UNIVERSITY OF CALCUTTA

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Dated the 15th December, 2016

To
The Principals /T.I.C.
of all the Undergraduate Colleges
offering B.Sc. (Honours) in Geology
affiliated to the University of Calcutta

Sir/Madam,

The undersigned would like to forward you the **Draft Syllabus for Geology (Honours),** to be implemented from the academic session 2017-2018 to get feedback from the Department of Geology in your college.

You are requested to send your feedback within 30th December, 2016.

In this regard you may send your observation/ suggestion to the **Department of U.G. Councils, C.U.** or through email (u.g.councilsc.u@gmail.com) or you may contact **Prof. Tapas Bhattacharyya (Mob:9231686468, email: tapasfs@gmail.com).**

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Enclo: Copy of the Draft Syllabus.

Yours faithfully,
15.12.16
(Milan Kr. Pal)
O.S.D., C.U.

PART – I
THEORY
Paper 1
Unit – I (75 marks, 95 hours)
Group A, 50 marks, Introduction to Earth Systems Science

1. Earth Systems Science: Definitions and Scope.
2. Elementary information on solar system, members of the solar system, terrestrial and Jovian planets. Origin of the solar system, nebular hypothesis, formation of planets. Layered structure of Earth, differentiation of Earth's core, mantle and crust, formation of Earth's oceans and atmosphere.
3. Earth as a system of interacting components- solid earth, atmosphere, hydrosphere, biosphere. History of development of geological thoughts, Neptunism, Plutonism, Uniformitarianism, law of superposition, law of faunal succession. Contribution of Werner, Hutton, Smith and Lyell.
4. Earth's materials, minerals and rocks. Broad groups of minerals, oxides, sulphides, carbonates, sulphates and phosphates, silicates. Rocks as mineral assemblages, fabric, texture. Igneous rocks, acid, intermediate, mafic and ultramafic rocks. Sedimentary rocks, clastic and non-clastic. Metamorphic rocks, foliated, nonfoliated. Common rocks – granite, granodiorite, pegmatite, rhyolite, syenite, trachyte, diorite, andesite, gabbro, dolerite, basalt, peridotite; conglomerate, sandstone, shale, limestone, slate, phyllite, schist, gneiss, quartzite, marble.
5. Structure of geologic bodies. Extrusive and intrusive igneous rock bodies, lava flows, sills, dykes, batholiths. Bed and stratum, dip and strike. Folds, antiform, synform, anticline, syncline. Fractures, joints and faults. Foliation, lineation. Unconformity.
6. Earth's surface processes. Weathering, erosion, mass wasting; bed rock, regolith, soil, soil profile. Erosion, transportation and deposition by wind, river, glacier, groundwater and ocean. Common landforms related to action of wind, river, glacier; coastal landform. Ice ages, evidence and causes. Oceanic and atmospheric circulation patterns.
7. Elementary idea of theory of plate tectonics. Lithosphere, asthenosphere. Plates and plate boundaries, relative motion of plates. Present day configuration of plates.
8. Earth's internal processes, magmatism, metamorphism, deformation. Volcanoes and volcanism, products of volcanic eruption, eruptive styles, volcanic belts, recent volcanism in India.
9. Earthquakes, causes, elastic rebound theory, focus and epicenter, intensity and magnitude. Seismic waves, seismograms, travel-time curves for seismic waves, seismic discontinuities, locating epicenter, and determining magnitude. Earthquake belts. Effects of earthquakes, seismic zones of India.
10. Internal Constitution of Earth. Evidence from seismic waves, meteorites, other lines of evidence.
11. Heat flow, basic concepts, geothermal gradient. Hotspot and mantle plume.
12. Gravity and gravity anomaly on Earth, Bouguer and free-air anomaly. Concept of isostasy and compensation, hypotheses of Airy, and Pratt.
13. Principles of determination of relative ages of rock bodies and geologic events. Absolute ages of rocks and minerals, fundamental principles of radiometric dating. Age of the Earth. Geologic Time Table up to the level of Eras and Periods.
14. The fossil record. Fossils as evidence of past life. Modes of preservation of fossils. Uses of fossils.

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PART – I
THEORY
Paper 1
Unit – I (75 marks, 95 hours), ***Continued from previous page***

Group B, 15 marks, Optical Mineralogy

1. Optical behaviour of crystals: isotropic and anisotropic media, double refraction, polarization of light, methods of production of plane polarized light, construction of polarizing microscopes; Ray velocity surface, Optical indicatrix of uniaxial and biaxial crystals.
2. Absorption colour and Pleochroism
3. Interference phenomenon in crystals, order of interference colour, birefringence, extinction
4. Determination of Refractive Index by (a) comparative method using Becke line, and by (b) liquid immersion method of isotropic minerals
5. Interference phenomenon in convergent light, Michael Levy chart of interference colours, interference figures, and use of interference figures for determination of optic sign
6. Diagnostic optical properties of the minerals prescribed under practical Paper 2, Unit II, Group 1.

Group C, 10 marks, Crystallography

1. Essential characteristics of crystalline and non-crystalline states of matter.
2. Crystal measurements: interfacial angle, zone, law of constancy of interfacial angles, principles of stereographic projection, notation of crystal faces, edges and corners, crystallographic axes, Miller indices, law of rational indices, general zonal relations of faces.
3. Stereographic projections
4. Crystal symmetry: elements of symmetry, Hermann-Mauguin symmetry notation, crystal forms – classification and nomenclature.
5. Classification of crystals into systems and classes
6. Crystal habit, types of crystal aggregates, general twin laws.
7. Space lattice, unit cell

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PART – I
THEORY
Paper 2
Unit – I (75 marks, 95 hours)
Group A, 15 marks, Mineralogy – I

1. Crystal chemistry: chemical bonds of different types, coordination principles, Pauling's rules, electronegativity, polymorphism, polymorphism of SiO_2, $CaCO_3$, Al_2SiO_5, displacive and reconstructive transformations, order-disorder transformations as in alkali feldspar, enantiotropy and monotropy, diadochy and solid solution, exsolution, pseudomorphism, defects in crystals.
2. Atomic structure of silicates, classification of silicates on the basis of their atomic structures. Outline of atomic structures of Olivine, Pyroxene, Amphibole, Mica - group of minerals.
3. Classification of the following rock forming minerals: Feldspar, Olivine, Pyroxene, Amphibole, Mica, Garnet.

Group B, 15 marks, Mineralogy - II

1. Scope and definitions; Physical properties of minerals: form and structure, colour and transparency, lustre, streak, specific gravity, hardness, cleavage, fracture, para-, dia- and ferromagnetic properties, radioactivity.
2. Classification of minerals on the basis of chemical composition.
3. Diagnostic physical properties of the following minerals:
   Haematite, magnetite, goethite, ilmenite, chromite, pyrolusite, psilomelane, bauxite;
   Pyrite, chalcopyrite, pyrrhotite, sphalerite, galena;
   Calcite, aragonite, dolomite, magnesite, siderite, malachite;
   Fluorite, gypsum, barite, wolframite, apatite, graphite;
   Quartz, feldspar, muscovite, biotite, pyroxene, amphibole, beryl, tourmaline, garnet, serpentine (including asbestos variety), talc, chlorite, kyanite, sillimanite, staurolite.

Group C, 25 marks, Principles of Petrology

1. Concept of system, component, phase; different types of system; intensive and extensive variables; rocks as systems.
2. Elementary thermodynamics: concept of enthalpy, entropy, molar volume, Gibbs free energy, chemical potential, fugacity and activity.
3. Concept of chemical equilibrium and equilibrium constant; pressure-temperature dependence of Gibbs free energy; relation between Gibbs free energy and equilibrium constant K.
4. Phase rule and its derivation; mineralogical phase rule; degrees of freedom, invariant, univariant and bivariant equilibrium condition; cryoscopic relationship; concept of the liquidus; one-, two- and three-component systems
5. Concept of ionic and redox potential and pH; factors controlling chemical sedimentation.

Group D, 20 marks, Igneous Petrology – I

1. Physical properties of magma – factors influencing physical properties of magma; ascent and emplacement of magma.
2. Forms of igneous rock bodies: description of the major forms of extrusives and intrusives and a general idea of their mode of emplacement – central eruptions, fissure eruptions, pyroclastic deposit, volcanic neck, sill, dyke, ring dyke, cone sheet, laccolith, lopolith, phacolith, stock, batholith.
3. Description and origin of the following structures of igneous rocks: vesicular structure, amygdaloidal structure, pillow structure, flow banding, flow lines, schlieren, ropy lava, block lava, columnar joint.

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4. Description and general idea of origin of textures and microstructures of common igneous rocks: porphyritic, poikilitic, ophitic, perthitic, corona, symplectite, spherulitic, spinifex, cumulus, intergrowth, equigranular, directive.
5. General knowledge of the basis of classification of igneous rocks – mineralogical, textural, chemical, chemico-mineralogical, and associational. Concept of CIPW norm and its significance; Hatch and Wells classification of igneous rocks; IUGS classification of plutonic rocks; TAS diagram for volcanic rocks.
6. Important mineralogical and textural features of the following rocks with Indian examples: alkali feldspar granite, alkali granite, granite, granodiorite, tonalite, trondhjemite, pegmatite, aplite; rhyolite; syenite; foid syenite, diorite; trachyte, phonolite, andesite; dolerite, gabbro, norite, anorthosite; basalt, spilite, oceanite, ankaramite; pyroxenite, peridotite, kimberlite; lamprophyre, carbonatite, pyroclastic rocks including agglomerate, volcanic breccia, ignimbrite, welded tuff, tuff, and ash.

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PART – I
PRACTICAL
Paper 1
Unit – II (25 marks, 40 hours)
Group A, 15 marks, Mineral identification under microscope

1. Study of the following minerals in transmitted polarized light: quartz, orthoclase, microcline, plagioclase, perthite, nepheline, olivine, orthopyroxene, clinopyroxene, hornblende, tremolite, kyanite, sillimanite, andalusite, cordierite, staurolite, epidote, zoisite, garnet, tourmaline, zircon, sphene (titanite), muscovite, biotite, chlorite, apatite, carbonate, scapolite.
2. Becke test, determination of order of interference colour, use of 1 lambda, and ¼ lambda accessory plate; extinction angle, scheme of pleochroism of minerals.

Group B, 10 marks, Crystallography

1. Study of crystal models: symmetry elements, forms, and crystal systems.
2. Orthographic projection of cubic, tetragonal and orthorhombic crystal models.
3. Stereograms (with and without the stereonets) from given crystallographic data.

PRACTICAL
Paper 2
Unit – II (25 marks, 40 hours)
Group A, 10 marks, Mineral identification in hand specimen

Systematic study of hand specimens of the minerals listed below on the following points:
Form and structure, colour, transparency, lustre, streak, cleavage, parting, fractures, hardness, specific gravity, magnetism, and treatment with dilute HCl.
Haematite, magnetite, goethite, ilmenite, chromite, pyrolusite, psilomelane, bauxite;
Pyrite, chalcopyrite, pyrrhotite, sphalerite, galena;
Calcite, aragonite, dolomite, magnesite, siderite, malachite;
Fluorite, gypsum, barite, wolframite, apatite, graphite;
Quartz, feldspar, muscovite, biotite, pyroxene, amphibole, beryl, tourmaline, garnet, serpentine (including asbestos variety), talc, chlorite, kyanite, sillimanite, staurolite.

Group B, 15 marks, Identification of common rocks in hand specimen

1. Identification in hand specimen by studying mineralogical composition and texture of the following rock types:
   Granite, granodiorite, syenite, nepheline syenite, aplite, granophyre, diorite, gabbro, anorthosite, peridotite, mica-lamprophyre, dolerite, basalt, andesite, and rhyolite.
2. Study of hand specimens of different types of sedimentary rocks:
   Sandstone, siltstone, mudstone, shale, conglomerate, breccia, limestone, chert, dolomite.
3. Description and identification of the following rocks in hand specimens: quartzite, marble, schists (including biotite-, muscovite-, chlorite-, garnet-, staurolite-, hornblende-, kyanite-, schists), amphibolite, granitoid gneiss, charnockite, khondalite, calc-silicate rock, mafic granulite

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PART – I

PRACTICAL

Field Work

Field work of approximately 10 days

Reconnaissance study of areas preferably having sedimentary rocks with fossil bearing units, igneous rocks and metamorphic rocks; students are to be introduced to different types of rock exposures e.g. surface outcrop, sections like river cut, road cut, railway cut etc.; field work should include reading topographic maps, locating oneself on topographic maps; measurement of attitude of planar and linear structures; measurement of true bed thickness; collection of samples and preparation of field report.

***Suggested areas (other appropriate areas will also be acceptable)*:**

1. Chhotonagpur gneissic complex, in and around Purulia.
2. Singhbhum craton, in and around Ghatsila.
3. Maihar-Jabalpur (Madhya Pradesh);
4. Himalayan sections: Darjeeling district (West Bengal), Himachal Pradesh;
5. Nagpur-Chirimiri;
6. Deccan trap and intertrappeans in different parts of Maharashtra;
7. Gondwana basins of Jharia and Ranigunj;
8. Different parts of South India including Cretaceous succession of Trichinopally.

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PART – II
THEORY
Paper 3
Unit – I (50 marks, 75 hours)
Group A, 20 marks, Structural Geology – I

1. Geometric, kinematic and dynamic analysis of structures. Penetrative and non-penetrative structural elements: primary and secondary planar and linear structural elements, strike and dip, pitch and plunge, representation of planes and lines in stereographic and equal area projection diagrams. Outcrops of planes on horizontal and uneven surfaces: outlier and inlier. Scales of observation of structures.
2. Folds, parts of a fold, antiform, synform, neutral fold, anticline, syncline, nomenclature of folds based on fold shape and orientation of axis and axial plane. Equal area projection diagrams of different types of folds. Ramsay's classification of folds, variation of thickness of folded layers, isogons. Outcrops of folded planes on horizontal and sloping surfaces. Relation between major folds and minor folds.
3. Foliation: morphological features of cleavage and schistosity, morphological classification of rock cleavage. Relation of cleavage and schistosity to major folds.
4. Types of lineation and their geometrical relation to folds.

Group B, 30 marks, Structural Geology – II

1. Concept of stress, normal stress, shear stress, principal axes of stress, planes of maximum shear stress. Displacement and strain, longitudinal and shear strain, principal axes of strain, homogeneous and inhomogeneous strain, rotational and irrotational strain, pure shear and simple shear, strain ellipse and strain ellipsoid. Factors controlling deformation behaviour of rocks – confining pressure, temperature, time, solution. Brittle and ductile deformation. Creep of rocks, elastic, viscous, and plastic behaviour.
2. Basic concepts of superposed deformation, interference patterns in superposed folding, deformation of older planar and linear structures, geometry of new structures.
3. Concept of buckle (flexure), flexure slip, bending and slip (shear) folds, geometrical characteristics of folds formed by buckling and inhomogeneous simple shear.
4. Fracturing of rocks: tension and shear fractures. Joint sets and joint systems, relation of joints to folds.
5. Faults: translational and rotational movements, slip and separation; nomenclature of faults based on geometrical relation of faults to beds, slip and separation. Effects of faults on outcrop of strata. Horst and graben, autochthon, allochthon, nappe, window and klippe. Criteria for recognition of faults.
6. Fold and thrust belt, imbricate structure, fault related folding, duplex structure.
7. Shear zone, basic concepts, shear zone rocks, common structures in shear zones.
8. Unconformity: types of unconformity, criteria for distinguishing unconformity from faults and intrusive contacts.

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PART – II
THEORY
Paper 4
Unit – I (50 marks, 65 hours)
Group A, 20 marks, Igneous Petrology – II

1. Studies on crystallization of melts (at 1 atm dry pressure and high pH_2O) in the following systems with particular reference to phase rule: diopside-anorthite, forsterite-silica, albite-anorthite, albite-orthoclase, diopside-albite-anorthite; diopside-forsterite-silica, nepheline-kalsilite-silica; petrogenetic significance of these systems; Role of volatiles in magmatic crystallization; Bowen's reaction series and its use in petrogenesis.
2. Concept of petrographic consanguinity, and petrographic province.
3. Processes of diversification of igneous rocks: differentiation, assimilation, and partial melting; Chemical variation during differentiation – silica variation diagram, Fe-Mg-(Na+K) and Ca-Na-K diagram; Commonly used parameters in differentiation: differentiation index, fractionation index, solidification index, Mg-number.
4. Trends of variation in calc-alkaline and tholeiitic series in AFM diagrams.
5. Petrogenesis of the following rocks: granite, basalt, anorthosite, alkaline rocks.

Group B, 15 marks, Sedimentology – I

1. Scope and purpose.
2. Sediment genesis to diagenesis: processes of sediment generation to formation of sedimentary rocks; Weathering, erosion, transportation, deposition and diagenesis.
3. Texture: primary and secondary; Textural components: framework, matrix, cement, allochemical and orthochemical components; Textural parameters: grain size, shape and their statistics; Surface texture; Fabric: orientation, packing; Porosity and permeability.
4. Classification of sedimentary rocks: based on composition (siliciclastic, limestone, chert etc.), based on source (terrigenous-extrabasinal, chemogenic-intrabasinal), based on grain size (conglomerate-rudaceous, sandstone-aranaceous, shale-argillaceous, calcarenite, calcareous sandstone, micrite), based on mode of deposition (clastic-terrigenous-allochemical, non-clastic-orthochemical); Naming of rocks according to terrigenous-allochemical-orthochemical proportions.

Group C, 15 marks, Sedimentology – II

1. Natural flows: elementary concepts of Newtonian, non-Newtonian, and plastic flows; Reynolds number and Froude number; Concept of flow regime and bedform stability diagram.
2. Primary sedimentary structure: fluidal flow, bedforms - current, wave, and combined flow and their internal structures; structures generated by mass flow; Soft-sediment deformation structures; Biogenic structures including elementary concepts of stromatolite.
3. Conglomerate and breccia: composition, fabric and structure, classification, mode of deposition; Intraformational and extraformational conglomerates and their significance.
4. Sandstone, limestone, dolostone: definition, composition, classification, petrogenesis; Sandstone classification - Pettijohn, Folk; Limestone classification - Dunham, Folk.
5. Brief descriptions of shale, chert, evaporite, BIF, and volcaniclastics; elementary ideas on composition and depositional conditions.
6. Facies concept: Definition of facies; Basic concept of facies association and modelling.

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PART – II

PRACTICAL

Paper 3

Unit – II (50 marks, 60 hours)

Group A, 15 marks, Structural Geology – I

1. Reading and interpretation of topographic maps.
2. Use of Clinometer and Brunton compass, measurement of attitude of planar and linear structural elements.
3. Graphical solution of true dip – apparent dip problems, three-point problems.
4. Stereographic projection of planes and lines: solution of simple structural problems using a net, e.g., true dip – apparent dip relations, determination of axis of cylindrical folds.
5. Construction of block diagrams of homoclinal beds and folded beds.

Group B, 35 marks, Structural Geology – II

1. Interpretation of maps showing unconformity, intrusive bodies, folded and faulted beds. Construction of structural cross sections.
2. Use of stereographic net in solving structural problems in folded terrains.
3. Determination of net slip on faults using stereographic nets.

PRACTICAL

Paper 4

Unit – II (50 marks, 70 hours)

Group A, 30 marks, Petrography of Igneous and Sedimentary rocks under microscope

1. Study, under microscope, of the following textures of igneous rocks:
   Porhpyritic, poikilitic, ophitic, intergranular, intersertal, graphic, perthitic, myrmekitic, hypidiomorphic, allotriomorphic, corona, flowage.
2. Description and identification by microscopic characters of the following rocks:
   Granite, granodiorite, tonalite, syenite, nepheline syenite, aplite, granophyre, diorite, gabbro, anorthosite, pyroxenite, peridotite, mica-lamprophyre, dolerite, rhyolite, basalt, andesite
3. Petrography of Siliciclastics – quartz arenite, arkose, lith-arenite, greywacke; Carbonates allochemical, micritic, dolomitic; Chert.

Group B, 20 marks, Sedimentology

1. Study in hand specimens, and model sketches: bedforms and internal structures, sole structures, deformational structures, biogenic structures: interpretation of sedimentation mechanism and environment as much as possible
2. Determination of mean, mode, median, sorting, skewness, and kurtosis from grain size data.
3. Determination of vector mean and vector magnitude of directional data of sedimentary rocks. Plotting of directional data on Rose diagrams.
4. Interpretation of sedimentary environment from grain size analyses.

PART – II

PRACTICAL

Field Work

Field work of approximately 15 days

(a) Geological mapping of a small area, collection and study of samples and preparation of geological map.

(b) Tape and compass surveying and use of Brunton compass, and GPS.

***Suggested areas (other appropriate areas will also be acceptable)*:**

1. Jharkhand: Ghatshila-Galudih;
2. Maharashtra: Nagpur-Ramtek;
3. Rajasthan: Pur, Beawar, Zawar;
4. Karnataka: Chitradurga, Dodguni.

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PART – III
THEORY
Paper 5
Unit – I (50 marks, 70 hours)
Group A, 30 marks, Palaeontology – I

1. Introduction: Definition and types of fossils; major disciplines in palaeontology; significance of study of fossils; Brief introduction to Precambrian and Phanerozoic life forms.
2. Fossilization: definition, conditions and modes of preservation of ancient life forms, taphonomy; imperfections of fossil record.
3. Taxonomy: hierarchical nature of classification of organisms – species to kingdom; identification and classification; species concept in biology and binomial nomenclature; rules and procedure for naming a new species; typomorphic and cladistic taxonomy.
4. Distribution of fossils in space and time; law of faunal succession; index fossil.
5. Principles of functional morphology of fossil taxa; hard part morphology of brachiopoda, anthozoa, echinoidea, bivalvia, gastropoda, cephalopoda and trilobita.

Group B, 20 marks, Palaeontology – II

1. Organic evolution: introduction to patterns and mechanism of evolution; evolution of ammonoidea.
2. Suprageneric categories of Indian Gondwana flora.
3. Suprageneric categories of Gondwana and Siwalik vertebrates of India.
4. Palaeoecology: environment-biota interaction, Palaeoecological significance of corals, bivalves and brachiopods; brief idea on application of trace fossils in palaeoecology; plants as indicators of past climate.

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PART – III
THEORY
Paper 6
Unit – I (75 marks, 95 hours)
Group A, 20 marks, Metamorphic Petrology – I

1. P-T limits of metamorphism, types of changes in metamorphism - mineralogical, textural and chemical.
2. Agents of metamorphism – temperature, pressure and fluid. Source of heat, heat transfer (conduction, convection and advection), geothermal gradient, steady-state and transient geotherm. Load pressure and fluid pressure. Fluids in metamorphism: evidence and role.
3. Types of metamorphism on the basis of agents, association, plate tectonic settings and classification of metamorphic rocks. Composition of protolith and its control on metamorphism.
4. Texture of metamorphic rocks, metamorphic crystallization and growth of porphyroblasts in relation to deformation.
5. Classification of metamorphic rocks: Basis of classification: Non-foliated and foliated, High strain rocks; Mineralogy and texture of phyllite, schist, greenschist, greenstone, white schist, blue schist, amphibolite, hornfels, granulite, eclogite.

Group B, 15 marks, Metamorphic Petrology - II

1. Concept of metamorphic grade, isograd, iso-reaction grad, basic divisions of metamorphic grade, metamorphic zones, index minerals. Metamorphic facies, facies classification, P-T fields of different facies, concept of facies series, interrelation between grade, facies and metamorphic zone. Prograde and retrograde metamorphism. Metamorphism and tectonics, paired metamorphic belts.
2. Metamorphic reactions: different types of reactions. Composition-paragenesis diagrams: ACF, AKF, AKFM diagrams, AFM projection, merits and demerits. Schreinemaker's analysis, petrogenetic grid.
3. Regional metamorphism of pelitic and mafic rocks, and contact metamorphism of impure carbonate rocks (both open and close systems).
4. Elementary ideas on crustal anatexis, metamorphic differentiation, migmatite. Granulites: definition and types. Metamorphic belts of India.

Group C, 40 marks, Global Tectonics

1. Tectonics – definitions and scope; structure of continents and oceans, bulk compositions and densities; active and passive continental margins, shield, continental rift systems.
2. Continental drift hypothesis; geological, palaeoclimatological and palaeontological evidence of break up of Gondwanaland; criticism of continental drift hypothesis.
3. Palaeomagnetism and palaeopoles; Geographic poles, Magnetic poles, and Geomagnetic poles; Apparent polar wandering curve, and continental reconstruction; Polarity reversals, and polarity reversal scales.
4. Seafloor spreading, marine magnetic anomalies and their interpretation.
5. Plate tectonics: Structure, composition, and densities of lithosphere and asthenosphere; Plate boundary processes: subduction zones - volcanic arcs and island arcs, paired metamorphic belts, trenches, accretionary prism, marginal basins, oceanic ridges and spreading rates; Transform faults; Ophiolites and their emplacement mechanisms.
6. Elementary ideas on magmatism in oceanic ridges and subduction zone.
7. Plate velocity vectors: relative and absolute velocities; Relative movement of the plates on a spherical Earth, pole of rotation; Determination of pole of rotation from transform faults and mid-oceanic ridges.
8. Supercontinents and their breakup, Wilson Cycle.

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PART – III
THEORY
Paper 7
Unit – I (50 marks, 65 hours)
Group A, 20 marks, Hydrogeology, Engineering Geology, and Environmental Geology

Hydrogeology

1. Hydrologic cycle, surface water-groundwater interaction, and Springs
2. Vertical distribution of groundwater, genetic classification of groundwater, Classification of aquifers, water table and piezometric surface
3. Properties of aquifer – Porosity, hydraulic conductivity, transmissivity and storage coefficient
4. Groundwater quality
5. Groundwater provinces of India and West Bengal
6. Water balance – recharge and discharge
7. Basic concepts of rainwater harvesting and artificial recharge

Engineering Geology:

1. Engineering properties of rocks and soils
2. Geological investigations for dams and reservoirs
3. Landslides-causes, prevention and rehabilitation

Environmetal Geology

1. Global degradation of environment, Toxicity, Residence time, Impact of man on geoenvironment.
2. Natural hazards definition and impact. Earthquake, volcanic eruption, landslides, floods, and droughts as agent for natural hazards.
3. Ecology and ecosystem- basic concepts
4. Global and Indian water resource, water pollution, effects of water pollution on human health
5. Composition of air, structure of atmosphere, air pollution, effects of air pollution on human health
6. Mining and Geoenvironment- impact of mining on atmosphere, biosphere, lithosphere and hydrosphere; acid mine drainage, measures to mitigate the adverse impact of mining

Group B, 30 marks, Economic Geology

1. Economic Geology and its principal contents; definitions of the terms: protore, ore, gangue, tenor, hypogene and supergene ore deposits, epigenetic and syngenetic mineral deposits; mineral beneficiation; common morphologies of mineral deposits.
2. Mineral deposits and their litho-tectonic environments, e.g., in continental rifts and continental margins, greenstone belts and ophiolites, in convergent plate boundaries, in shallow shelves, accompanied by mafic volcanism.
3. An introduction to the following ore forming processes: magmatic crystallization-differentiation and magma immiscibility, precipitation from hydrothermal solutions, sedimentation-diagenesis, ore forming processes on metamorphism and supergene transformation of protore; placer deposits: their distribution and origin.
4. Mineral deposits in space and time.
5. Metallic mineral deposits of India, such as, iron of Jharkhand-Orissa and Karnataka, manganese of central India, chromite of Orissa, copper of Singhbhum and Malanjkhand, lead-zinc of Zawar, uranium of Singhbhum and Andhra Pradesh, gold of Kolar-Hutti, tungsten of Rajasthan, with particular reference to their geologic set up, modes of occurrence, mineralogy, age and genesis.
6. Non-metallic mineral deposits of India such as bauxite, mica, phosphates, barite, diamond and graphite, with special reference to their distribution, geology, origin and usage.
7. Specifications of the raw (mineral/rock) materials used in the following industries: iron and steel, cement, refractories, fertilizer.
8. Coal, its chemical, petrographic constituents, classification and origin of different varieties of coal and their distribution in India.
9. Study of petroleum and natural gas deposits with special reference to their origin, migration, accumulation, and distribution in India (both on- and off-shore).

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PART – III
THEORY
Paper 8
Unit – I (75 marks, 90 hours)
Group A, 25 marks, Principles of Stratigraphy

1. Introduction; Concept of strata and their orders; Law of Superposition; Law of Faunal Succession; Principle of Uniformitarianism.
2. Geochronology: principles of Rb-Sr, Sm-Nd, and U-Pb dating and their applicability.
3. Stratigraphic units: Lithostratigraphy, Biostratigraphy, Chronostratigraphy and relevance of type section.
4. Principles of Allostratigraphy, Event stratigraphy, Magnetostratigraphy, Chemostratigraphy, Cyclostratigraphy and Seismic stratigraphy.
5. Principles of stratigraphic correlation.

Group B, 50 marks, Stratigraphy of India

1. Precambrian Geology of India:
   (A) Geologic evolution of the following Precambrian terrains in terms of sedimentation, structure, magmatism, metamorphism, and geochronology:
   Dharwar, Singhbhum, Rajasthan, and Central India
   (B) Introduction to Proterozoic (Purana) basins of India with special reference to Cuddapah and Vindhyan basins.
3. Generalized succession, broad lithology, flora and fauna, correlation and palaeoenvironment of the following Phanerozoic basins of India: Spiti, Kashmir, Assam-Arakan, Kutch, Gondwana, Bengal, and Siwalik.
4. A brief introduction to the Quaternary Geology.

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PART – III
PRACTICAL
Paper 5
Unit – II (50 marks, 75 hours)
Group A, 25 marks, Palaeontology – I

Hard part morphology and identification of the following:

1. Brachiopoda: *Terebratula, Rhynchonella, Atrypa, Athyris, Spirifer, Productus.*
2. Anthozoa: *Halysites, Favosites, Calceola, Zaphrentis, Montlivaltia.*
3. Trilobita: *Calymene, Phacops*
4. Echinoidea: *Hemiaster, Breynia, Schizaster, Echinolampas, Stygmatopygus, Clypeaster.*

Group B, 25 marks, Palaeontology – II

1. Hard part morphology, identification and modes of preservation and elementary structure-function relations of Cephalopoda: *Nautilus, Ceratites, Perisphinctes, Macrocephalites, Belemnites, Acanthoceras*.
2. Hard part morphology and identification and inferences on modes of living of Bivalvia: *Unio, Ostrea, Pecten, Venus, Hippurites, Gryphaea*.
3. Hard part morphology and identification of Gastropoda: *Turritella, Cerithium, Nerita, Natica, Conus, Murex, Cypraea, Physa, Bellerophon.*
4. Morphology, identification and modes of preservation of Gondwana flora: *Glossopteris, Gangamopteris, Vertebraria, Ptilophyllum, Schizoneura, Pterophyllum, Cladophlebis, Dadoxylon*.

PRACTICAL
Paper 6
Unit – II (25 marks, 35 hours)
Group A, 25 marks, Study of metamorphic rock in thin section

1. Study of metamorphic textures in thin sections: schist, gneiss, porphyroblast, reaction textures.
2. Time relation between fabric and prophyroblast growth.
3. Description and identification of the following rocks in thin sections: quartzite, marble, schists (including biotite-, muscovite-, chlorite-, garnet-, staurolite-, actinolite-, hornblende-, kyanite-, sillimanite schists), amphibolite, granitoid gneiss, charnockite, khondalite, calc-silicate rock, mafic granulite

PRACTICAL
Paper 7
Unit – II (50 marks, 30 hours)
Group A, 20 marks, Chemical igneous petrology and graphical presentation of metamorphic mineral assemblages and

1. Construction of ACF, and AKF diagrams and plotting of the mineral assemblages in greenschist and amphibolite facies.
2. Plotting of mineralogical and chemical data of igneous rocks in triangular diagram.
3. C.I.P.W. norm calculation of granitic and basic rock (without foid).

Group B, 30 marks, Field Work

1. Assessment of Field Notes and Field Reports of all three mandatory field work in the three years.

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PRACTICAL
Paper 8
Unit – II (25 marks)
Group A, 25 marks, General Viva-Voce

PART – III
PRACTICAL
Field Work

Field work of approximately 10 days

Study in the field of two economic mineral deposits and study of local geology of the deposits, preferably one underground mine and one open cast mine. If possible, one day visit to a dam site.

***Suggested areas (other appropriate areas will also be acceptable)*:**

1. Rajasthan: Zawar and adjoining areas, Khetri;
2. Karnataka: Chitradurga and adjoining areas;
3. Jharkhand and Orissa: Copper, Iron, Limestone;
4. Madhya Pradesh and Chhattisgarh: Iron, Manganese, Coal;
5. Vindhyans of Madhya Pradesh: Limestone.

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SUGGESTED BOOKS

Introduction to Earth Systems Science

Text:

1. Press, F., Siever, R., Grotzinger, J. and Jordan, T.H., 2004, Understanding Earth, 4th Edn., W.H. Freeman, 567 p. [A later 5th Edn., will also be useful]
2. Tarbuck, E.J. and Lutgens, F.K., 2006, Earth Science, 11th Edn., Pearson Prentice Hall, New Jersey, 726 p. [Earlier editions e.g. 10th or 9th, or even earlier, will also be useful].

Reference:

1. Duff, P.McL.D., editor, 1992, Holme's Principles of Physical Geology, ELBS – Chapman Hall, 791p. [Earlier editions will also be helpful]
2. Skinner, B.J., Porter, S.C. and Park, J., 2003, The Dynamic Earth: An Introduction to Physical Geology [With CDROM], John Wiley & Sons, 631 p. [Earlier editions will also be helpful]
3. Skinner, B.J., 2010, The Blue Planet: An Introduction to Earth System Science, John Wiley & Sons, 592 p.

Mineralogy

Text:

Klein, C., 2002, The Manual of Mineral Science, 22nd Edn., John Wiley & Sons, 641 p. [Earlier editions of this book with Hurlbut and Klein as authors will be also useful]

Reference:

Nesse, W.D., 2000, Introduction to Mineralogy, Oxford University Press, New York, 442 p.

Crystallography

Text:

Klein, C., 2002, The Manual of Mineral Science, 22nd Edn., John Wile & Sons, 641 p. [Earlier editions of this book with Hurlbut and Klein as authors will be also useful]

Reference:

Nesse, W.D., 2000, Introduction to Mineralogy, Oxford University Press, New York, 442 p.

Optical Mineralogy

Text:

1. Nesse, W.D., 2003, Introduction to Optical Mineralogy, 3rd Edn., Oxford University Press. [Older edition of this book will also be useful].
2. Klein, C., 2002, The Manual of Mineral Science, 22nd Edn., John Wiley & Sons, 641 p. [Earlier editions of this book with Hurlbut and Klein as authors will be also useful]

Reference:

1. Deer, W.A., Howie, R. Zussman, J., 1992, An Introduction to Rock Forming Minerals, 2nd Revised Edn, Pearson Education Limited, 712 p. [Any edition of this book will be equally useful].
2. Nesse, W.D., 2000, Introduction to Mineralogy, Oxford University Press, New York, 442 p.

Principles of Petrology

Text:

1. Philpotts, A.R. and Ague, J.J., 2009, Principles of Igneous and Metamorphic Petrology, Cambridge University Press, Cambridge, 667 p. [The older edition from Prentice Hall, 1990, is also useful]

Reference:

2. Winter, J.D., 2009, Principles of Igneous and Metamorphic Petrology, 2nd Edn., Prentice Hall, 702 p. [The first edition (2001) named An Introduction to Igneous and Metamophic Petrology, is also useful].
3. Krauskopf, K.B. and Bird, D.K., 1994, Introduction to Geochemistry, 3rd Edn., McGraw Hill, 640 p.
4. Mason, B. and Moore, C.B, 1982, Principles of Geochemistry, 4th Edn., John Wiley & Son, New York, 352 p. [Earlier edition, with Mason as the only author will also be helpful]

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Structural Geology

Text:

1. Davis, G.H. and Reynolds, S.J., 1996, Structural Geology of Rocks and Regions, 2nd Edn., John Wiley & Sons, New York, 776 p.
2. Van der Pluijm B.A. and Marshak, S., 2004, Earth Structure: An Introduction to Structural Geology and Tectonics, 2nd Edn., W.W. Norton & Co., New York, 656 p.

Reference:

3. Twiss, R.J. and Moores, E.M., 2007, Structural Geology, 2nd Edn., W.H. Freeman, New York , 736 p. [Earlier edition (1992) of the same book will be equally useful]
4. Ghosh, S.K., 1993, Structural Geology: fundamentals and modern developments, Pergamon, Oxford, 598 p.

Igneous Petrology

Text:

1. Bose, M.K., 1997, Igneous Petrology, The World Press, Kolkata, 568 p.
2. Winter, J.D., 2009, Principles of Igneous and Metamorphic Petrology, 2nd Edn., Prentice Hall, 702 p. [The first edition (2001) named An Introduction to Igneous and Metamorphic Petrology, is also useful].

Reference:

3. Philpotts, A.R. and Ague, J.J., 2009, Principles of Igneous and Metamorphic Petrology, Cambridge University Press, Cambridge, 667 p. [The older edition from Prentice Hall, 1990, is also useful]
4. Best, M.G., 2002, Igneous and Metamorphic Petrology, 2nd Edn., Blackwell, Oxford, 752 p.
5. Wilson, M., 1989, Igneous Petrogenesis: a global tectonic approach, Springer (2007), 466 p.

Metamorphic Petrology

Text:

1. Winter, J.D., 2009, Principles of Igneous and Metamorphic Petrology, 2nd Edn., Prentice Hall, 702 p. [The first edition (2001) named An Introduction to Igneous and Metamorphic Petrology, is also useful].

Reference:

2. Philpotts, A.R. and Ague, J.J., 2009, Principles of Igneous and Metamorphic Petrology, Cambridge University Press, Cambridge, 667 p. [The older edition from Prentice Hall, 1990, is also useful]
3. Best, M.G., 2002, Igneous and Metamorphic Petrology, 2nd Edn., Blackwell, Oxford, 752 p.
4. Yardley, B.W.D., 1989, An Introduction to Metamorphic Petrology, Longmans, 248 p.
5. Bucher, K. and Frey, M., 2002, Petrogenesis of Metamorphic Rocks, Springer, 341 p.

Sedimentology

Text:

1. Pettijohn, F.J., 1975, Sedimentary Rocks, 3rd Edn., Harper and Row, New York, 628 p.
2. Tucker, M.E., 2001, Sedimentary Petrology – an introduction to the origin of sedimentary rocks, Blackwell, Oxford, 262 p.
3. Folk, R.L., 1974, Petrology of Sedimentary Rocks, Hemphill Publishing Company, Austin, 159 p.
4. Collison, J.D. and Thompson, D.B., 1989, Sedimentary Structures, Allen & Unwin, London, 194 p.

Referenence:

5. Boggs, S.Jr., 2005, Principles of Sedimentology and Stratigraphy, 4th Edn., Prentice Hall, New Jersey, 688 p.
6. Sengupta, S., 2007, Introduction to Sedimentology, 2nd Edn, CBS, 325 p.
7. Reineck, H.E. and Singh, I.B., 1980, Depositional Sedimentary Environments, 2nd Edn., Springer-Verlag, Berlin, 551 p.
8. Blatt, H., Middleton, G., and Murray, R., 1972, Origin of Sedimentary Rocks, 2nd Edn., Prentice-Hall, New Jersey, 782 p.
9. Leeder, M.R., 1985, Sedimentology: Processes and Products, 2nd Edn., Allen & Unwin, London, 344 p.

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Palaeontology

Text:

1. Black, R.M., 1989, Elements of Palaeontology, 2nd Edn., Cambridge University Press, 420 p.
2. Doyle, P., Doyle, M. and Florence, M.L., 1996, Understanding Fossils: An Introduction to Invertebrate Palaeontology, John Wiley & Sons, 426 p.
3. Ray, A.K., 2008, Fossils in Earth Sciences, 1st Edn., Prentice Hall, India, 444 p.

Reference:

4. Nield, E.W., and Tucker, V.C.T., 1985, Palaeontology: An Introduction, 1st Edn., Pergamon Press, 178 p.
5. Raup, D.M., and Stanley, S.M., 1985, Principles of Palaeontology, 1st Edn., CBS Publishers. 481 p.
6. Foote, M., and Miller, A.T., 2007, Principles of Palaeontology (3rd Edn. of Raup & Stanley), W.H. Freeman, 480 p.
7. Dasgupta, A., 2007, An Introduction to Palaeontology, 1st Edn., The World Press, Kolkata.
8. Moore, R.C., Lalicker, C.G., and Fischer, A.G., 1952, Invertebrate Fossils, McGraw Hill 766 p.
9. Clarkson, E.N.K., 1998, Invertebrate Palaeontology and Evolution, 4th Edn., Blackwell, 468 p.

Principles of Stratigraphy

Text:

1. Lemon, R.R., 1990, Principles of Stratigraphy, Merrill, Ohio, 559 p.
2. Nichols, G., 1999, Sedimentology and Stratigraphy, Blackwell, Oxford, 262 p.

Reference:

3. Reading, H.G., 1996, Sedimentary Environments: processes, facies, and stratigraphy, Wiley-Blackwell, Oxford, 704 p.
4. Krumbein, W.C. and Sloss, L.L., 1963, Stratigraphy and Sedimentation, W.H. Freeman, San Francisco, 660 p.
5. Faure, G., 1986, Principles of Isotope Geology, 2nd Edn., John Wiley & Sons, New York, 589 p.

Economic Geology

Text:

1. Evans, A.M., 1997, An Introduction to Economic Geology and its Environmental Impact, Wiley-Blackwell, 364 p.
2. Chandra, D., 1990, The Story of Petroleum, Dev Sahitya Kutir (P) Ltd., Calcutta, 39 p.
3. Chandra, D., Singh, R.M. and Singh, M.P., 2000, Text Book of Coal: Indian Context, Tara Book Agency, Varanasi, 402 p.
4. Banerjee, D.K., 1992, Mineral Resources of India, The World Press, Calcutta, 440 p.

Reference:

5. Robb, L.J., 2005, Introduction to Ore Forming Processes, Wiley-Blackwell, 373 p.
6. Stanton, R.L., 1972, Ore Petrology, McGraw-Hill, 713 p.

Global Tectonics

Text:

1. Kearey, P., Klepeis, K.A., and Vine, F.J., 2009, Global Tectonics, 3rd Edn., Wiley-Blackwell, Oxford, 482 p. [Earlier edition of this book with Keary and Vine as authors is also useful]
2. Moores, E.M. and Twiss, R.J., 1995, Tectonics, W.H. Freeman, New York, 415 p.

Reference:

3. Condie, K.C., 1997, Plate tectonics and crustal evolution, 4th Edn., Butterworth-Heinemann, Oxford, 294 p.
4. Mussett, A.E. and Khan, M.A., 2000, Looking into the Earth: An Introduction to Geological Geophysics, Cambridge University Press, Cambridge, 470 p.

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Hydrogeology, Engineering Geology, and Environmental Geology

Text:

1. Agrawal, K.M, Sikdar, P.K., and Deb, S.C., 2002, A text book of environment, 1st Edn., Macmillan India, 464 p.
2. Karanth, K.R., 1987, Groundwater assessment, development and management, Tata McGraw Hill, 448 p.
3. Singh, P., 1999, Engineering and General Geology, S.K. Kataria & Sons, New Delhi 110 006.

Reference:

4. Aswathanarayana, U., 1995, Geoenvironment - An introduction, Capital Books, 270 p.
5. Valdiya, K.S., 2004, Geology, Environment and Society, Universities Press, 240 p.

Stratigraphy of India

Text:

1. Krishnan, M.S., 2006, Geology of India and Burma, 6th Edn., CBS, 536 p. [Earlier editions also useful]
2. Ramakrishnan, M. and Vaidyanathan, R., 2008, Geology of India, Vol. 1, Geological Society of India, Bangalore.

Reference:

3. Pascoe, E.H., 1950, A manual of the geology of India and Burma (3 volumes), 3rd Edn., Geological Survey of India.
4. Sarbadhikari, T, 1974, *Bharater shilastar o bhutatiyo itihash [Stratigraphy and Historical Geology of India]*, Paschim Banga Rajya Pustak Parshad [West Bengal State Book Board], Kolkata.

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B.Sc. Geology (H) 1+1+1 System, NEW SYLLABUS, Effective Session 2017-2018

COURSE STRUCTURE, THREE-YEAR B.SC. GEOLOGY (H), CU

Full Marks – 800

The Curriculum/Course Structure for 1+1+1 system, also adaptable in 6-semester system

Division of Marks

For the first and the second years Geology (H) is taught along with two subsidiary subjects, hence total marks for the first and the second years for Geology are 200 each. In the proposed semester system, for the first four semesters the total marks for each semester will be 100. In the third and final year, only Geology (H) is taught and the total marks will be 400. In the proposed semester system for the final two semesters the total marks for each semester will be 200.

The course structure is made such that it can be used in six different semesters with the examination at the end of each 6-month semester. Also it can be used for 3-year 1+1+1 system with the examination at the end of each year (Part I, II, & III) by using the two papers of semesters 1 & 2 in Part I, the two papers of semesters 3 & 4 in Part II, and the four papers of semesters 5 & 6 in Part III.

Of the total 800 marks for the Geology (H) 500 is in theory, and 300 is in practical.

Each Paper has 100 marks, with two parts (Units): **Unit – I is Theory**, and **Unit – II is Practical**. The division of marks for each paper is either

Unit –I: 75 marks and Unit -II: 25 Marks, **or**, Unit –I: 50 marks and Unit -II: 50 Marks.

Therefore, there will be **eight papers each with 100 marks**:

Four papers, each having Theory: 50 marks, and Practical 50 marks, and
Four papers, each having Theory: 75 marks, and Practical 25 marks

Each paper in each year (semester) is self contained, that is, if a subject or a module has both theory and practical portions then both will be included in the same paper and will not be carried over to another paper or another year (semester).

Allocation of Time:

A year has 52 weeks. Hence each six-month semester will have 26 weeks, that is 26x7 = 182 days.

There will be 26 weekends, i.e. 26x2 = 52 days
There will be vacations (Summer/Puja) = 30 days
Miscellaneous (Birthdays, Bandhs, Exams etc.) = 20 days
Available days each Semester for teaching = 182-102 = 80 DAYS
Available days for teaching each Year = 2x80 = 160 DAYS

On the average there will be around 160 working days in each year, with 800 hours of teaching (or, 80 working days in each Semester, with 400 hours of teaching).

50% time will be taken up by the classes on the subsidiary subjects for the first two years (first four semesters). On the average, for Geology (H) classes, for each of the first two years (four semesters) there will be 400 hours each, and in the third year 800 hours (for the last two semesters 400 hours each) of teaching.

Distribution of Marks and Teaching hours per Year and also per Semester:

1+1+1 System	6-Semester System	Paper(s)	Theory		Practical		Total	
			Marks	*Hours*	Marks	*Hours*	Marks	*Hours*
1st Yr	Semester 1	Paper 1	75	*95*	25	*40*	100	*135*
	Semester 2	Paper 2	75	*95*	25	*40*	100	*135*
2nd Yr	Semester 3	Paper 3	50	*75*	50	*60*	100	*135*
	Semester 4	Paper 4	50	*65*	50	*70*	100	*135*
3rd Yr	Semester 5	Papers 5 & 6	125	*160*	75	*110*	200	*275*
	Semester 6	Papers 7 & 8	125	*155*	75	*30*	200	*185*
			500	***645***	**300**	***350***	**800**	***1000***

This time calculation does not include about total 35 days of field work (in three separate semesters) in three different years. For details see at the top of page 3.

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The Curriculum/Course Structure

Exm	Paper	Unit	Group	Name	Marks	*Hours*
PART – I (End of Year 1) **Th 150 + Pr 50 = 200**	**Paper 1** Th 75, Pr 25	I (Th)	A	Introduction to Earth Systems Science	50	*60*
			B	Optical Mineralogy	15	*20*
			C	Crystallography	10	*15*
		II (Pr)	A	Mineral identification under microscope	15	*40*
			B	Crystallography	10	
				Total	100	*135*
	Paper 2 Th 75, Pr 25	I (Th)	A	Mineralogy –I	15	*25*
			B	Mineralogy – II	15	*20*
			C	Principles of Petrology	25	*25*
			D	Igneous Petrology –I	20	*25*
		II (Pr)	A	Mineral identification in hand specimen	10	*20*
			B	Identification of common rocks in hand specimen	15	*20*
				Total	100	*135*
PART – II (End of Year 2) **Th 100 + Pr 100 = 200**	**Paper 3** Th 50, Pr 50	I (Th)	A	Structural Geology -I	20	*30*
			B	Structural Geology -II	30	*45*
		II (Pr)	A	Structural Geology – I	15	*20*
			B	Structural Geology –II	35	*40*
				Total	100	*135*
	Paper 4 Th 50, Pr 50	I (Th)	A	Igneous Petrology –II	20	*25*
			B	Sedimentology - I	15	*20*
			C	Sedimentology – II	15	*20*
		II (Pr)	A	Study of igneous and sedimentary rocks under microscope	30	*40*
			B	Sedimentology	20	*30*
				Total	100	*135*
PART – III (End of Year 3, the Final Year) **Th 250 + Pr 150 = 400**	**Paper 5** Th 50, Pr 50	I (Th)	A	Palaeontology -I	30	*40*
			B	Palaeontology – II	20	*30*
		II (Pr)	A	Palaeontology – I	25	*40*
			B	Palaeontology – II	25	*35*
				Total	100	*145*
	Paper 6 Th 75, Pr 25	I (Th)	A	MetamorphicPetrology-I	20	*25*
			B	Metamorphic Petrology - II	15	*25*
			C	Global Tectonics	40	*45*
		II (Pr)	A	Study of Metamorphic rocks in thin section	25	*35*
				Total	100	*130*
	Paper 7 Th 50, Pr 50	I (Th)	A	Hydrogeology, Engineering Geology, and Environmental Geology	20	*30*
			B	Economic Geology	30	*35*
		II (Pr)	A	Chemical igneous Petrology and graphical presentation of Metamorphic mineral assemblages	20	*30*
			B	Field report and field note book	30	
				Total	100	*95*
	Paper 8 Th	I (Th)	A	Principles of stratigraphy	25	*35*
			B	Stratigraphy of India	50	*55*
		II (Pr)	A	General Viva Voce	25	
				Total	100	*90*
				TOTAL	**800** Marks	*1000 Hours*

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FIELD WORK: In three years (six semesters), there must be **three different field trips totaling at least 35 days of field work**. The recommended split up of days is:

Year 1: 10 days
Year 2: 15 days
Year 3: 10 days

Minimum number of required Exam-days:

Part	Theory day(s)	Practical day(s)	Total Days	Viva day(s)
1	2	2	**4**	
2	2	2	**4**	
3	4	2	**6**	**5**
Total	**8**	**6**	**14**	**5**

Subject-wise Distribution of Marks

	Subject		Theo	Prac	Theo Total	Prac Total	TOTAL
1	Introduction to Earth Systems Science		50	-	50	-	**50**
2	Mineralogy	I	15	10	30	10	**40**
		II	15	-			
3	Crystallography		10	10	10	10	**20**
4	Hand specimen rocks			15		15	**15**
5	Optical Mineralogy		15	15	15	15	**30**
6	Structural Geology	I	20	15	50	50	**100**
		II	30	35			
7	Global Tectonics		40	-	40	-	**40**
8	Principles of Petrology		25	-	25	-	**25**
9	Igneous Petrology including Chemical Petrology	I	20	25	40	25	**65**
		II	20				
10	Metamorphic Petrology Chemical Petrology	I	20	35	35	35	**70**
		II	15				
11	Sedimentology	I	15	35	30	35	**65**
		II	15				
12	Principles of Stratigraphy		25	-	25	-	**25**
13	Palaeontology	I	30	25	50	50	**100**
		II	20	25			
14	Stratigraphy of India		50	-	50	-	**50**
15	Economic Geology		30	-	30	-	**30**
16	Hydrogeology, Engineering Geology, and Environmental Geology		20	-	20	-	**20**
17	Field Work, Field report and Field note book		-	30	-	30	**30**
18	Viva Voce		-	25	-	25	**25**
	16+1+1 Subjects		500	300	500	300	**800**

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