COURSE OF STUDIES

FOR POST GRADUATE DEGREE IN GEOLOGY

(SEMESTER SYSTEM)

FOR THE ACADEMIC SESSION 2023-24

POST GRADUATE DEPARTMENT OF GEOLOGY

D Behera 26/7/23

26.07.23

S S Mishra 26.7.23

GOVERNMENT AUTONOMOUS COLLEGE ROURKELA

Courses of Studies for M. Sc. Examination in Geology
(From the academic session 2023-24 onwards till further revision)
M. Sc.Geology
(CBCS-Semester System)

Semester	Paper	Course Title	Credits	Marks		
				Mid Sem.	End Sem.	Total
I	AECC-I	Entrepreneurship and Development	2	20+20(assignment)	60	100
	101	General Geology and Geodynamics	4	20	80	100
	102	Structural Geology	4	20	80	100
	103	Crystallography and Mineralogy	4	20	80	100
	104	Geomorphology and Remote Sensing	4	20	80	100
	105	Practical corresponding to (P-101 & P-102)	2	--	50	50
	106	Practical corresponding to (P-103 & P-104)	2	--	50	50
	Total Credit /Marks for First Semester		22			600
II	AECC-II	Environmental Studies And Disaster Management	2	20+20(assignment)	60	100
	201	Igneous Petrology	4	20	80	100
	202	Sedimentary Petrology and Metamorphic Petrology	4	20	80	100
	203	Geo-statistics and Computer Application	4	20	80	100
	204	Seminar & Field Report	4	20	80	100
	205	Practical (corresponding to P- 201 & P- 202)	2	--	50	50
	206	Practical (corresponding to P- 203) & Report on Geological Mapping	2	--	50	50
	Total Credit /Marks for Second Semester		22			600
III	IDC	General Geology (common for other departments)	3	20+20(assignment)	60	100
	301	Paleontology	4	20	80	100
	302	Stratigraphy	4	20	80	100
	303	Geochemistry, Theories of Mineral Formation and MineralExploration	4	20	80	100
	304	Metallic Minerals/ Ores and Industrial Minerals	4	20	80	100
	305	Practical (corresponding to P- 301 & P-302)	2	--	50	50
	306	Practical (corresponding to P- 303 & P- 304)	2	--	50	50
	307	MOOCs one paper from Swayam or others	3	-	-	-
	Total Credit /Marks for Third Semester		26			600
IV	401	Hydrogeology and Engineering Geology	4	20	80	100
	402	Fossil Fuels, Nuclear Minerals, Mineral Economics	4	20	80	100
	403	Elective	4	20	80	100
	404	Project (Project Work (50)+ Viva (30)+ Presentation(20))	4	50+30+20		100
	405	Practical (corresponding to P- 401 & P- 402)	2	--	50	50
	406	Practical (corresponding to P- 403) & Field report	2	20	50	50
	Total Credit /Marks for Fourth Semester		20			500
	Total Credit		90			2300
One Non-credit course will be taken by the students during the 2 year of study NCC/NSS/Sports/Yoga/Gardening/ Socially Useful Productive Work (SUPW)						

IDC – Inter Department Course or Open Elective

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M. Sc. Geology
(CBCS-Semester System)

Semester - I		Credit Hour	Mark
AECC-1	Entrepreneurship and Development	2 CH	20 + 20 (Assignment) + 60
P- 101	General Geology and Geodynamics	4 CH	100
P- 102	Structural Geology	4 CH	100
P- 103	Crystallography and Mineralogy	4 CH	100
P- 104	Geomorphology and Remote Sensing	4 CH	100
P- 105	Practical corresponding to (P-101 & P-102)	2 CH	50
P- 106	Practical corresponding to (P-103 & P-104)	2 CH	50
	Total Credit / Marks	**22 CH**	600
Semester - II			
AECC - II	Environmental Studies and Disaster Management	2 CH	Midterm 20 + 20 (Assignment) + final 60 = 100
P-201	Igneous Petrology	4 CH	100
P- 202	Sedimentary Petrology and Metamorphic Petrology	4 CH	100
P- 203	Geo-statistics and Computer Application	4 CH	100
P- 204	Seminar & Field Report	4 CH	100
P- 205	Practical (corresponding to P- 201 & P- 202)	2 CH	50
P- 206	Practical (corresponding to P- 203) & Report on Geological Mapping	2 CH	50
	Total Credit / Marks	**22 CH**	600

Semester - III			
IDC	General Geology (common for other departments)	3 CH	20+ 20 (Assignment) + 60
P- 301	Paleontology	4 CH	100
P- 302	Stratigraphy	4 CH	100
P- 303	Geochemistry, Theories of Mineral Formation and Mineral Exploration	4 CH	100
P- 304	Metallic Minerals/ Ores and Industrial Minerals	4 CH	100
P- 305	Practical (corresponding to P- 301 & P-302)	2 CH	50
P- 306	Practical (corresponding to P- 303 & P- 304)	2 CH	50
P-307	MOOCs one paper from Swayam or others	3 CH	
	Total Credit / Marks	**26 CH**	600
Semester IV			
P- 401	Hydrogeology and Engineering Geology	4 CH	100
P- 402	Fossil Fuels, Nuclear Minerals, Mineral Economics	4 CH	100
P- 403	Elective	4 CH	100
P- 404	Project	4CH	100
P- 405	Practical (corresponding to P- 401 & P- 402)	2CH	50
P- 406	Practical (corresponding to P- 403) & Field report	2CH	50
	Total Credit / Marks	**20CH**	500
	Total Credit	**90**	2300

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Semester - I	16 CH Theory	4 CH Practical	No Seminar	20 CH
Semester - II	12 CH Theory	4 CH Practical	4 CH Seminar& Field Report	20 CH
Semester - III	16 CH Theory	4 CH Practical	No Seminar	20CH
Semester - IV	12 CH Theory	4 CH Practical	4 CH Project	20 CH
			Grand total	**80 CH**

Common Theory Course	AECC-I, IDC & AECC-II	**7CH**
MOOC	Available for Second / Third Semester	**3CH**
Grand Total		**90CH**
Furthermore the following non-credit courses will be taken up by the student		
1.Yuva-Sanskar, 2. NCC/NSS/Sports/Yoga(of which any one to be opted)		

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Semester-I

P- 101 (4CH)

Objectives of the course:

General geology gives an idea about endogenetic process operating inside the earth and its resultant land forms. The idea of different processes operates on earth and their external manifestations are covered in geotectonics aspect.

Expected outcome:

The said courses will make the students to understand about crystal chemistry and the interior of earth. They shall have the knowledge of the mechanism of formation of continents, sea and mountain ranges.

a) General Geology

General characteristics of solar system, origin of earth (cataclastic and evolutionary hypothesis; seismic waves, interior of the earth (historical perspective, crust, mantle and core; concept of lithosphere, asthenosphere and mesosphere), discontinuities and its classification, shadow zone, Earth quake (cause, types), vulnerability of Odisha to earth quake, Hypothesis of Isostasy (Pratt's hypothesis, Airy's hypothesis, Heiskanen hypothesis)

b) Geodynamics

Earth and its internal structure. Continental drift – geological and geophysical evidence and objections. An overview of plate tectonics including elementary concepts of plates, lithosphere, asthenosphere, types of plate boundaries and associated important geological features like oceanic trenches, volcanic arcs, accretionary wedges, topography of mid-ocean ridges, magnetic anomaly stripes and transform faults. Gravity anomalies at mid-ocean ridges, deep sea trenches, continental shield areas and mountain chains. Palaeomagnetism and its application for determining palaeoposition of continents.

Books Recommended:

1. Beloussov, V. V. (1974) Basic Problems in Geotectonic, McGraw-Hill Book Company page no. 1-312.
2. Valdiya, K. S. (1985) Aspects of Tectonics, McGraw-Hill Education page no. 1-304.
3. Condie, K. C. (1989) Plate tectonics and Crustal development, Pergamon; 3 edition, page no. 1-504.

P- 102 (4CH)

Objectives of the course: In these units, the students can know the characteristic properties, origin and types of various structural features found in rocks.

Expected outcome:

The above knowledge will enable the students to study the history of deformation, deformational aspects and their relevance in rocks to quantify generation of force pictures.

Structural Geology

Principle of geological mapping and map reading, projection diagrams. Stress-strain relationships for elastic, plastic and viscous materials. Measurement of strain in deformed rocks. Behaviour of minerals and rocks under deformation conditions. Structural analysis of folds, cleavages, lineations, joints and faults. Superposed deformation. Mechanism of folding, faulting and progressive deformation. Shear Zones: Brittle and ductile shear zones, geometry and products of shear zones; Mylonites and cataclasites, their origin and significance.Time relationship between crystallization and deformation. Unconformities and basement-cover relations. Introduction to petrofabric analysis.

Books Recommended:

1. Billings, M. P. (1972) Structural Geology, Pearson College Div; 3 editionspage no. 1-606.
2. Ghosh, S. K. (1993) Structural Geology, Pergamon, page no. 1-598.
3. Park, R. G. (1989) Fundamentals of Structural Geology, Chapman & Hall; 2nd editionpage no. 1-148.
4. Davis, G. H. and Reynolds, S. J. (1997) Geology of Rocks and Regions, 2nd (second)Edition Wiley, John & Sons page no. 1-669.

P- 103 (4CH)

Objectives of the course: The aim of this course is to study the crystals through external elements of symmetry, crystal classes and systems, and the relations of symmetry to the internal structure using the chemical and physical properties of the minerals. The course aims also to study the major mineral groups, their occurrences, physical, chemical and crystallographic properties and their possible uses in industry. Apart from them, the physical, chemical and optical properties of the minerals are described. One should know them to identify the types of rocks.

Expected outcome:

The students will be equipped with the knowledge of identifying different crystals and minerals with their possible varieties and their occurrence in different types of rocks as a combining unit.

a) Crystallography

Symmetry and symmetry elements, Miller Indices, zonal relations, lattice network. Bravaies lattices; Twin crystals and laws of twining, types of twining in crystal systems; crystal projections, X-ray study of crystals by different methods

b) Mineralogy

Silicate structure, Study of important silicate groups:Isomorphism and Polymorphism; Olivine, Pyroxene, Amphibole, Feldspar, Silica, Garnet, Alumino- silicates, Mica, Feldspathoids and Clay minerals. Study of oxides, sulphides, sulphates, phosphates, carbonates, halides and native elements. Properties of light- reflection, refraction, total internal reflection and double refraction. Nicol Prism.Polarisation of light. Refractive index and its measurement; Birefringence; Extinction angle- types and their determination. Interference colour, Pleochroism, Use of accessory plates; Uniaxial and biaxial Optical indicatrix, Study of anisotropic minerals under microscope orthoscopic (polarized) and conoscopic (convergent light) set-up.

Books recommended:

1. Phillips, F. C. (1977) An Introduction to Crystallography, Longman Higher Education, pageno. 1-295.
2. Dana, E. S. (2006) A Text Book of Mineralogy, CBS Publishers & Distributors; 4th edition,page no. 1-156.
3. Rutley, (2005) Elements of Mineralogy, CBS; 27th edition page no. 1-482.
4. Barry and Mason. (1958) Elements of Mineralogy, W.H. Freeman & Co Ltd; 1st editionpage no. 1-630
5. Deer, W. A., Howaie. R. A. and Zusmann, (2013) Rock forming Minerals, MineralogicalSociety of Great Britain and Ireland; Third edition, page no. 1-498.
6. Kerr, P. F. (1977) Optical Mineralogy, McGraw-Hill College; 4 edition, page no. 1-492.
7. Mitra, S. (1989) Fundamentals of optical, spectroscopic and X-ray mineralogy, Wiley-Blackwell, page no. 1-236.

P- 104 (4CH)

Objectives of the course:

In this unit, different types of earth features and their causative geological agents have been described. The students can analyse the type of agents that has shapes a particular zone of the earthsurface.

Expected outcome:

In this unit, the students are introduced with the concepts of statistics and satellite data. While statistics is a part and parcel of every science subject, remote sensing has become very helpful for resolving so many geological problems.

a. Geomorphology

Geomorphic principles and processes; Concept of weathering and erosion cycle; Concept of fluvial, Aeolian and glacial processes; Drainage pattern and drainage analysis; River basins in India; Methods of analysis of landform; Major geomorphological divisions of India, Tectonic geomorphology.

b. Remote Sensing

Aerial photography, Types of aerial photographs. Characteristic features of aerial photography- scale, overlap, side lap, vertical-exaggeration etc. Photo/image features - form, shape, texture, tone, drainage pattern etc., Stereoscopic perception, Conditions for stereoscopic vision. Advantages of Remote sensing data products (satellite images and aerial photographs). Uses of Remote sensing data products in different branches of geology.

Books Recommended:

1. Thurnbury, W. D. (2004) Principles of Geomorphology, CBS; 2 edition Page no. 1-213.
2. Majid Husain, (2010) Fundamentals of Physical Geography, Rawat Publication, Page no. 1-784.
3. Strahler, A. (2010) Physical Geography, Wiley; 5 edition Page no. 1-656.
4. Lillesand, M., Thomas and Ralph., Kiefer, W. (2007) Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
5. Jensen, R., John, (2006) Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education Pvt. Ltd., Delhi, page no. 1-736.

P- 105 (2 CH)

(Practical Corresponding to Course No. P- 101 and P- 102)

Practical Corresponding to Course GEOL 423 and Report on geological mapping.

Topographic map study, Measurement of attitude of planar and linear structures, Profile and cross section. from given geological map. Outcrop completion, Three-point problem, Geometric and trigonometric methods of calculation of orientation and thickness of beds, Equal area projection of planar and linear structural data. Two-dimensional strain analysis from the supplied specimen and data.

P- 106 (2 CH)

(Practical Corresponding to Course No. P- 103 and P- 104)

Study of symmetry elements and identification of crystal models of 32 classes, Stereographic projections, Determination of axial ratio and face symbol.

Megascopic and microscopic identification of minerals; Determination of specific gravity.

Determination of extinction angle, sign of elongation, optical sign and order of interference colours, pleochroic schemes.

Drainage maps and drainage analysis. Study of toposheets, geomorphic models. Visual interpretation of aerial photographs and satellite imageries.

AECC- I (2 CH) - Environmental Studies & Disaster Management

Semester-II

P- 201(4CH)

Objectives of the course:

In these units, the students can know the characteristic properties of initial rocks (those formed from molten material) as well as their origin and types.

Expected outcome:

The students shall have the potential to know the mechanism of formation of different types of igneous rocks. They will be in a position to classify the igneous rocks basing on various parameters.

Igneous Petrology -

Origin of magma, Phase equilibrium in igneous systems: Binary and ternary systems. Bowen's reaction principle: Reaction series and its application to petrogenesis. Magmatic evolution and differentiation: Fractional crystallization, gravitational differentiation, gas streaming, liquid immiscibility and assimilation. Structures and textures: Definition, description, rock examples and genetic implications of common structures and textures of igneous rocks. Classification of igneous rocks: Mode, CIPW norm, IUGS and other standard classifications; Magmatism and tectonics: Inter-relationship between tectonic settings and igneous rock suites. Igneous rock suites: Form, structure, texture, modal mineralogy, petrogenesis and distribution of Ultramafic rocks: Dunite-peridotite-pyroxenite suite; kimberlites, lamprophyres, lamproites, komatiites; Basic rocks: Gabbro-norite-anorthosite-troctolite suite, Dolerites; Basalts and related rocks; Intermediate rocks: Diorite-monzonite-syenite suite; Andesites and related rocks; Acidic rocks: Granite-syenite-granodiorite-tonalite suite; Rhyolites and related rocks; Alkaline rocks: Shonkinite, ijolite, urtite, melteigite, malignite, alkali gabbros, alkali basalt, alkali granite, alkali syenite, nepheline syenite and phonolite; Carbonatites; Ophiolite suite.

Books Recommended:

1. Turner, F. J. and Verhogen (2002) Igneous and Metamorphic Petrology, CBS; 2 edition page no. 1-185.
2. Best. (2002) Igneous and Metamorphic Petrology, Wiley-Blackwell; 2 edition, page no. 1-752.
3. Mc Birney, A. R. (2006) Igneous Petrology Jones & Bartlett Learning; 3 edition, page no. 1-550.
4. Hall, A. (1996) Igneous Petrology, Prentice Hall; 2 edition page no. 1-568.
5. Gupta, A. K. (2007) Igneous Rocks, Narosa Pub House page no. 1-450.
6. Tyrell, G. W. (1926) The Principles of petrology, Chapman and Hall; New edition page no. 1-364.

P- 202 (4CH)

Objectives of the course:

In this paper, the students can know the characteristic properties of the stratified rocks (formed by deposition of sediments) and the metamorphic rocks together with their knowledge on the origin and types of the said rocks.

Expected outcome: The students shall have the potential to know the mechanism of formation of different types of sedimentary and metamorphic rocks. They will be in a position to classify the said rocks basing on various parameters.

a) Sedimentary Petrology:

Processes of formation of sedimentary rocks; Provenance and diagenesis of sediments. Sedimentary textures. Framework, matrix and cement of terrigenous sediments. Definition, measurement and interpretation of grain size. Elements of hydraulics. Primary structures,

palaeocurrent analysis. Biogenic and chemical sedimentary structures. Sedimentary environment and facies. Facies modeling for marine, non-marine and mixed sediments.
Tectonics and sedimentation. Classification and definition of sedimentary basins. Sedimentary basins of India.

b) Metamorphic Petrology:

Concept of metamorphism; Types, causes and agents of metamorphism; Concepts and Theory: Types of Metamorphism and their controlling factors; Common minerals of metamorphic rocks; Field observations, petrographic classification of common metamorphic rocks; Metamorphic facies and facies series. Effects of Metamorphism : Phase diagrams and graphic representation of mineral assemblages; Prograde and retrograde metamorphism, Matasomatism; Deformation textures and textures related to recrystallization; Metamorphic reactions, elemental exchange and Pressure – Temperature conditions of Isograds; Mineral assemblages equilibrium/reaction textures and geo-thermo barometry. Plate tectonics and metamorphism; Important metamorphic rocks of India - Khondalite, Charnockite, Marble.

Books Recommended:

1. Pettijohn, F. J. (1983) Sedimentary rocks, HarperCollins; 3 edition, page no. 1-526.
2. Pettijohn, F. J., Potter. P. E. and Siever, R. (1987) Sand & Sandstones, Springer; 2nd edition, page no. 1-553.
3. Sengupta, S. M. (2007) Introduction to Sedimentology, CBS; 2 edition,page no. 1-339.
4. Turner, F. J. and Verhogen, (1960) Igneous and Metamorphic Petrology, McGraw-Hill; 2nd Edition, page no. 1-694.
5. Miyashiro, A. (1973) Metamorphism & Metamorphic Belts, Springer, page no. 1-492.
6. Bhaskar Rao, B. (1986) Metamorphic Petrology, 1st Edition CRC Press, page no. 1-190.

P- 203 (4CH)

Objectives of the course:

In this paper, the students can know the basics of statistics. How normal statistics have its limitations in solving geological field problems and therefore the introduction of geo-statistics. Further, the use of computers is a basic need for all branches of science,

Expected outcome: In this unit, the students are introduced with the concepts of statistics and use of computers. Statistics and computers are part and parcel of every science subject and it helps solving so many geological problems.

Geostatistics

Method of sampling, Frequency distribution and frequency tables. Graphical representation of frequency data i. e. Histogram, Frequency curve and Cumulative frequency curve), Mean, Standard deviation, Skewness and Kurtosis. Understanding a semi-variogram; the range, sill and nugget. Different semi-variogram functions. Preliminary idea on krigging. Application of geo-statistics in geological exploration.

Books Recommended:

1. Sharma, D. D. (2008) Geostatistics with application in earth sciences, Springer; 2nd edition, page no. 1-204.
2. Mckillup, S. and Dyarr, M.D. (2010) Geostatistics Explianed, Cambridge university press, page no. 1-396.

P- 204 (4 CH) Seminar & Field Report

P- 205 (2CH)

(Practical corresponding to Course P- 201 and P- 202)

Megascopic and microscopic identification of igneous, sedimentary and metamorphic rocks, CIPW normative calculation, Use of ACF, AKF and AFM diagrams for the study of metamorphic rocks. Mechanical analysis of supplied sediment sample. Graphical plotting of given size data and determination of sample statistics. Determination of paleocurrent direction with the help of rose diagram drawn from supplied data. **Practical Record and Viva**

P- 206 (2CH)

(Practical Corresponding to Course No. P- 203 & Report on Geological Mapping) Sample statistics, Histogram, frequency curve, Cumulative frequency curve. Application ofstatistics to geological problems. Preparation of scatter diagram, histogram, pie-diagram; Computer application in solving geological problems.

Report on Geological Mapping, Viva and Practical Record

IDC (3 CH) General Geology (common for all departments)

General Geology

UNIT – I

General characteristics of solar system, origin of earth (cataclastic & evolutionary hypothesis); Age of Earth.

UNIT – II

Internal constitution of Earth; Earthquake & Volcanoes.

UNIT- III

Hypothesis of Isostasy (Pratt's hypothesis, Airy's hypothesis, Heiskanen hypothesis); Weathering of rocks.

Books recommended:

1. Mukherjee P.K. (1931) A textbook of Geology, The World Press Pvt. Ltd.
2. Datta A.K. (1984) Introduction to Physical Geology, Kalyani Publishers.
3. Mahapatra G.B. (1992) Text book of Physical Geology, CBS Publishers & Distributors Pvt. Ltd

Semester –III

P- 301 (4CH)

Objectives of the course: In these units, the students can know the characteristic properties, origin and classification of fossils.

Expected outcome:

This knowledge will enable the students to find out the age of various strata and also to interpret the palaeoenvironment.

a) Invertebrate Paleontology

Mode and conditions of preservation of fossils, a review of life through ages. Morphology, classification and evolution of Corals, Trilobites, Brachiopods, Lamellibranchs, Cephalopoda, Gastropods, Echinoids, Graptolites.

b) Paleobotany, Paleopalynology,Vertebrate Paleontology and Micropaleontology

Classification of plant fossils; Gondwana flora of India, study *of Glossopteris, Gangamopteris, Verebraria, Nilsonia* and *Ptylophyllum,* Basic concepts of paleo-palynology. Evolution history of man, horse and elephant. Methods of separation and classification microfossils. Morphology and classification of Foraminifera, Elementary idea about radliolaria and ostrocoda.

Books Recommended:

1. Moor, Lalicker and Fisher, (1952) Invertebrate Fossils, McGraw-Hill Book Company, page no. 1-766.
2. Shrock and Twenhofel, (1953) Principles of Invertebrate Paleontology, McGraw-Hill Book Company; 2nd Revised & Enlarged edition page no. 1-816.
3. Woods, H. (1961) Invertebrate Paleontology, Cambridge University Press; Eighth Edition page no. 1-123.
4. Jones. D. J. (1969) Introduction to Microfossils, Hafner Publishing Co Ltd page no. 1-406.
5. Taylor (2009) Paleobotany, Academic Press; 2 edition page no. 1-1252.

P- 302 (4CH)

Objectives of the course:

In these units, the students can know the logical deposition of strata according to geological time. They shall come to know about the distribution of rocks of various time period in different parts of India.

Expected outcome:

This knowledge will enable the students to find out the age, lithological constitution and economic importance of various strata.

a) Precambrian Stratigraphy

Principles and code of stratigraphic nomenclature. Standard geological time scale, Stratigraphic correlation; Precambrian stratigraphy of Karnataka,Orissa, Central India, Rajasthan, Eastern Ghats; Stratigraphy of Vindyan basin, Cuddaph basin and Chhattisgarh basin. Proterozoic rocks of Himalayan belt.

b) Phanerozoic Stratigraphy

Cambrians of Peninsular area; Paleozoic rocks of Extra Peninsular area; Triassic rocks of Spiti, Jurassic of Kutch, Cretaceous of Trichinopolly and their equivalents, Deccan Traps, Tertiary rocks of Assam, Siwaliks, Quaternary Stratigraphy of India

Stratigraphic boundaries: Stratigraphic boundary problems in Indian geology. Gondwana Supergroup and Gondwanaland. Deccan Volcanics. Quaternary stratigraphy- Rock records, palaeoclimates and palaeogeography.

Books Recommended:

1. Weber. (2004)Principles of Stratigraphy, Wiley-Blackwell; 1 edition page no. 1-340.
2. Krumbein and Sloss. (1951) Stratigraphy and sedimentation, San Francisco, CA: W. H. Freeman & Company, page no. 1-497.
3. Dunbar. C. O. (1960) Historical Geology, Wiley; Chapman & Hall, page no. 1-500.
4. Krishnan, M. S. (2009) Geology of India and Burma, CBS; 6 edition page no. 1-536.
5. Wadia. D. N. (1975) Geology of India, McGraw Hill Education India Pvt Ltd; 4 editionpage no. 1-560.
6. Ravindra Kumar (1998) Historical Geology and Stratigraphy of India, NEW AGE; First edition, page no. 1-268.

P-303 (4CH)

Objectives of the course: In these units, the students can know the characteristic properties, origin and distribution of ore minerals.

Expected outcome: After the study, the student will have the knowledge of exploring them by sampling and geophysical methods.

a) Geochemistry

Principles of crystal chemistry; Chemical bonds, Coordination principle, Radius ratio, Crystal structure; Cosmic abundance of elements, Geochemical classification and distribution of elements in the earth; Geochemical cycle (Sulphur cycle, Nitrogen cycle, Phosphorous cycle) Primary geochemical differentiation of the earth; Composition of the Earth's core, mantle and crust; Composition of hydrosphere and atmosphere. Role of Eh-pH in ore formation; Phase rule and its application, Introduction to isotope geochemistry. Geochronology and age of the Earth: Law of Radioactivity; Principles of isotopic dating, Decay schemes and Derivation of equation of age. Rb/Sr, U- Th –Pb methods of dating the rocks. Age of the Earth.

b) Theories of Mineral Formation and Mineral exploration

Processes of formation of economic minerals; Controls of ore localization; Metallogenic provinces and epochs; Geological, geophysical and geochemical methods of prospecting. Principles of mineral prospecting and exploration - conceptualization, methodology and stages; sampling, subsurface sampling including pitting, trenching and drilling, core and non-core drilling, planning of bore holes and location of bore holes on ground.

Books Recommended:

1. Mason, B. (1968) Principles of Geochemistry, John Wiley & Sons; 3rd International edition, page no. 1-330.
2. Goldschmidt, V. M. (1954) Geochemistry, Oxford University Press, page no. 1-742.
3. Rankama and Sahama, T. G. (1950) Geochemistry, University of Chicago Press page no. 1-928.
4. Krausokf, K. B. (1994) Introduction to Geochemistry, McGraw-Hill College; Subsequent edition, page no. 1-640.
5. Bateman, A. M. (1981) Economic Mineral deposits, John Wiley & Sons Inc; 3rd edition, page no. 1-604.
6. Arogyaswamy, R. H. P. (1973) Courses in Mining Geology, Oxford & IBH Pub. Co. page no. 1-916.

P- 304 (4CH)

Objectives of the course: In these units, the students can know the characteristic properties, origin and distribution of economic minerals.

Expected outcome:

After the study, the student will have the knowledge of various uses of minerals, exploiting them by many means such as beneficiation etc.

a) Metallic Minerals/ Ores

Mineralogy, uses, mode of occurrence, genesis and Indian distribution of ores Iron, Manganese, Aluminium, Copper, Lead, Zinc, Tin, Gold and Chromite; Strategic, critical and essential minerals. Need and methods of mineral ore beneficiation of iron, copper, bauxite, chromite, gold.

b) Industrial Minerals

Mineralogy, uses, mode of occurrence, genesis and Indian distribution of Limestone and Dolomite, Mica, Gypsum, Asbestos, Graphite, Magnesite, Gemstone, Raw materials for ceramic, cement, refractory, abrasive and fertiliser industry.

Books Recommended:

1. Krishnaswamy, S. (1988) Mineral Resources of India, Oxford & IBH, page no 1-613.
2. Banerjee, D. K. (2010) Mineral Resources of India, Vikas Publishing House, Technology & Engineering, page no. 1-672.
3. Deb, S. (1980) Industrial Minerals and Rocks of India, Allied Publishers, page no. 1-603.
4. Sharma, N. L., and Ram, K. S. V.: (1964) Introduction to India's Economic Minerals, Dhanbad Publications,Mines and mineral resources, page no. 1- 258.
5. Gokhle, K. V. G. K. and Rao. (1978) Ore Deposits of India, Thomson Press (India), Ore deposits, page no. 1-226.

P- 305 (2CH)

Practical Corresponding to Course No. P- 301 and P- 302

Idientification and labelling of invertebrate, vertebrate, plant and micro- fossils. Construction of stratigraphic sequence from given fossils and rock assemblage, Paleogeographic maps of different geologic periods.

Viva, Practical record

P- 306 (2CH)

Practical Corresponding to P- 303 and P- 304

Megascopic identification of ores and industrial minerals, Block diagram, fence diagram, isopach maps from supplied data, Ore reserve calculation. Calculation of grade/ assay value from the supplied data, identification of common ores (Hematite, magnetite, pyrite, galena, chromite, chalcopyrite, pyrolusite and psilomelane etc.) under reflected light. Flow charts of mineral beneficiation. Maps showing distribution of mineral and ore deposits.

Viva and Practical Record

AECC- II (2 CH) Entrepreneurship & Development

Semester-IV

P- 401(4CH)

Objectives of the course: In this, course, the students can know the characteristic properties, origin, movement and types of groundwater. The students can also know the requirement of geology for the construction of various engineering structures such as bridge, tunnel etc.

Expected outcome:

This knowledge will enable the students to use groundwater properly and will have the knowledge to install various types of wells. They shall have the knowledge to utilize the geological skills in the construction of various engineering structures.

a) Hydrogeology

Water on earth; Types of water meteoric, juvenile, magmatic and sea water; Hydrological Cycle and its components; Water balance; Water-bearing properties of rocks porosity, permeability, specific yield and specific retention; Vertical distribution of water; Zone of aeration and zone of saturation; Classification of rocks according to their water bearing properties; Aquifers; Classification of aquifers; Aquifer parameters- transmitivity and storage coefficient; Water table and piezometric surface; Fluctuations of water table and piezometric surface; Geologic and geomorphic controls on groundwater; Groundwater provinces of India, Theory of groundwater flow; Darcy's law and its applications.

Geologic and hydrogeologic methods of ground water exploration; Role of remote sensing in groundwater exploration; Surface geophysical methods - seismic, gravity, geo-electrical and magnetic methods; Types of water wells and methods of construction; Design, development, maintenance and revitalization of wells; Sub-surface geophysical methods

Physical and chemical properties of water; Quality criteria for different uses; Graphical presentation of groundwater quality data.

b) Engineering Geology

Engineering properties of rocks and soil. Geological investigation of dam site, reservoir site, tunnels and bridges, Landslides and stability of hill slopes; Properties and selection of construction material.

Books Recommended:

1. Todd, D. K. (2015) Ground water Hydrology, page no. 1- 656.
2. Davis, S. N. and Dewiest, (1966) Hydrogeology, John Wiley & Sons, page no. 1- 464.
3. Garg, S. P. (1979) Ground water and Tube wells, Oxford and IBH Publishing Co., page no. 1-348.
4. Krynine and Judd, (2005) Principles of Engineering Geology, CBS Publishers & Distributors; 1st edition, page no. 1-425.
5. Stagg & Zeinkiewics, (1968) Rock mechanics in Engineering Practice, Wiley-Blackwell, page no. 1-442.
6. Jager and Cook, (2012) Fundamentals of Rock mechanics, Wiley India Pvt. Ltd; Fourth edition, page no 1-488.

P- 402 (4CH)

Objectives of the course: In this course, the students can know the characteristic properties, origin and distribution of coal, petroleum and nuclear minerals. After the study, the student will have the knowledge of their conservation and management.

Expected outcome: The students can have the knowledge of various environmental laws related to mining of minerals. This knowledge will enable them to deal with issues relating to environmental pollution.

a) Fossil Fuels, Nuclear Minerals and Mineral Economics

Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Techniques of exploration. Geographical and geological distributions of onshore and offshore petroliferous basins of India. Coal and its properties: Different varieties and ranks of coal. Origin of coal. Coalification process and its causes. Lithotypes, microlithotypes and macerals: their physical, chemical and optical properties. Mode of occurrence, genesis and Indian distribution of Coal. Mode of occurrence, genesis and Indian distribution of Nuclear Minerals. Need and methods of resource evaluation and reserve calculation of economic mineral deposits. National Mineral policy.

b) Mineral Economics

Strategic, critical and essential minerals. India's status in mineral production vis a vis world scenario, Changing patterns of mineral consumption. UNFC classification, National Mineral Policy. Mineral Concession Rules. Marine mineral resources and Laws of Sea.

Books Recommended:

1. Krishnaswamy, S. (1988) Mineral Resources of India, Oxford & IBH, 1988 -Mines and mineral resources, page no. 1-613.
2. Banerjee, D. K. (1998) Mineral Resources of India, Calcutta: World Press Private Limited, 6th Edition, page no. 1-415.
3. Deb, S. (1980) Industrial Minerals and Rocks of India, Allied Publishers, page no. 1-603.
4. Chandra, D., Singh, R. M. and Singh, M. P. (2000) Textbook of Coal (Indian context), Tara Book Agency
5. Francis, W. (1961) Coal-its formation and composition, Edward Arnold, page no. 1-806.
6. Levorsen. A, I. (2004) Geology of Petroleum, CBS Publishers & Distributors Pvt. Ltd., second edition.

P- 403 (4 CH)

Elective (any one)

i) Geoinformatics
ii) Digital image processing and Geographic information system
iii) Coal Geology
iv) Isotope Geology
v) Surface and sub-surface water resource management
vi) Environmental Geology
vii) Applied Micropaleontology
viii) Ore Genesis:
ix) Clay Mineralogy & Soil Geology
x) Management of Mineral Resources

P- 404 (4 CH) Project

P- 405 (2 CH)

Practical Corresponding to P- 401 and P- 402

Determination of pH, Temperature, TDS and other parameters for ground water quality assessment. Graphical representation of supplied ground water quality data. Resistivity survey for ground water.

Engineering geological problems. Viva, Practical record

P- 406 (2 CH)

Practical Corresponding to Course P 403 and Field Report.

P- 403-Elective (any one)

i) Geoinformatics

Concept of resources and reserve and their classification. Mineral resources and National economy- concept and future. Ground and surface water resources of India; Sustainable development of Mineral and water resources; Geostatistical methods for reserve calculation, Computer application in Groundwater studies; Geostatistical methods for the interpretation of geochemical data to study genesis of igneous rocks, ore deposit modeling, quality of water, correlation of borehole data; Mine area planning and environmental management; Geographic Information system and its use in natural resource management.

Practical:

Sampling techniques; Sample statistics; Statistical methods of presentation of analysed sample data. Histogram; frequency curve, Cummulative frequency curve. Application of statistics to geological problems; Programming in C/ C++ for presentation of data; Computer application in solving geological problems. Extraction of statistical data fom digital data.

Books recommended:

1. Bloom, A. L. (2003) Geomorphology - A systematic analysis of Late Cenozoic landforms. Pearson Education, New Delhi, Page no.1-415.
2. Chorley, R. J., Schumm, S.A. and Sugden, D.E. (Eds) (1985) Geomorphology. Methuen, Page no.1-620.
3. Kale, V. S. and Gupta, A. (2001) Introduction to geomorphology. Orient Longman Page no.1-836.
4. Thorn, C. E. (1998) Introduction to theoretical geomorphology. Unwin Hyman, Page no.1-529.
5. Thornbury, W. D. (1996) Principles of geomorphology. John Wiley, Page no.1-620.
6. Summerfield, M. A. (Ed) (1999) Geomorphology and global tectonics. John Wiley Page no.1-911.

ii) Digital image processing and Geographic information system

Image processing system characteristics, CPU, Arithmitic coprocessor, RAM, Operating system and compiler, Basic features of digital images. Image display system; Black and white image display. Video image display; transforming video displays to hard copy displays. Data input, verification, correction and storage data quality and errors, image analysis and pattern recognisition image enhancement reduction and magnification, contrast enhancement. Rationing. Spatial filtering, Edge enhancement. Special transformation. Thematic information extraction, Classification scheme. Training site selection; Supervised classification. Map accuracy assessment Introduction of Geographic information system, Advantages of GIS, Data structure of GIS, Raster and vector data for geographical entities. Data encoding, data manipulation, Data analysis and spatial modelling. Data quality, Errors and natural variation and interpretation.

Practical:

Study of the nature and characteristic features of digital images; Methods of digital image collection; Interpretation of digital images; Brightness contrast; Image Analysis; Supervised and unsupervised classification; Preparation of Mosaic; preparation of maps using GIS software.

Books Recommended:

1. Lillesand M. Thomas and Ralph W. Kiefer (2007) Remote Sensing and Image Interpretation, John Wiley & Sons, New York, Page no.1-736 .
2. Arthur H. Robinson (2002) Elements of Cartography, John Wiley & Sons, New York, Page no.1-428
3. Dennis P. Curtin, Kim Foley, Kunal Sen & Cathleen Morin (1999) Information Technology - The Breaking Wave, Tata McGraw Hill Ed Page no.1-830.
4. M. Anji Reddy (2004) Geoinformatics for Environmental Management, BS Publications, Hyderabad, Page no.1-472

5. Sharma V.K. (1991) Remote Sensing for Land Resources Planning, Concept Publishing Company, New Delhi, Page no.1-586.

iii) Coal Geology

Origin of coal. Geological and geographical distribution of coal, Geological aspects of strata control and vary methods of coal prospecting and exploration, coal mining methods. Evaluation of coal characteristics, Application of coal petrology. Beneficiation of coal, coal washing, blending, Desulphurization of coal. Carbonisation, gasification of coal. Fertiliser from coal, Environmental problems due to coal mining and its use in different industries, use of fly ash. Future prospect and conservation coal.

Practical:

Megascopic identification of coal; study of coal under reflected light; Proximate analysis of coal. Preparation of maps showing Indian distribution of coal; sketch map of different coal fields of India. Reserve calculation methods for coal.

Books Recommended:

1. Francis, W. (1961) Coal-its formation and composition, Edward Arnold, Page no.1-806.
2. Stach, E. (1982) Text book of Coal Petrology, Lubrecht & Cramer Ltd; Subsequent edition Page no.1-611.
3. Van Krevelen, D. W. and Schuyer (1957) Coal science, Elsevier Cleaver-Hume, Page no:1-352.
4. Fettweis, G. B. (1979) World Coal resources- methods of assessment and results, Elsevier Scientific , Page no.1-415.

iv) Isotope Geology

Internal structure of atoms; Atomic weight, Nuclear stability and abundance; Isotopes; Decay mechanics of radioactive elements - positron decay, electron capture decay, branchel decay. Beta decay, alpha decay. Decay of a radioactive parent to a stable daughter; Principle of mass spectrometry. K-Ar, Sm-Nd, U Pb and C14 method of dating. Sulphur and Oxygen isotopes and their application in geological studies,

Practical:

Study of radioactive minerals under microscope. Theoretical methods of age calculation. Measurement of oxygen and sulpher isotopes.

Books Recommended:

1. Faure, G. (1986) Principles of Isotope Geology, Wiley; 2 edition, page no. 1-608.
2. Rankama, K. (2013) Progress in Isotope Geology, Literary Licensing, LLC, page no. 1-724.

v) Surface and sub-surface water resource management

Water cycle; measurement of surface run off; infiltration and evaporation; Ground water flow (steady, unsteady and radial); Darcy's Law; Storage equation; Fresh and salt water interaction in coastal and inland areas; Ground water conditions in different parts of India, Design and construction of tube wells; Pumping tests;. Ground water recharge; Quality of ground and surface water. Surface and ground water pollution and their management, Geological and Geophysical prospecting of ground water. Concept of watershed and their management.

Practical:

Sampling of water; Determination of pH, Temperature, TDS and other parameters for ground water quality assessment. Graphical representation of supplied ground water quality data. Resistivity survey for ground water.

Books Recommended:

1. Todd, D. K. (2011) Groundwater Hydrology, Wiley India Pvt Ltd; Third edition, page no. 1-656.

2. Raghunath, H. M. (2007) Groundwater, New Age International Publishers; Third edition, Page no. 1-520.
3. Davis, S, N. and Dewiest. (1966)Hydrogcology, John Wiley & Sons, Page no. 1- 464.
4. Karanth, K. R.: (1989) Hydrogeology, Tata McGraw-Hill Publishing Company, Page no. 1-458.

vi) Environmental Geology

Ecology and Environment. Anthopogenic changes in Ecosystem; Dynamics of human, Population, Non-renewable natural resources. Mineral consumption. Conservation of mineral resources. Impact of mining activities on environment; Energy resources & their consumption. Energy crisis. Alternative energy resources; Natural hazards. Environmental security and hazard -zoning; Risk assessment analysis; Strategies for hazard mitigation; Seismic hazards; Seismic condition in India; Management of Seismic hazards; Stability of hill slopes and Land Slide; Controlling landslides; Causes of floods; Flood scenario in India; Management of Floods. Environmental and mining laws. National Mineral Policy

Practical:

Sampling of water, soil, dust from environmentally polluted areas; Analysis of water, soil, and dust. Determination of pH, Temperature, TDS and other parameters for ground water quality assessment. Graphical representation of the analysed samples. Resistivity survey for ground water. Determination of heavy metals in the soil and dust samples. Preparation of hazard zonation maps.

Books Recommended:

1. Valdiya, K. S. (2004) Environmental Geology-Indian context, Orient Blackswan Private Limited - New Delhi page no. 1-240.
2. Keller E. A. (2010) Environmental Geology, Pearson; 9 edition, page no. 1-624.
3. Coates, D.R. (1981) Environmental Geology, John Wiley & Sons, Inc. page no.1-701.
4. Betz, F. Jr (Ed) (1976) Environmental Geology John Wiley & Sons Inc, page no. 1-119.
5. Dasmann, R. F. (2011) Environmental Conservation, Wiley India, page no.1-127.
6. Bolt, B. A. et al. (1975) Geological Hazards, Springer, page no.1-328.

vii) Applied Micropaleontology, Palaeobotany,Palynology

Applications of palaeontology, objective of micropalaeontology, microfossil groups; **Foraminifera** (test morphology, life style, food, symbiosis, life cycle, wall structure and composition, Chamber growth and development, Evolution of Foraminifera, General classification, Foraminiferal bioenvironmental indicators, Palaeoecological significance of Foraminifera, Distribution of planktonic foraminifera; **Ostracods** (morphology of the ostracod carapace, ontogeny, articulation, distribution and ecology of ostracods, ecological variables, applications of ostracods; classification, geological history of Ostracod), **Coccolithophores** (Introduction; Coccolith morphology; Coccolith Life-Style, Ecology and Reproduction; Coccoliths and Sedimentation; Geologic history of coccoliths); **Diatoms** (Introduction; living diatom, Cell contents of living diatom; Structure and morphology of a diatom [Diatom frustule; diatom symmetry planes; diatom ornamentation); Taxonomy; Growth and reproduction; Diatom distribution and ecology; Geologic record and evolution; Applications and importance of diatoms, and **Radiolaria, Palynology** (introduction, history of Palynology; method of study, applications), **Gondwana flora** (Glossopteris flora, Dicroidium flora, Ptillophyllum flora) and their significance, important Gondwana plant fossils

Practical:

Identification of microfossils. Preparation of paleo-geographic maps, identification of plant fossils.

Books recommended:

1. Jones, D. J.: (1969) Introduction to Microfossils, Hafner Publishing Co Ltd., page no. 1-406.

2. Bignot, G. (2008) Elements of Micropaleontology, Springer page no. 1-368.

viii) Ore Genesis:

Ore formation as a natural process in the crust; Metallogeny - space-time rationale; Mineralisation in relation to tectonics and crustal evolution; Ores in Mafic Ultramafic rocks, Classification scheme, immiscible liquid segregation, thermodynamic modelling of partitioning of metals with regard to composition of Cu-Ni- Co-sulfide ores; ores in felsic rocks: end-stage processes during felsic magmatism and their ore genetic significance; Hydrothermal fluids, plurality of sources, fluid inclusions, stable isotope studies, complexing and thermodynamic aspects of solubility and precipitation of minerals. Stratiform and stratabound ores, phase equilibria in simple sulfide systems, Fe-S; Fe-Zn-S, Cu-Fe-S,Fe-Ni-S, their application to natural ores. Ores and metamorphism, cause and effect relations.

Practical:

Study of ore minerals in hand specimen. Study of polished ore minerals under reflected light. Micro hardness testing. Etching study. Paragenetic study from mineral assemblage. Chemical analysis of ore minerals. Reserve calculation methods for estimation of ore reserve.

Books Recommended:

1. Mookherjee, A. (199) Ore genesis- a holistic approach, Allied Publishers Pvt. Ltd. page no. 1-324.
2. Spurr, J. E. (1923) The Ore Magmas, McGraw Hill, page no. 1-234.
3. Sawkins, F. J, (1989) Metal deposits in relation to Plate Tectonics, Springer Verlag; Subsequent edition,page no. 1-123.
4. Stanton (1972) Ore Petrology, McGraw Hill Higher Education, page no. 1-713.
5. Wolf, K. H. (1976) Handbook of Strata-Bound and Stratiform Ore Deposits: Part II: Regional Studies and Specific Deposits: Volume 5: Regional Studies, Elsevier Publishing Company, page no. 1-312.

ix) Clay Mineralogy & Soil Geology

Introduction, Classification of clay minerals. Structure of I: I layer silicates (Kaolinite group). Structure of 2 :1 layer silicates, (Smectite group, dioctohedralsmectites, trioctahedralsmectites). Structure of 2:1:1 layer silicates. (dioctabedral chlorite, trioctahedral chlorite). Mixed-layer clay minerals, ion exchange of clay minerals; X-ray identification and semi quantitative estimation of major clay mineral groups, origin and diageaesis of clay minerals. Formation of Soil, Soil profile, classification ofoil. Soil Chemistry, Classification of Soils. Soil type of India, Soil & vegetation. Soil erosion. Soil conservation. Soil pollution and prevention

Practical:

Study of clay minerals in hand specimen. Separation of clay minerals from sedimentary rocks and loose sediments. X-ray, DTA and TGA method of clay mineral analysis. Physical and thermal properties of clay minerals. Classification of soils.

Books Recommended:

1. Grim, R. E. (1968) Clay Mineralogy, McGraw-Hill, page no.1-127.

x) Management of Mineral Resources

Prospecting criteria and guides to mineral/ ore search, Review of Geological Geophysical, Geochemical, Geobotanical methods of mineral prospecting, changing concepts, approaches, techniques and planning in regional scale mineral exploration, concept of plate tectonics and mineral location, Remote sensing. Methods of data acquisition and RS techniques in Mineral Exploration, Statistical methods and mineral/ore deposit modelling for prospecting and exploration. Methods of resource evaluation and reserve calculation, property valuation. Treatment and marketing of ores. Demand, supply and substitute. Changing pattern of mineral consumption. Strategic, critical and essential minerals, National mineral policy, Mineral concession rules, Marine mineral resources & Law of Sea, Conservation of strategic mineral resources with special reference to India, Monitoring of land degradation due to mining and natural process.

Practical:

Techniques of survey of mineral deposits. Preparation of block diagram, fence diagram, isopach

diagram etc. Reserve calculation methods. Advance method of mineral survey.

Books Recommended:

1. McKinstry (1949) Mining Geology, Prentice-Hall, Inc.; 2nd Printing edition, page no. 1-736.
2. Dorbin, M.S. (1976) Introduction to geophysical prospecting, McGraw-Hill; 3rd edition, page no. 1-630.
3. Hoover (2009) Principles of Mining, Biblio Life, page no. 1- 212.

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