotanical and geochemical methods	7
C) Mining terminology Pits, Trenches and Boreholes, core drilling, Core drill sampling, core splitting, logging, storage, sludge	5 2
D) Types of mining Surface and underground mining	
Equipment and accessories for mining Calculation of Specific gravity, Porosity, Bulk density, compression factor	2
Credit II: Mining Methods	**18**
A) Sampling: Sampling Principle, Methods, Size and quantity, Reduction, Errors, Sampling practices in open-cast mining	5
B) Categories of reserves, estimation of reserves, cross- sectional method,	6

Area of influence method, triangular method and weighted volume estimate method	
C) **Classification of mining methods**: a. Open cast mining, b. Underground mining, c. Coal mining methods **Factors influencing choice of mining method**	4 1
D) **Mining Acts and Regulations in India and Conservation of mineral resources**	2

Reference Books:

1. Arogyaswamy R.N.P. (1973) Courses in Mining Geology, Oxford and IBH Publishers Co. Ltd., 916 pages

2.Sinha R. K. and Sharma N. L. (1989) Mineral Economics, Oxford and IBH Publishers Co. Ltd, 4th Edition, 410 pages

3. McKinstry H. E.(1980)Mining Geology, Prentice Hill Inc., 667 pages.

4.Babu S. K. and Sinha D. K.(1988)Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi

5. Sharma J. P.(2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi, Indian Bureau of Mines publications

6. Krieter, V. M. (2004) Geological prospecting and exploration, University Press of Pacific.

T.Y.B.Sc. Geology (SEMESTER VI)
Paper III: GL 323 Oceanography
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

A student will understand and learn about the basic concepts of oceanography with respect to geology as to enable them to work as an oceanographer.

(ii) Broad contents of the course:

To provide essential concepts of oceanography and to study the physical oceanography, ocean currents, sea level changes, beach and coastal zones. resources with respect to the oceans.

(iii) Skills to be learned:

The students will equip himself with knowledge and skills related to dealing with the physical and chemical components and phenomena related to oceanography.

Title and Contents	No of Lectures
Credit I: Physical Oceanography	**18**
A) Physical oceanography (Introduction, Pressure, temperature, density)	2
B) Ocean salinity (Definition, Salinity Variations, Surface Salinity Variation, Salinity Variation with Depth, Processes Affecting Seawater Salinity)	6
C) Ocean currents (Introduction, Origin of surface currents, Main Components of Ocean Surface Circulation, Indian Ocean Circulation)	5
D) El-Nino-La Nino effect relation between climate and ocean in the Indian context	5
Credit II: Oceanic Processes and Coastal Regulatory Zones	**18**
A) Sea level changes (Introduction, Processes Affecting Sea Level, Past Sea Level Changes & Effects)	6
B) The Coast: Beach (Definition, movement of sand on beach, Features Exist Along Erosional and Depositional Shores); Coastal erosion (Introduction, Causes, Types of coasts) and conservation methods	7
C) Coastal Regulatory Zones (Introduction, Classification & Prohibited activities within CRZ & Regulation of permissible activities in CRZ)	5

REFERENCE BOOKS

1. Bender, M. (2013) Paleoclimate, Princeton Premiers in Climate
2. Bradley R. S. (1999) Paleoclimatology: Reconstructing climates of the quaternary. Academic Press v. 64 of International Geophysical series.
3. Brown E., Coiling A., Park D., Phillips J., Rothery D., Wright J. (1998) The Ocean Basins: Their Structure and Evolution
4. Dronkers J. (2005) Dynamics of coastal systems, World Scientific

5. Ruddiman, W.F. (2008) Earth's Climate, Past and Future, WH Freeman & Co.
6. Savindra Singh (2015) Oceanography
7. Stewart R. H. (2000) Introduction To Physical Oceanography
8. The Open University (1989) Ocean chemistry and deep sea sediments.
9. Trujillo A. P., Thurman H. V. (2018) Essentials of Oceanography
10. Webb P. (2019) Introduction to Oceanography
11. Woodroffe, C.D. (2013) Coast: Form, process and evolution, Cambridge University Press.
12. Wright J. and Colling A. (1995) Seawater: its Composition, Properties and Behaviour, The Open University

T.Y.B.Sc. Geology (SEMESTER VI)
Paper IV: GL 324 Petroleum Geology
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

A student will understand and learn about the basic concepts of Petrology Geology with respect to geology as to enable them to work as a Petroleum Geologist.

(ii) Broad contents of the course:

To provide the student essential and basic concepts of Petroleum Geology and to study the process and the operations involved in Petroleum exploration

(iii) Skills to be learned:

The students will be appraised about the origin, migration and accumulation of petroleum; It will also provide basic skills in prospecting, drilling and logging operation in oil exploration. Further PG studies in this subject will enable them towards getting employment in the oil industry

(iv) The detail contents of the course:

Title and Contents	No of Lectures
Credit I: Petroleum Geology I	**18**
a. Origin of petroleum	2
b. Kerogen: Source Material and Formation, Composition and Distribution	3
c. Petroleum Chemical composition and physical properties of crudes oil	4
d. Occurrence of petroleum, nature of source rock	3
e. Reservoir fluids: Water, oil and gas	3
f. Origin, migration and accumulation of oil and natural gas	3
Credit II: Petroleum Geology II	**18**
A) Study of Reservoir and Traps	5
B) Petroliferous Basins of India Bombay basin; Krishna-Godavari basin, Assam basin, Cauvery basin and Rajasthan basin	7
C)Petroliferous Basins of World Spraberry (USA), Greater Burgan (Kuwait,) and Carabobo 1 (Venezuela)	6

Reference Books:

1. Tissot, B.P. and Welte, D.H. (1984) Petroleum Formation and Occurrence, Springer- Verlag, Berlin.
2. Levorsen, A.I, (2004) Geology of Petroleum, CBS Publishers and Distributors
3. North, F.K. (1986) Petroleum Geology, Allen & Unwin, London. 607p
4. Hunt, J.M. (1996) Petroleum Geochemistry and Geology, W.H. Freeman
5. Selley, R.C., 1998, Elements of Petroleum Geology: W.H. Freeman & Company,NY.

T.Y.B.Sc. Geology (SEMESTER VI)

Paper V: GL 325 Climate Change: Past, Present and Future
(Total Credits: 2)
(Total No. of Lectures: 36)

i) Course learning outcome:

The course introduces the students to the Earth's climate system and explores the science of global climate change using different proxies.

ii) Broad contents of the course:

Course topics include the greenhouse effects and the science of global warming and climate change impacts.

iii) Skills to be learned:

Students should be able to describe how the Earth's climate system works and summarize general atmosphere circulation patterns, ocean circulation patterns and climate oscillations such as the El-Niño Southern Oscillation. Besides, they will also be in a position to illustrate the Earths carbon cycle and quantitatively describe how addition of CO2 to the atmosphere due to burning of fossil fuels influences the climate.

Title and Contents	No of Lectures
Credit I: Introduction to climate change and Processes	**18**
a. Composition and structure of the atmosphere, Study climate change models	3
b. The factors affecting the earth's climate will be examined, along with anthropogenic impacts both globally and regionally	3
c. Milankovitch cycles: Introductions, Earth's movement	3
d. Effects on climate change: Greenhouse gases, El Nino, Ocean circulation	7
e. Climate changes vis-à-vis atmospheric hazards	2
Credit II: Climate change and its modelling	**18**
a. Changes in rainfall patterns/intensity vis-à-v is storm surges, cyclone, floods, droughts	4
b. Evolution of Indian monsoon system through the geological time	3
c. Agro-climatic divisions of Indian subcontinent	4
d. Climate and landscape evolution	3
e. Use of climate proxies to model and motor past and present climate indicators	4

Reference Books:

1. BradleyR.S.(1999) Paleoclimatology: Reconstructing climates of the quaternary. Academic Press v. 64 of International Geophysical series.
2. Peixoto and Oort, (1992) Physics of Climate.
3. Ruddiman,W.F.(2008)Earth's Climate, Past and Future, W H Freeman & Co.
4. Bell,M.andWalker,M.J.C.(1992)LateQuaternaryEnvironmentalChange;Physical and human perspective. Longman Scientific and Technical, NewYork.
5. Bradely, R.S. (1999) Palaeoclimatology; reconstructing climates of the Quaternary. 2nd Edition Harcourt Academic Press: SanDiego.
6. Dawson Alastair G. Ice Age Earth: Late Quaternary Geology and Climate (Physical Environment)
7. Bell, Martin. Late Quaternary Environmental change: Physical and Human Perspective

T.Y.B.Sc. Geology (SEMESTER VI)

Paper VI: GL 326 Geological Field Methods and Mapping
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

This course is devised to provide basic knowledge of geological mapping and surveying techniques. It also will upgrade and relate the theoretical knowledge of geological aspects to field observations.

(ii) **Broad contents of the course:**

Students will be expected to understand how preliminary surveys are carried out especially in mining and natural resource bearing areas. They would be trained to work independently in the field of geological mapping and sampling.

(iii) **Skills to be learned:**

Skill of using of Brunton Compass and GPS is only taught and learnt in the field. Hence, these are imperative to geological mapping and preparation of cross sections**.**

Title and Contents	No. of lectures
Credit I: Introduction to Geological Mapping	**18**
A) Introduction to the study of geological field methods and mapping	1
A) Use and applications of Brunton, Clinometer Compass and GPS in fieldwork	2
B) Geological Mapping: a. Reconnaissance study of areas having igneous and metamorphic and sedimentary rocks. b. Locating oneself on topographic map, Identification, discrimination and tracing of different type of contacts, c. Geological mapping of a small area, collection, identification and labelling of rock and mineral specimens.	7
C) Students will make geological observations in the field, record data in field notes, and prepare geological maps: a. Field safety, b. Logistics, c. Navigation	8
Credit II: Techniques in geological mapping	**18**
A) Field mapping techniques and data collection a. Traversing b. Mapping techniques c. Data collection d. Litholog preparation and interpretation	7
B) Toposheet reading a. Toposheets: reading of toposheet with reference to toposheet number, latitude, longitude, state, district, scale, adjacent toposheet numbers and conventional signs.	4

b. Orientation of topographic sheet in field; marking location in toposheet; Bearing (Front and back)	
C)Interpretation of geological maps and data a. Reconnaissance study of areas having igneous and metamorphic and sedimentary rocks. b. Locating oneself on topographic map, Identification, discrimination and tracing of different type of contacts, c. Geological mapping of a small area, collection, identification and labelling of rock and mineral specimens.	7

References:

1. Lahee Fredrick H. (1961) Geology in the field by Robert R. Compton, John Wiley and Sons.

2.Compton Robert R. (1962) Manual of Field Geology John Wiley & Sons.

3.Lahee Fredrick H. (1961) Geology in the field by Robert R. Compton, John Wiley & Sons.

4.Gokhale N.W. (2001) A Guide to Field Geology. CBS Publishers & Distributors 1st ed.

5.Mathur S.M. (2004) Guide to Field Geology, PHI.

T.Y.B.Sc. Geology (SEMESTER VI)
Paper SEC-III: Applications of Remote Sensing in Geosciences
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

The course is meant to address the fundamental techniques used for remote sensing. At the end of this course, the student will be appraised with all the theoretical knowledge, information and skills to use Remotely Sensed data for geological applications.

(ii) Broad contents of the course:

This course intends to introduce students to the fundamental principles and techniques of remote sensing, basic properties of electromagnetic radiation and its interaction with matter, It will also include topics like instruments and platforms used for remote sensing, and the ways those systems can be used to determine geological structure and rock types.

(iii) Skills to be learned:

After completion of this course, the student will be well versed with the world of Remote Sensing and the applications and Interpretation of data related to geosciences.

Title and contents	No. of Lectures
Credit I: Principles of Remote sensing and Aerial photography	**18**
A) Definition, Types of Remote sensing Systems (Active & Passive), Elements of passive Remote sensing system (data acquisition & data analysis)	4
B) Energy source and radiation principles (EM wave, Wave theory, EM spectrum, particle theory, Stefan-Boltzman's law, Emissivity, Black, white & grey bodies)	4
C) Energy interactions in the atmosphere (Scattering, absorption, atmospheric windows & related sensing systems); Energy interactions with the earth (principles of the Conservation of energy, specular & diffused reflectors), Spectral reflectance of vegetation, soil & water; Data acquisition & interpretation.	4
D) Aerial Photography a. Classification of aerial photographs on the basis of Camera axis b. Film and filter combination, lens -system, types of cameras, high and low sun angle photography, digital cameras	3

E) Planning of Aerial photography a. Time of photography, Acquiring stereographic photography, Discrepancies in aerial photographs (tip, tilt, drift, crab, gap) and their effects. b. Geometric characteristics of Aerial photos, marginal information on Aerial photos, Scale of Aerial photos, ground and photographic resolution of Aerial photos, Vertical exaggeration and relief displacement in Aerial photos. c. Mirror and pocket stereoscopes.	3

Credit II: Interpretation and application of Remote sensing data	**18**
A) Photo Recognition Elements Tone, texture, pattern, shape, size, site, shadow, associations. Basic drainage patterns and their geological significance. Advantages and limitations of Aerial photos.	3
B) Photo-geological interpretations Photo characters of Sedimentary, igneous and metamorphic rocks. Interpretation of geologic structures (folds & faults), Interpretation of photo-lineament maps.	4
C) Introduction to Satellites, Sensors &their applications: Brief history, Types of Satellites (Orbital Characteristics, Sensors and applications with reference to latest IRS & LANDSAT: LANDSAT 7 and 8, IRS satellites (Oceansat, Cartosat, Resourcesat, SARAL)	4
D) Scanners: Hyperspectral Scanners, Active Remote Sensing Systems - RADAR and LIDAR (Principles & applications)	2
E) Image characteristics & Spectral responses of various features: Lithology, geologic structures, geomorphic features, vegetation (cultivated, forest), land use, water bodies (shallow, deep, clear, polluted),Utility (traffic, telecom, power, settlement etc.) & soils.	3
F) Applications of Remote sensing: In studying the natural resources like minerals, ground water, soil, forests & in geo-technical investigations.	2

Reference Books:

1. Lillesand T. M., Kiefer R. W. and Chipman J. (2015) Remote Sensing and Image Interpretation, Wiley
2. Drury S.A. (1990) A Guide to Remote Sensing - Interpreting Images of Earth, Oxford Science Publications
3. Pandey S. N. (2001) Principles and Applications of Photogeology, New Age International

4. John R. Jenson (2003) An earth resource perspective
5. Miller Victor C. Miller Calvin F. (1961): Photogeology (International Series in the
6. Earth Sciences):
7. Paine, D.P (1981) management: Aerial photography and image interpretation for resource
8. Gary L. Prost: Remote Sensing for Geologists- A Guide to image interpretation
9. Reddy A. (2012): Introduction to Remote Sensing and GIS
10. Ramasamy, SM. (1999) Trends in Geological Remote Sensing

T.Y.B.Sc. Geology (SEMESTER VI)
Paper SEC-IV: Oil Field Services
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) Course learning outcome:

This course is to be taken in combination with Petroleum geology. The course focuses on the mud logging component as a supplementary service industry in oil and natural; gas exploration.

(ii) Broad contents of the course:

The course deals with Oil Well Drilling, logging and monitoring. It also deals with techniques for formation evaluation and testing for oil and gas.

(iii) Skills to be learned:

The students who complete this course will have acquired all the skills needed for mud logging job and can be employed with private and public organisations engaged in oil exploration.

(iv) The detail contents of this course:

Title and contents	No. of Lectures
Credit I: Oil Well Drilling	**18**
A) Introduction to Oil Well Drilling,	1
a. Types oil wells and geotechnical order	2
b. Methods of Oil well drilling: Cable tool drilling and rotary drilling	2
B) Components of rotary drilling system	
a. Monitoring of drilling process Concept of Subsurface pressure	2 2
b. Types of Drilling Rigs, Controlled Directional Rotary Drilling and Horizontal Drilling	4
c. Drilling Mud	2
d. Introduction, Techniques and Applications of Coring in Petroleum Geology	3
Credit II: Formation Evaluation	**18**
A) **Formation Evaluation**: Wire line logs, Basic Principles, tools of SP, gamma ray, Neutron, Density, Caliper, Dipmeter, Temperature and Sonic Logs and their interpretation.	6
B) **Mud logging**: Principle, techniques and tools of mud logging.	6

Interpretation of gas, drilling and mud parameters. MWD (Measurement While Drilling)/LWD (Logging While Drilling). Principle and tools of MWD/LWD, data analysis and interpretation,	3
C) **Formation (Drillstem) Testing**: Introduction, Tools and Techniques of DST	3

Reference Books:

1. Sahay, B., Rai, A. and Ghosh, M. Wellsite (1997): Geological Techniques for Petroleum Exploration, Oxford & IBH, New Delhi
2. Nakayama K.1987 Jan.: Two-dimensional basin analysis for petroleum Exploration University of South Carolina, Columbia.
3. A.M.Akramkhodzhaev,etal :Geology and Exploration of oil and gas bearing ancient delta.
4. "The Business of Petroleum Exploration" (1992) by ed. Steinmetz, R. AAPG Treatise of Petroleum Geology: Handbook of Petroleum Geology.
5. Willard De Merit: Instrumental Methods
6. Ewing: Instrumental Methods of Analysis
7. Selley, R.C. (1984): Elements of Petroleum Geology, Academic Press, London.

T.Y.B.Sc. Geology (SEMESTER VI)

Paper SEC-V: Watershed Development
(Total Credits: 2)
(Total No. of Lectures: 36)

(i) **Course learning outcome:**

This course introduces the fundamental concepts of watershed management planning and principles. It encompasses the water quality issues, storm water management, drought management, soil erosion, rainwater harvesting and watershed modeling. Finally the course provides inputs for integrated watershed management.

(ii) **Broad contents of the course:**

Watershed Management concept and principles, Assessment of water resources i.e. surface water and ground water in a watershed: rainfall-runoff and ground water analysis. Soil erosion estimation. Water quality and guidelines. Watershed Modelling, Drought assessment and management. Integrated watershed management.

(iii) **Skills to be learned:**

Upon completion of this course the student will acquire all skills to undertake watershed development and integrated watershed management thereby enhancing his employability with NGOs, Government agencies, etc. working in the fields of watershed and rural development.

Title and Contents	No of Lectures
Credit I: Watershed Development	**18**
a. Concept of watershed, watershed characteristics	2
b. Importance of water resources in watershed, concept of watershed development in relation to water resources, salient features of development measures like contour bunding, gully plugs, stream bunds, percolation tank, subsurface dams, afforestation etc.	5
c. Significance of geology in watershed development	3
d. Assessment of water resources, i.e. surface water and ground water in a watershed: rainfall-runoff and ground water analysis	4
e. Role of NGO"s and State Government in watershed development	4
Credit II: Watershed Management	**18**
a. Concept of watershed management in relation to water resources.	3
b. Water balance equation for watershed, sustainability of water resources, conjunctive use of surface and groundwater resources.	4
c. Watershed Modelling	3
d. Drought assessment and management	4
e. Integrated watershed management	4

Reference Books:

1. Brooks, K.N. Folliott, P.F., Magner, J.A. (2012) Hydrology and the Management of Watersheds, John Wiley & Sons
2. Murthy, J.V.S. (2012) Watershed Management New Age International Publisher
3. Heathcote, I.W. (2009) Integrated Watershed Management: Principles and Practice, John Wiley & Sons Ltd
4. Debarry, P. A. (2004) Watersheds: Processes, Assessment and Management, Wiley
5. Naiman, R.J. (1994) Watershed Management: Balancing stainability and Environmental Change, Springer
6. Gonenc, I.E., Vadineanu, A., Wolflin, J.P. (2014) Sustainable Use and Development of Watersheds, Springer
7. Raghunath H.M. (2003) Groundwater, New age education.
8. Karanth K.R. (1987) Groundwater assessment development and management, Tata Mcgrath Hill education.
9. Todd, D. K. and Mayo, L. W. (2004) Groundwater hydrology, Wiley.

T.Y.B.Sc. Geology (SEMESTER VI)
Practical IV: GL 327 Practicals related to GL 321 and GL 322
(Total Credits: 2)
(Total No. of Practicals: 10)

Practicals related to GL 321

Sr. no.	Title and Contents	No. of Practicals
1	**Study of typical hand specimens of rocks from different lithological units of Phanerozoics of India.** Gondwana Supergroup, Jurassics of Kachchh and Rajasthan, Cretaceous of Narmada Valley/Bagh beds, Cretaceous of Tamil Nadu and Meghalaya, Deccan Volcanic province, Cenozoic formations.	1
2	Study of paleogeographical maps of different periods of Phanerozoics of India.	1
3	Geographic distribution of various geological formations of Phanerozoics of India.	1
4	Interpretation of geological map of India	1
5	Study of Gondwana flora	1

Practicals related to GL 322

Sr. no.	Title and Contents	No. of Practicals
1	Calculation of assay values	1
2	Exercises on mine sampling and determination of tenor, cut-off grades, ore reserves, etc.	1
3	Calculation of Specific gravity, Porosity, Bulk density	1
4	Correlation of subsurface data from different logs.	1
5	Calculation of ore reserves from the given map data.	1

T.Y.B.Sc. Geology (SEMESTER VI)
Practical V: GL 328 Practicals related to GL 323 and GL 324
(Total Credits: 2)
(Total No. of Practicals: 10)

Practicals related to GL 323

Sr. no.	Title and Contents	No. of Practicals
1	Reading coastal toposheets, hydrographic sheets and ocean floor topography	1
2	Preparing of bathymetric cross-sections using Hydrographic sheets	1
3	Assigning different kinds of marine sediments to different bathymetric settings	1
4	Study of important global surface and deep-water currents, with special emphasis on the 'Conveyor Belt'	1
5	Distribution of Global Pressure belts	1

Practicals related to GL 324

Sr. no.	Title and Contents	No. of Practicals
1	Determination of porosity and permeability by crude method / core samples	1
2	Numerical problems based on porosity and permeability	1
3	Study of Isopach maps	1
4	Panel / Fence diagrams	1
5	Study of Petroliferous basins of India	1

T.Y.B.Sc. Geology (SEMESTER VI)
Practical VI: GL 329 Practicals related to GL 325 and GL 326
(Total Credits: 2)
(Total No. of Practicals: 10)

Practicals related to GL 325

Sr. no.	Title and Contents	No. of Practicals
1	Preparation and interpretations of Isotherm and Isobar on map.	1
2	Distribution of major wind patterns on World map.	1
3	Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals.	1
4	Numerical exercises on interpretation of proxy records for paleoclimate.	1
5	To show ocean current on world map	1

Practicals related to GL 326

Sr. no.	Title and Contents	No. of Practicals
1	Plane table chain survey	1
2	Magnetic compass survey or GPS survey.	1
3	Stereographic Problems involving two intersecting planar features	1
4	Field work for about ten days, in an area of geological interest anywhere in India. Systematic collection of geological samples, data collection & preparation of geological field report.	2