GUJARAT UNIVERSITY

(Recognised by University Grants Commission)

SYLLABUS
(As per the guidelines of UGC)

SEMESTER V AND VI

C. B. C. S.
For Bachelor of Science (B. Sc.) Graduate Degree in

GEOLOGY
(EARTH SCIENCES)

(In force from June, 2013)

Three year – six semester studies leading to degree of
Bachelor in Science (B. Sc.)

Submitted by
Department of Geology
M. G. Science Institute
Navrangpura
Ahmedabad – 9.

May, 2013

GUJARAT UNIVERSITY

Design and Structure of Geology (Earth Sciences) UG semester V & VI Courses for Credit Based Semester System to be implemented from June 2013

Department	Semester	Course		No. of Hours per week				Course credits
		No.	Name	Lectures	Others	Practicals	Total	
Geology	**5** (V)	GEL301	Mineralogy; Crystallography.	3	1		4	4
		GEL302	Petrology – Igneous and Metamorphic.	3	1		4	4
		GEL303	Structural Geology; Sedimentary Petrology.	3	1		4	4
		GEL304	General & Standard Stratigraphy; Geology of Peninsular India.	3	1		4	4
		GEL305 (CSE)	Hydrogeology; Engineering Geology.	3			3	2
		GEL306 PR - 1	Mega/Micro Minerals crystallography; crystal projections.			6	6	2 1/2
		GEL306 PR - 2	Structural – Maps (with Unconformity, Overlap and Fault), simple Geometrical exercise, simple Out Crop Filling Problems.			6	6	2 1/2
			Total	**15**	**4**	**12**	**31**	**23**
	6 (VI)	GEL307	Economic Geology.	3	1		4	4
		GEL308	Geology of Extra Peninsular India.	3	1		4	4
		GEL309	Palaeontology.	3	1		4	4
		GEL310	Applied Geology.	3	1		4	4
		GEL311 (CSE)	Remote sensing and GIS, Mining Geology.	3			3	2
		GEL312 PR – 1	Optics; Mega/Micro Rocks; Palaeontology, Blow Pipe analysis; Aerial Photo interpretation.			6	6	2 1/2
		GEL312 PR – 2	Structural – Maps (with Folding), 3 - point problems, Out crop Filling problems with fault.			6	6	2 1/2
			Total	**15**	**4**	**12**	**31**	**23**

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Semester V

GEOLOGY - THEORY and PRACTICALS

Course Outline

Course	Details
GEL301	Mineralogy; Crystallography.
GEL302	Petrology – Igneous and Metamorphic.
GEL303	Structural Geology; Sedimentary Petrology.
GEL304	General and Standard Stratigraphy; Geology of Peninsular India.
GEL305 (CSE) (Core Subject Elective)	Hydrogeology; Engineering Geology.
GEL306PR - 1	Megascopic and Microscopic identification of Minerals; Crystallography, Crystal Projections.
GEL306PR - 2	Structural – Maps (with Unconformity, Overlap and Fault), Simple Geometrical exercise, Simple Out Crop Filling Problems.

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Semester V

GEOLOGY - THEORY and PRACTICALS

Course-wise detail syllabus

GEL 301: Mineralogy; Crystallography:

Unit	Course details	Credits
Unit –1	**Mineralogy** Structure of silicate minerals, Study of Rock forming minerals, chemical classification of minerals and study of chief mineral families – Silica, Feldspar, Feldspathoid, Mica.	**1**
Unit –2	**Mineralogy (Conti.)** Study of chief mineral families – Amphibole, Pyroxene, Olivine, Garnet, Zeolite, Aluminosilicate, Epidote, Zoisite.	**1**
Unit - 3	**Optical Mineralogy** Detail study of optical properties - Extinction, Interference colours, Order of interference colours – their controlling factors. Uniaxial and Biaxial interference figures and optic sign determination – microscopic accessories.	**1**
Unit - 4	**Crystallography** Crystallography – Hexagonal (Tourmaline and Quartz types), Monoclinic and Triclinic crystal systems – their detailed study. Twinning in crystals.	**1**

REFERENCE BOOKS:

Read, H.H. (1960): Rutley's Elements of Mineralogy (26th Edition). CBS Publishers and Distributers.

Kerr, P.F. (1977): Optical Mineralogy. Mc Graw Hills Inc

Winchel, N.H.; Winchel, A.N. (1968): Elements of Optical Mineralogy. Willey Eastern Ltd. Delhi.

GEL 302: Petrology: Igneous and Metamorphic:

Unit	Course details	Credits
Unit –1	**Igneous Petrology** Magma - Types, origin and composition. Pyrogenetic minerals – Ortho-, meta- and poly silicates. Saturated – Undersaturated minerals. Crystallisation of Unicomponent and bicomponent magma with influencing factors and appropriate examples. Bowen reaction series.	**1**
Unit –2	**Igneous Petrology (Conti.)** Textures of igneous rocks. Classification – mineralogical, chemical, textural and Hatch scheme. Basic principles of thermodynamics. Phase equilibrium in two and three component silicate system.	**1**
Unit - 3	**Metamorphic Petrology** Types of metamorphism – Thermal, Dynamothermal, Cataclastic and Plutonic.	**1**
Unit - 4	**Metamorphic Petrology (Conti.)** Metamorphic structures and Textures. Classification of metamorphic rocks. Outlines of zones, facies and phase diagrams of metamorphism. Facies series and isograde. Relationship between metamorphism and deformation. Equilibrium and non-equilibrium reactions in metamorphic processes. Composition-paragenetic diagrams. Projective analysis.	**1**

REFERENCE BOOKS:

Bose, M.K. (1997): Igneous Petrology. World Press.

Tyrell, G.W. (1960): The Principles of Petrology. Asia Publishing House.

Bhaskar Rao, B.C. (1986): Metamorphic Petrology. Oxford and IBH Publishers, New Delhi.

Moorhouse, W.W. (1964): The Study of Rocks in Thin Sections. Harper and Row.

GEL 303: Structural Geology; Sedimentary Petrology:

Unit	Course details	Credits
Unit –1	**Structural Geology** Causes, Mechanism, Classification and types of Faults and Joints.	**1**
Unit –2	**Structural Geology (Conti.)** Causes, Mechanism, Classification and types of Folds. Structural concepts of main mountain ranges – Himalaya and Aravalli. Order of superposition in the field.	**1**
Unit - 3	**Sedimentary Petrology** Genesis, classification and Types of sedimentary deposits – Residual, Detrital, Chemical and organic. Sedimentary structures.	**1**
Unit - 4	**Sedimentary Petrology (Conti.)** Diagenesis of terrigenous and chemical sediments. Dynamics of aeolian, fluvial, near-shore and deep-sea environments. Concept of sedimentary facies. Basic principles of palaeoenvironment and palaeoclimate analysis.	**1**

REFERENCE BOOKS:

Billings, M.P. (1977): Structural Geology. Prentice Hall.

Hobbs, B.E.; Means, W.E. and Williams, P.F. (1957): An Outline of Structural Geology.

Tyrell, G.W. (1960): The Principles of Petrology. Asia Publishing House.

Blatt, H. (1982): Sedimentary Petrology. Freeman & Company.

Nichols, G. (1999): Sedimentology and Stratigraphy. Blackwell.

Reading, H.G. (1996): Sedimentary Environments. Blackwell.

Pettijohn, F.J.; Potter, P.E. and Siever, R. (1990): Sand and Sandstone. Springer Verlag.

Sengupta, S. (1997): Introduction to Sedimentology. Oxford & IBH Publishing Company.

Bhattacharya, A. & Chakraborti, C. (2000): Analysis of Sedimentary Successions. Oxford & IBH Publishers. New Delhi.

Moorhouse, W.W. (1964): The Study of Rocks in Thin Sections. Harper and Row.

GEL 304: General and Standard Stratigraphy; Indian Stratigraphy (Peninsular):

Unit	Course details	Credits
Unit –1	**General Stratigraphy** Facies concept in stratigraphy, Index fossils, Concept of Palaeogeography, Igneous phenomena, Tectonic phenomena, Rock Suites and petrographic provinces. Geological Time, Geological eras and their sub-divisions.	**1**
Unit –2	**Standard Stratigraphy** Stratigraphical eras and their sub-divisions – Outlines of Standard Stratigraphy and their general study. (Emphasis to be given on Palaeogeography and life forms of the time). Correlation of the major Indian formations with their world equivalents.	**1**
Unit - 3	**Indian Stratigraphy (Peninsular)** Detail study of fundamental complex- Archaean-Dharwar, Cuddapah and Vindyan Super Groups.	**1**
Unit - 4	**Indian Stratigraphy (Conti.)** Detail study of Post Archaean formations of Peninsular India - Gondwana Super Group, Mesozoic, Deccan Trap and Tertiary of Peninsula.	**1**

REFERENCE BOOKS:

Wadia, D.N. (1962): Geology of India. Tata Mc Graw Hill.

Krishnan, M.S. (1968): Geology of India and Burma. Higgin Bothams.

Ravindra Kumar (1982): Fundamentals of Historical Geology and Stratigraphy of India. Willey Eastern Ltd.

Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India. Oxford University Press.

Pascoe, E.H. (1968): A Manual of Geology of India and Burma. Vol. I-IV. Govt. of India Press.

GEL 305 (CSE): Hydrogeology; Engineering Geology:

Unit	Course details	Credits
Unit –1	**Hydrogeology** Hydrological properties of rocks - porosity, permeability, specific yield. Subsurface classification of ground water. Classification of aquifers. Darcy's law and its validity.	**1**
Unit –2	**Hydrogeology (Conti.)** Concept of watershed management. Elementary knowledge of use of Aerial photographs and remote sensing techniques in hydrogeology.	**1**
Unit - 3	**Engineering Geology** Important building stones of India. Foundations.	**1**
Unit - 4	**Engineering Geology (Conti.)** Geology of Reservoirs and Dam sites.	**1**

REFERENCE BOOKS:

Karanth, K.R. (1989): Hydrogeology. Tata Mc Graw Hill.

Karanth, K.R. (1987): Groundwater Assessment – Development and Management. Tata Mc Graw Hill.

Davis, Stanley N. and Dewiest Roger, J.M. (1966): Hydrogeology. John Willey & Sons, Inc.

Raghunath, H.M. (1987): Ground Water. Willey Eastern Ltd.

Subramaniam, V. (2000): Water. Kingston Publishers. London.

Mahajan, Gautam (1989): Evaluation and Groundwater. Ashish Publishing House.

Todd, D.K. (1980): Groundwater Hydrology. John Wiley.

Tallman, C.E. (1937): Ground Water. Mc Graw Hill.

Schultz, J.R. and Cleaves, A.B. (1955): Geology in Engineering. John Willey.

Singh, P. (1985): Principles of Engineering Geology.

GEL 306 PR – I: Megascopic and Microscopic Identification of Minerals; Crystallography; Crystal Projections Lab.:

Course details	Credits
Mineralogy Megascopic study of metallic and non-metallic minerals representing important mineral families: Leucite, Nepheline, Sodalite, Scapolite, Enstatite, Hypersthene, Bronzite, Wollastonite, Tremolite, Actinolite, Glaucophane, Serpentine, Andalusite, Sillimanite, Kyanite, Topaz, Staurolite, Sphene, Epidote, Analcime, Stilbite, Apophyllite, Kaolin, Aragonite. **ORES:** Stibnite, Rutile, Psilomelane, Cassiterite, Corundum, Franklinite, Willemite, wolframite, Azurite. Study of the following minerals in thin sections: Chlorite, Staurolite, Kyanite, Sillimanite, Andalusite, Enstatite, Bronzite, Tremolite, Diopside, Nepheline, Leucite, Hauyne, Nosean.	**2**
Crystallography Study of crystal models representing Four types (Tourmaline and Quartz of Hexagonal system, Gypsum of Monolinic and Axinite of Triclinic system) with diagrams. Study of twin crystals with diagrams. **Crystal Projection:** Clinographic projections of simple crystals of Cubic, Tetragonal and Orthorhombic systems. Representation of elements of symmetry of four types of symmetry with stereographic projections.	**2**

GEL 306 PR – II : Structural Geology Lab.:

Course details	Credits
Section and description of geological maps with structural features such as unconformity, overlap, faulting, inliers, outliers and igneous intrusions. Outcrop problems with one series of strata with inlier, outlier. Graphic solutions of structural problems. Viva Voce.	**2**

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Semester VI

GEOLOGY - THEORY and PRACTICALS

Course Outline

Course	Details
GEL307	Economic Geology.
GEL308	Geology of Extra Peninsular India.
GEL309	Palaeontology.
GEL310	Applied Geology.
GEL311 (CSE) (Core Subject Elective)	Remote sensing and GIS; Mining Geology.
GEL312PR – 1	Optics; Megascopic and Microscopic identification of Rocks; Palaeontology; Blow Pipe analysis; Aerial Photo interpretation.
GEL312PR – 2	Structural – Maps (with Folding), 3 -point Geometrical problems, Out crop Filling problems with fault.

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Semester VI

GEOLOGY - THEORY and PRACTICALS

Course-wise detail syllabus

GEL 307: Economic Geology:

Unit	Course details	Credits
Unit –1	**Definitions and introduction of Economic Geology** Historical development of economic geology. Definition of Mineral, Ore, Gangue, and Mineral deposits. Various aspects of mineral exploitation. Methods of mineral exploration, exploitation and processing. Classification of mineral deposits – Outlines of Bateman's and Lindgren's classification. **Metamorphic processes** Metamorphic deposits - Asbestos, Talc, Graphite, Kyanite – Sillimanite – Andalusite deposits with examples from India and other countries.	**1**
Unit –2	**Igneous processes** Processes of mineral formations with examples from India and world - Magmatic, Hydrothermal, Pneumatolytic, Metasomatic Replacement and Cavity Filling Deposits.	**1**
Unit - 3	**Sedimentary processes** Weathering processes – Residual : Bauxite, Iron, Manganese, Clay, Nickel, Barites, etc. Mechanical Concentrations : Placer Deposits: Stream, Beach, Alluvial and Aeolian. Oxidation and Secondary enrichment with necessary chemical reactions involved. Process of Sedimentation – source material, solution, transportation and deposition. Conditions of deposition of – Iron ores, Manganese ores, Sulphur, Carbonates, Clays, Coal and Petroleum.	**1**

	Evaporation deposits – Gypsum, Sodium chloride and Potash deposits.	
Unit - 4	**Economic Minerals** Study of the following economically important minerals with reference to India in particular and with world in general: Gold, Base metals, Ilmenite, Barite, Magnesite. Brief study of the following minerals - Pneumatolytic minerals; Minerals used for refractory; abrasives; atomic minerals; gemstones and minerals utilized in chemical industries.	**1**

REFERENCE BOOKS:

Craig, J.M. and Vaughan, D.J. (1981): Ore Petrography and Minerology. John Willey.

Sawkins, F.J. (1984): Metal Deposits in relation to Plate Tectonics. Springer Verlag.

Chandra, D.; Singh, R.M. and Singh, M.P. (2000): Textbook of Coal (Indian Context). Tara Book Agency. Varanasi.

Bateman, A.M. (1959): Economic Mineral Deposits. Asia Publishing House.

Gokhale, K.V.G.R. and Rao, T.C. (1972): Ore Deposits of India. Thompson Press.

Krishnaswamy, S. (1979): Indian Mineral Resources. Oxford & IBH Publishers.

Sinha, R.K. and Sharma, N.L. (1981): Mineral Economics. Oxford & IBH Publishers.

Banerjee, D.K. (1992): Mineral Resources of India. The World Press Pvt. Ltd.

GEL 308: Indian Stratigraphy (Extra Peninsula):

Unit	Course details	Credits
Unit - 1	**Indian Stratigraphy – ExtraPeninsula** Study of Archaeans, Proterozoics and Palaeozoic formations of Extra Peninsular India.	1
Unit - 2	**Indian Stratigraphy – ExtraPeninsula (Conti.)** Study of Mesozoic and Cenozoic formations of Extra Peninsular India. Nature, origin and geology of Indo-Gangetic Plains and their economic importance.	**1**
Unit –3	**Important Features of Indian Stratigraphy** Nature, origin and geology of Rajasthan desert and Runn of Kutch and their economic importance. Geology of Gujarat and associated mineral wealth.	**1**
Unit –4	**Indian Stratigraphy - General** History of Geology of India, Major thrust Area of research. Important stratigraphic sections of different formations in India. Type areas of important formations.	**1**

REFERENCE BOOKS:

Wadia, D.N. (1962): Geology of India. Tata Mc Graw Hill.

Krishnan, M.S. (1968): Geology of India and Burma. Higgin Bothams.

Ravindra Kumar (1982): Fundamentals of Historical Geology and Stratigraphy of India. Willey Eastern Ltd.

Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India. Oxford University Press.

Pascoe, E.H. (1968): A Manual of Geology of India and Burma. Vol. I-IV. Govt. of India Press.

GEL 309: Palaeontology:

Unit	Course details	Credits
Unit –1	**Invertebrate Palaeontology** Study of phyla - Protozoa, Cnidaria, Hemichordata.	**1**
Unit –2	**Invertebrate Palaeontology** Study of Phyla - Arthropoda, Echinodermata, Brachiopoda.	**1**
Unit - 3	**Invertebrate Palaeontology** Study of Phyllum - Mollusca.	**1**
Unit - 4	**Micropalaeontology** Basic ideas about micropalaeontology and microfossils. Taxonomic categories and codes of systematic nomenclature. Vertebrate Palaeontology: Introduction, Major types, evolutionary trend and distribution. **Palaeoecology -** Outlines of Palaeoecology. Concepts of natural ecosystems on the earth and their mutual interrelations and interactions (atmosphere, hydrosphere, lithosphere and biosphere). **Palaeobotany:** Outlines of palaeobotany**.**	**1**

REFERENCE BOOKS:

Wood, H. (1982): An Introduction to Invertebrate Palaeontology.

Shrock and Twenhofel: Principles of Invertebrate Palaeontology.

Cambridge University Press.

Davies, A.M. (1972): An introduction to Palaeontology. Thomas Murby & Company.

Clarkson, E.N.K. (1998): Invertebrate Palaeontology and Evolution. IV Edition. Blackwell.

Benton, M.J. (1990): Vertebrate Palaeontology and Evolution. Unwin Hyman.

Arnold, C.A. (1947): An Introduction to Palaeobotany. Mc Graw Hill.

Haq, B.V. and Boersma, A. (1998): Introduction to Marine Micropalaeontology, Elsevier.

GEL 310: Applied Geology:

Unit	Course details	Credits
Unit –1	**Applied Geology** Toposheets, Geological maps and reports. Methods of Prospecting. Methods of geological and geophysical prospecting and their applications – Magnetic, Gravity, Seismic and Electrical methods. Geobotanical and geochemical methods of exploration. Field techniques – Use of Clinometer Compass, Brunton Compass, Methods of Sampling. Introduction to geological mapping and report writing.	**1**
Unit –2	**Environmental Geology** Concept and definition of environmental geology. Earth processes and Geological hazards - Causes and remedies of natural and man-made geohazards. Environmental implication of floods, landslides, earthquakes, volcanism and avalanche.	**1**
Unit - 3	**Geomorphology and Neotectonics** A general outline of geomorphology – topography and its relation to structures and lithology. Major landforms. Drainage systems. Geomorphic features of India. Active faults - geomorphological indicators - drainage changes, recurrent seismisity.	**1**
Unit - 4	**Global Tectonics** Introduction to Palaeomagnetism, sea floor spreading and Mid Oceanic Ridges.	**1**

REFERENCE BOOKS:

Sharma, P.V. (1986): Geophysical Methods in Geology. Elsevier.

Dobrin, M.B. (1976): Introduction to Geophysical Prospecting. Mc Graw Hill.

Ramchandra Rao, M.B. (1993): Outlines of Geophysical Prospecting – A Manual for Geologists. EBD Educational Pvt. Ltd. Dehradun.

Lahee, F.H. (1961): Field Geology. Mc Graw Hill.

Compton, R.R. (1962): Manual of Field Geology.

Valdiya, K.S. (1987): Environmental Geology – Indian Context. Tata Mc Graw Hill.

Subramaniam, V. (2001): Textbook in Environmental Science. Narosa International.

Thornbury, W.D. (1969): Principles of Geomorphology. John Willey Inc.

Holmes, A. (1978): Principles of Physical Geology. The English Language Book Society.

Patwardhan, A.M. (1999): The Dynamic Earth System. Prentice Hall.

GEL 311(CSE): Remote Sensing and GIS, Mining Geology:

Unit	Course details	Credits
Unit –1	**Remote Sensing** Introduction to Remote Sensing: History and concepts - Advantages of Remote Sensing over conventional surveys - Aerial versus Satellite Remote Sensing. Electromagnetic Radiation: Physics of Remote Sensing - Energy Sources – Radiation.	**1**
Unit –2	**Geographic Information System** Introduction to GIS: Meaning and Usefulness of GIS - Components of GIS. Computer Hardware, Software Modules and Organisational Context of GIS.	**1**
Unit - 3	**Mining Geology** Terminology of Mines, Types of mining methods. Prospecting for economic minerals - drilling, sampling and assaying.	**1**
Unit - 4	**Surveying** Borehole logging and deviation testing. Elements of surveying – use of prismatic compass, altimeter and plane table.	**1**

REFERENCE BOOKS:

Sabbins, F.F. (1985): Remote Sensing – Principles and Applications. Freeman.

Pandey, S.N. (1987): Principles and Applications of Photogeology. John Willey.

McKinstry, H.E. (1962): Mining Geology. II Edition. Asia Publishing House.

Clark, G.B. (1967): Elements of Mining. III Edition. John Wiley.

Arogyaswami, R.P.N. (1996): Courses in Mining Geology. IV Edition. Oxford & IBH Publisher.

GEL 312 PR – I: Optics, Megascopic and Microscopic Rocks, Palaeontology Lab.:

Course details	Credits
Uniaxial and Biaxial interference figures, Optic sign determination. Megascopic identification of the following rock specimens: Anorthosite, Pyroxenite, Dunite, Eclogite, Dolerite, Pitchstone, Andesite, Breccia, Grit, Oolitic and Pisolitic limestone, Phyllite, Schist-different varieties, Granulite, Peat, Lignite, Bituminous, Anthracite, China clay, Fire clay, Laterite. Identification of typical rocks in thin sections: Tourmaline granite, Hypersthene granite, Diorite, Picrite, Dolerite, Andesite, Limburgite, Sillimanite garnet gneiss, Andalusite schist, Actinolite schist.	**2**
PALAEONTOLOGY: Study of invertebrate and plant fossil specimen representing important phyla belonging to different geological eras - with diagrams. Blow Pipe analysis; Aerial Photo interpretation.	**2**

GEL 312 PR – II Structural Geology Lab.:

Course details	Credits
Section and description of geological maps with structural features such as unconformity, overlap, faulting, inliers, outliers and igneous intrusions and ***FOLDS***. Outcrop problems with one series of strata with inlier, outlier and ***FAULTS***. Graphic solutions of 3 – POINT structural problems.	**2**

Field work:

Course details	Credits
Geological field work in any suitable area and submission of Field Report. Viva voce.	**2**