

Savitribai Phule Pune University, Pune
F.Y. B.Sc. – Geology
Course Structure

Syllabus W.e.f. A.Y 2020-21

Semester I (5.5 Credits)		
Core Courses		
Subject Code	Subject Title	Number of Credits
GL 111 T	Fundamentals of Geology and Understanding the Planet Earth	2 Credits
GL 112 T	Mineralogy and Crystallography	2 Credits
GL 113 P	Practicals related to GL 111 and GL 112	1.5 Credit
	Total	5.5 Credits
Semester II (5.5 Credits)		
Core Courses		
Subject Code	Subject Title	Number of Credits
GL 121 T	Stratigraphy and Sedimentation	2 Credits
GL 122 T	Petrology and Geochemistry	2 Credits
GL 123 P	Practicals related to GL 121 and GL 122	1.5 Credit
	Total	5.5 Credits

GL 111: Fundamentals of Geology and Understanding the Planet Earth (2Credits)

CC- I

Topics
Credit I:
A) Introduction Definition of Geology, its divisions, sub-divisions and scope
B) Planet Earth Origin of the Universe (Big Bang Theory), Origin of the Solar System (Nebular, Encounter and Tidal Hypothesis) a. Earth: Its size, shape and density. Temperature, pressure and magnetism within the Earth, Present day Hypsographic curve b. Age of the Earth: A brief account of the historical methods. Determination of age by U/Pb, Th/Pb, K/Ar and Carbon method of Dating.
C) Historical Geology (Introduction)
D) Geological time scale: Concept and Criteria
E) Fossils (Definition, Condition and Modes of preservation of fossils; Uses and Importance of fossils)
F) Mass Extinction Events (List of Events, Six different events and Causes of mass extinction)
G) Climate change (Introduction, Causes, Physical evidences for climate change)
Credit II:
A) Earth's Atmosphere: (Introduction, Classification of Atmosphere, Introduction to Atmospheric circulation, land-air-sea interactions), Hydrosphere (Introduction to ocean currents, types, causes and significance), Lithosphere (Structure and composition) and Biosphere (Ecology and food chain)
B) Earth's Crust, Mantle and Core
C) Evolution of the Earth's Crust (Earth crustal evolution: Introduction, Early crust; Crustal dichotomy; Types of crust and Crustal growth rates)
D) Evolution of the Oceans (Introduction, Formation of the Oceans)
E) Rock deformation (Definition, Stress, Types of differential stress; Strain; Types of deformation; Types of Forces; Introduction to Fold, Fault, Joints and Fracture)
F) Plate Tectonics: Plate, Platform and Shield; Different tectonic settings on Earth, Mid oceanic ridges, rift valley and island arcs. Sea floor spreading.
G) Volcanoes: Genesis of volcanoes, central and fissure types of eruptions, products of volcanoes, effects of volcanoes and Earth's volcanic belts.
H) Earthquakes: Definition, terminology, causes, intensity and magnitude; Recording of earthquakes (modern recording methods), Use of seismic waves and their importance in interpreting the earth's internal structure; Seismic zones; History and susceptibility of the Indian subcontinent to earthquakes.
I) Meteorites (Definition, types and origin)

Topics
Credit I: Mineralogy
A) Introduction: Definition, branches and scope of mineralogy. Importance and conservation of minerals.
B) Chemistry of Minerals a. Atoms and Ions. b. Bonding forces in crystals:- Ionic, Covalent, Vander Waal's and Metallic bond, crystals with more than one type of bonds. c. Major element constituting of minerals. d. Geochemical affinity & geochemical classification of elements. e. Geometrical and electrical stability of minerals. (concept of relative size of ions, radius ratio, co-ordination number & ionic substitution) f. Isomorphism, polymorphism, pseudomorphism. g. Silicate structures
C) Formation of minerals: Introduction and description of geological processes of mineral formation; a. Crystallization from melt. b. Crystallization from solution. (Evaporation and precipitation) c. Crystallization from vapour. (Sublimation) d. Metamorphic processes. e. Alteration and related weathering. (oxidation and supergene enrichment)
D) Uses of Minerals in Industries: Ceramic, Refractory, Pharmaceutical, Paint, Glass, Cement, Fertilizer, Oil Industry, Electrical and Electronics.
E) Physical properties of minerals a. Colour, streak, luster, cleavage, fracture, hardness, form, magnetic and electrical properties, radioactivity, specific gravity & luminescence. (Phosphorescence and Fluorescence) b. Methods of determining specific gravity – Chemical balance, Walker's steelyard, Jolly's spring balance, pycnometer, heavy liquids
F) Optical mineralogy a. Nature of light – ordinary and plane polarized light. b. Double refraction of light. (with the help of calcite crystal) c. Nicol's prism and polaroids. d. Petrological microscope. e. Optical properties of Minerals:– <ul style="list-style-type: none"> • In plane polarized light: Colour, form, cleavage, cracks, relief, twinkling, pleochroism. • In between crossed nicols: Isotropism, anisotropism, extinction positions (straight, oblique and symmetrical), extinction angle, interference colours, twinning, crosshatching

Credit II: Crystallography

- A.** Definition and conditions conducive for the formation of crystals.
- B.** Crystal morphology – faces, forms, edges, solid angles, interfacial angle and its measurement by contact Goniometer, law of constancy of interfacial angle.
- C.** Symmetry of crystals – Plane, axis and center of symmetry, crystallographic and geometrical symmetry. Crystallographic axes, lettering and order of crystallographic axes, parameters, axial ratio, indices, parameter system of Weiss, index system of Miller, Law of rational indices.
- D.** Bavaria's crystal lattice: Study of following crystallographic systems with respect to their elements of symmetry, crystallographic axes and their forms with indices.
 - i. Orthorhombic (Type: Barytes)
 - ii. Tetragonal (Type: Zircon)
 - iii. Cubic (Type: Galena)
 - iv. Hexagonal (Type: Beryl)
 - v. Monoclinic (Type: Gypsum)
 - vi. Triclinic (Type: Axinite)
 - vii. Trigonal

Topics	No. of Practicals
Mineralogy A) Physical properties of minerals: Colour, form, streak, luster, cleavage, fracture, hardness and specific gravity.	1
B) Identification of following Megascopic minerals in hand specimens with the help of physical properties: (Any 15) Quartz, Rock crystal, Rose Quartz, Milky Quartz, Smoky quartz, Amethyst, Chalcedony, Agate, Jasper, Flint, Opal, Orthoclase, Plagioclase, Biotite, Muscovite, Garnet, Olivine, Hornblende, Apophyllite, Stilbite, Kyanite, Talc, Calcite, Fluorite, Gypsum, Baryte.	2
C) Optical Mineralogy: Study of optical properties of minerals in plane polarised light and between crossed nicols.	1
D) Microscopic minerals:(Any 6) Olivine, augite, hornblende, microcline, plagioclase, muscovite, biotite, calcite, garnet, quartz and orthoclase.	1
E) Crystallography Study of elements of symmetry, crystallographic axes and forms with indices of the following crystal systems representing all the fundamental crystal forms: a) Cubic System (Type:Galena) b) Orthorhombic System (Type:Baryte) c) Tetragonal System (Type:Zircon) d) Hexagonal System (Type:Beryl)	2
F) Toposheets and study of landform models: Reading of toposheets with reference to toposheet number, latitude and longitude, state/districts, scale, adjacent toposheet number and conventional signs.	1
No. of Practicals	8

SEM II

GL 121: Principles of Stratigraphy and Sedimentation (2 Credits)

CC-III

(Lectures: 36)

Topics
Credit I: Principles of Stratigraphy and Sedimentation
A) STRATIGRAPHY c) Introduction, definition, principles of stratigraphy, development of stratigraphic concepts, importance of stratigraphy. ii) Stratigraphic classification & Nomenclature, study of stratigraphic elements, lithostratigraphy and its units, chronostratigraphy and its units, biostratigraphy and its units. Inter-relationship between lithostratigraphic, chronostratigraphic and biostratigraphic units. iii) Methods of collecting stratigraphic data - stratigraphic procedures on outcrop
Sedimentary Petrology A) Weathering (mechanical and chemical), erosion, denudation, Sediments, sedimentation and formation of sedimentary rocks –transportation, deposition, compaction, cementation and lithification Classification and description of sedimentary rocks. Sedimentary environment (definition and types) B) Derivation of sediments. i. Sources of sediments ii. Mineral composition of clastic / detrital sediments iii. Concept of matrix and cement and its effect on porosity and permeability C) Transportation of Detrital/ Clastic sediments: i. Modes of Transportation (Including phases of traction) ii. Definition of Competence, Capacity and Load of transporting Medium iii. Progressive changes in sediments during transport with respect to size, shape and mineral composition.
Credit II: Sedimentation
A) Textures and Primary structures of sedimentary rocks: a. Definition of texture & factors controlling textures of sedimentary rocks b. Clastic and non-clastic textures. primary sedimentary structures & their significance (a brief mention of their varieties): 1. Bedding 2. Lamination 3 Cross bedding 4 Graded bedding 5 Ripple marks 6. Chemical structures: stylolites, concretions, nodules 7. Penecontemporaneous sedimentary Structures: Load-cast, flute-cast, mud-cracks, ball & pillow, clastic dykes, slump folds, Dewatering folds 8. Study of organic sedimentary structures (in brief), Biogenic (Tracks and trails) B) Study of following secondary deposits with respect to sedimentary environments, definition, texture/structure, mineral composition and their

varieties.

- i) Residual-Latertite, Bauxite, Soil
- ii) Rudaceous- Conglomerate, Breccia
- iii) Arenaceous- Sandstones
- iv) Siltstones
- v) Argillaceous- Clays, Mudstone, Shale
- vi) Chemical deposits- Siliceous, Carbonates, Ferruginous and Salts.
- vi) Biochemical- Organic Limestone, Phosphatic Siliceous- and Carbonaceous Deposits.

GL: 122 PETROLOGY AND GEOCHEMISTRY

Credit I : IGNEOUS PETROLOGY
Definition of Petrology and Rock Cycle
Magma <ul style="list-style-type: none">i. Magma and its composition and physico-chemical characteristicsii. Bowen's Reaction Seriesiii. Formation of crystal and glass
(A) Crystallisation of Magma <ul style="list-style-type: none">i. Crystallisation of Unicomponent Magmaii. Bi-component Magma
(B) Textures and Structures <ul style="list-style-type: none">i. Texture : Definition and Factors controlling Textureii. Types of Textures : Equigranular and Inequigranular-Porphyritic, Poikilitic (Ophitic, Sub-Ophitic), Directive, Intergranular and Intersertal, Intergrowth Textureiii. Structures- Vesicular, Amygdaloidal, Blocky, Pillow, Columnar, Ropy and Flow.
(C) Igneous Classification <ul style="list-style-type: none">i. Classification based on- Depth of formation, silica percentage, TAS, QAPF.
Credit II: GEOCHEMISTRY & METAMORPHIC PETROLOGY
1. INTRODUCTION TO GEOCHEMISTRY <ul style="list-style-type: none">a) Nucleosynthesis and Stellar Evolution<p>Formation of elements, stability of Nuclei, structure of nucleus, isotopes, isobars, basic terms of radioactivity like α, β, γ decay.</p>b) Structure of Earth<p>Major elements and base elements in the Earth, Goldschmidt's Classification, Lithophile, chalcophile, siderophile elements, Geochemical Periodic table based on the behavior of elements, geochemical composition of crust, mantle and core, Composition of bulk earth.</p>c) Geochemical behavior in Igneous Processes<ul style="list-style-type: none">• Behavior and distribution of trace elements between co-existing phases (solid, liquid, gases), factors governing the value of partition coefficients (in mafic and ultramafic systems), equilibrium melting (batch melting) and fractional melting. The T-P gradient of Earth's crust and mantle.<ul style="list-style-type: none">• Equilibrium crystallization and fractional crystallization from

magma.

2. Radiogenic Isotope Geochemistry

- a. Basics of Radioactive decay: -Law of radioactive decay, geochronology, terms like isochrones and dating of rocks.
- b. Decay systems and their applications

Detail Rb-Sr and Re-Os system and its application for all crustal processes and petroleum (source rock) dating, dating calculation.

3. Stable Isotope Geochemistry

Introduction, low stable and radioactive isotope geochemistry in different with different application of $\delta^{18}\text{O}$, δD , $\delta^{13}\text{C}$, $\delta^{15}\text{N}$. Dating of fossils using ^{14}C carbon dating.

METAMORPHIC PETROLOGY

A. Definition of Metamorphism, Agents of Metamorphism

B. Metamorphism and types of Metamorphism.

- a. Definition, General Characteristics, factors controlling textures and structures
- b. Thermal Metamorphism- Pure and Impure Limestone
- c. Dynamic/Cataclastic Metamorphism
- d. Regional Metamorphism and its products

Argillaceous Rocks

Basic Igneous Rocks

C. Concept of Metamorphic Facies

Diagrammatic Representation of pressure, temperature conditions (with depth) of the different facies of contact, regional and plutonic metamorphism

GL 123: Practicals related to GL 121 and GL 122

(2Credit)

Topics	No. of Practicals
<p>A) Petrology Identification of the following megascopic and microscopic rocks with respect to their texture/structure, mineral composition and classification</p> <p>a) Igneous: Granite, gabbro, rhyolite, basalt (its varieties), pegmatite (Classification based on colour index, mineral composition and texture)</p> <p>b) Sedimentary: Laterite, bauxite, breccia, conglomerate, sandstone, shale, mudstone and limestone.</p> <p>c) Metamorphic: Slate, marble, quartzite, mica schist and mica gneiss.</p>	<p>2</p> <p>2</p> <p>1</p>
<p>B) Study of following Primary Sedimentary Structures in hand specimen with their Environmental Significance. 1. Bedding 2. Cross bedding 3. Graded bedding 4. Ripple marks 5. Mud/ Sun cracks</p>	<p>1</p>
<p>C) Stratigraphic correlation</p>	<p>1</p>
<p>D) One day Geological Fieldwork to be conducted in an area of geological interest and geological report to be submitted for the same.</p>	<p>1</p>
<p>No. of Practicals</p>	<p>8</p>

List of Reference Books:

1. Read H.H. (1947): Rutley's Elements of Mineralogy. London:ThomasMurby&Co..
2. Ford W.E. (2006) Dana's Text Book of Mineralogy (Fourth Edition). CBS Publishers and Distributors PvtLtd
3. Tyrrell G.W. (1926): Principles of Petrology. Asia PublishinhHouse
4. Cornelius, S. Hurlbut and Cornel Klein (2002): Manual of Mineralogy. John Wiley & SonsInc.
5. Woods H. (1958): Invertebrate Palaeontology. Cambridge UniversityPress.
6. Radhakrishnan (1987) General Geology. VVP Publishers
7. Shrock R. R. and TwenhofelW. H.(1935) Invertebrate Paleontology. McGraw Hill Book CompanyInc.
8. Miller, (1949) AnIntroduction to Physical Geology. East West PressLtd.
9. Spencer, E.V., (1962) Basic concepts of Physical Geology. Oxford &IBH.
10. Mahapatra, G.B., (1994) A text book of Physical Geology. CBSPublishers.
11. Press and Siever (1998) Understanding Earth, WH Freeman &Co.
12. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge UniversityPress
13. Wadia, D., (1973) Geology of India. McGraw Hill Bookco.
14. Krishnan, M.S., (1982) Geology of India and Burma, 6th Edition. CBSPubl.
15. Ramakrishnan M, and Vaidynadhan, R (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. I&II.
16. Friedman & Sanders, (1978) Principles of Sedimentology. John Wiley andsons.
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23. Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell ScienceLtd.

24. Ram S. Sharma and Anurag Sharma (2013) Crystallography and Mineralogy - Concepts and Methods. Text Book Series, Geological Society of India, Bangalore
25. Dana, E.S. and Ford, W.E., (2002) A textbook of Mineralogy (Reprints).
26. Flint, Y., (1975) Essential of crystallography, Mir Publishers.
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28. Berry, L.G., Mason, B. and Dietrich, R.V., (1982) Mineralogy. CBS Publ.
29. Read, H.H., (1968) Rutley's Element of Mineralogy (Rev. Ed.). Thomas Murby and Co.
30. Berry and Mason, (1961) Mineralogy. W.H. Freeman & Co. Kerr, B.F., (1995) Optical Mineralogy 5th Ed. McGraw Hill, New York.
31. Ram S. Sharma (2016) Metamorphic Petrology Concepts and Methods. Text Book Series, Geological Society of India, Bangalore
32. Bose M.K. (1997) Igneous Petrology. The World Press Pvt. Ltd. 568p.
33. Ehlers, W.G. and Blatt, H. (1987) Petrology, Igneous, Sedimentary and Metamorphic rocks, CBS Publishers
34. Turner, F.J., (1980) Metamorphic petrology. McGraw Hill.
35. Mason, R., (1978) Petrology of Metamorphic Rocks. CBS Publ.
36. Winkler, H.G.C., (1967) Petrogenesis of Metamorphic Rocks. Narosa Publ.
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39. Collinson J.D and Thompson D.B (1989) Sedimentary Structures (2nd Edition), Unwin Hyman Ltd, Sydney.
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42. Winter J. D. (2001) An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, 697p
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47. Moores E.M. and Twiss R.J. (1995) Tectonics, W. H. Freeman
48. Valdiya, K.S., (1984) Aspects of Tectonics: Focus on Southcentral Asia, Tata-McGraw Hill, New Delhi,
49. Belousov, V.V. (1980) Geotectonics, Springer-Verlag Berlin Heidelberg
50. Condie, K.C. (1989) Plate Tectonics & Crustal Evolution, Butterworth-Heinemann
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52. Badgley, P. C. (1965) Structural & Tectonic Principles, Harper & Row

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