Course at a Glance

(From the academic session 2024-26 onwards till further revision)

M. Sc. Applied Geology and M.Sc. Geology

(Semester System)

Semester - I		Credit Hour	Mark Distribution	Mark
Course- AG-C-411 **GL-C-411**	Crystallography, General Geology	4 CH	20+80	100
Course- AG-C-412 **GL-C-412**	Meteorology, Environmental Geology and Marine Geology	4 CH	20+80	100
Course- AG-C-413 **GL-C-413**	Mineralogy and Optical Mineralogy	4 CH	20+80	100
Course-AG-C-414 **GL-C-414**	Geomorphology, Geo-statistics and Remote Sensing	4 CH	20+80	100
Course-AG-C-415 **GL-C-415**	Practical (Corresponding to AG-C-411 & 412) Practical (Corresponding to GL-C-411 & 412)	2 CH	50	50
Course-AG-C-416 **GL-C-416**	Practical (Corresponding to AG-C-413 & 414) Practical (Corresponding to GL-C-413 & 414)	2 CH	50	50
	Total	**20 CH**		
Course-AG-C-417 **GL-C-417**	Environmental Studies and Disaster management	2 CH	50	50
Add on Non Credit Course (Optional) **1. Communicative Skill in English** **2. Leadership and Personality Development**				
Semester - II				
Course- AG-C-421 **GL-C-421**	Igneous Petrology	4 CH	20+80	100
Course-AG-C-422 **GL-C-422**	Sedimentary Petrology and Metamorphic Petrology	4 CH	20+80	100
Course-AG-C-423 **GL-C-423**	Structural Geology and Geotectonic	4 CH	20+80	100
Course-AG-C-424 **GL-C-424**	Practical (Corresponding to AG-C-421 & 422) Practical (Corresponding to GL-C-421 & 422)	2 CH	50	50
Course-AG-C-425 **GL-C-425**	Practical (Corresponding to AG-C-423 & 424) Practical (Corresponding to GL-C-423& 424)	2 CH	50	50
Course- AG-C-426 **GL-C-426**	Seminar and Field Report	4 CH	50+50	100
	Total	**20 CH**		
Course-AG-C-427 **GL-C-427**	IDC (Elective for other departments)	3 CH	60+20+20	100

Semester - III				
Course- AG-C-511 **GL-C-511**	Hydrogeology and Engineering Geology	4 CH	20+80	100
Course- AG-C-512 **GL-C-512**	Geochemistry, Theories of Mineral Formation and Mineral Exploration	4 CH	20+80	100
Course-AG-C-513 **GL-C-513**	Metallic Minerals/ Ores and Industrial Minerals	4 CH	20+80	100
Course-AG-C-514 **GL-C-514**	Fossil Fuels, Nuclear Minerals, Mineral Economics, Environmental laws and Mining laws	4 CH	20+80	100
Course-AG-C-515 **GL-C-515**	Practical (Corresponding toGL-C-511 & 512)	2CH	50	50
Course- AG-C-516 **GL-C-516**	Practical (Corresponding toGL-C-513 & 514)	2CH	50	50
	Total	**20 CH**		
Course-AG-C-517 **GL-C-517**	Entrepreneurship Development Program	2 CH	50	50
Semester - IV				
Course-AG-C-521 **GL-C-521**	Paleontology	4 CH	20+80	100
Course-AG-C-522 **GL-C-522**	Stratigraphy	4 CH	20+80	100

Course- AG-E-523 GL-E-523	Elective (Digital Image Processing/Ore Genesis)	4 CH	20+80	100
Course-AG-C-524 GL-C-524	Practical (Corresponding toGL-C-521 & 522)	2 CH	50	50
Course-AG-C-525 GL-C-525	Practical (Corresponding toGL-C- 523) & Field Report	2 CH	50	50
Course-AG-C-526 GL-C-526	Project& Viva	4 CH	80+20	100
	Total	**20 CH**		

Semester - I	16 CH Theory	4 CH Practical	No Seminar	20 CH
Semester - II	12 CH Theory	4 CH Practical	4 CH Seminar and Field report	20 CH
Semester - III	16 CH Theory	4 CH Practical	No Seminar	20 CH
Semester - IV	12 CH Theory	4 CH Practical	4 CH Project	20 CH
			Total	**80 CH**

Common theory course	AG-C-417, AG-C-427 and AG-C-517 GL-C-417, GL-C-427 and GL-C-517	**7 CH**
MOOC	Available for Second/Third semester	**3 CH**
Grand Total		**90 CH**
Furthermore the following non-credit course will be taken by the student:		
1. Yuva Sanskar, 2. N.C.C./ N.S.S/ Sports/ Yoga (of which one is to be opted)		

ସମ୍ବଲପୁର ବିଶ୍ୱବିଦ୍ୟାଳୟ

Sambalpur University

Accredited With Grade-A by NAAC (Third Cycle)

M.Sc. APPLIED GEOLOGY SYLLABUS (2024-2026)

M.Sc. GEOLOGY SYLLABUS (2024-2026)

Courses of Studies for M. Sc. Examination in Geology
(From the academic session 2024-26 onwards till further revision)
M. Sc. Applied Geology and M.Sc. Geology
(Semester System)

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Course- AG-C-412 GL-C-412	Meteorology, Environmental Geology and Marine Geology	4 CH	20+80	100
Course- AG-C-413 GL-C-413	Mineralogy and Optical Mineralogy	4 CH	20+80	100
Course-AG-C-414 GL-C-414	Geomorphology, Geo-statistics and Remote Sensing	4 CH	20+80	100
Course-AG-C-415 GL-C-415	Practical (Corresponding to AG-C-411 & 412) Practical (Corresponding toGL-C-411 & 412)	2 CH	50	50
Course-AG-C-416 GL-C-416	Practical (Corresponding to AG-C-413 & 414) Practical (Corresponding to GL-C-413 & 414)	2 CH	50	50
	Total	**20 CH**		
Course-AG-C-417 GL-C-417	Environmental Studies and Disaster management	2 CH	50	50
Add on Non Credit Course (Optional) **1. Communicative Skill in English** **2. Leadership and Personality Development**				
Semester - II				
Course- AG-C-421 GL-C-421	Igneous Petrology	4 CH	20+80	100
Course-AG-C-422 GL-C-422	Sedimentary Petrology and Metamorphic Petrology	4 CH	20+80	100
Course-AG-C-423 GL-C-423	Structural Geology and Geotectonic	4 CH	20+80	100
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Course- AG-C-511 GL-C-511	Hydrogeology and Engineering Geology	4 CH	20+80	100
Course- AG-C-512 GL-C-512	Geochemistry, Theories of Mineral Formation and Mineral Exploration	4 CH	20+80	100
Course-AG-C-513 GL-C-513	Metallic Minerals/ Ores and Industrial Minerals	4 CH	20+80	100
Course-AG-C-514 GL-C-514	Fossil Fuels, Nuclear Minerals, Mineral Economics, Environmental laws and Mining laws	4 CH	20+80	100
Course-AG-C-515 GL-C-515	Practical (Corresponding to AG-C-511 & 512) Practical (Corresponding to GL-C-511 & 512)	2CH	50	50
Course- AG-C-516 GL-C-516	Practical (Corresponding to AG-C-513 & 514) Practical (Corresponding to GL-C-513 & 514)	2CH	50	50
	Total	**20 CH**		
Course-AG-C-517 GL-C-517	Entrepreneurship Development Program	2 CH	50	50
Semester - IV				
Course-AG-C-521 GL-C-521	Paleontology	4 CH	20+80	100
Course-AG-C-522 GL-C-522	Stratigraphy	4 CH	20+80	100

Course- AG-E-523 **GL-E-523**	Elective (Digital Image Processing/Ore Genesis)	4 CH	20+80	100
Course-AG-C-524 **GL-C-524**	Practical (Corresponding to AG-C-521 & 522) Practical (Corresponding to GL-C-521 & 522)	2 CH	50	50
Course-AG-C-525 **GL-C-525**	Practical (Corresponding to AG-C- 523) & Field Report Practical (Corresponding to GL-C- 523) & Field Report	2 CH	50	50
Course-AG-C-526 **GL-C-526**	Project& Viva	4 CH	80+20	100
	Total	**20 CH**		

Semester - I	16 CH Theory	4 CH Practical	No Seminar	20 CH
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Common theory course	AG-C-417, AG-C-427 and AG-C-517 GL-C-417, GL-C-427 and GL-C-517	**7 CH**
MOOC	Available for Second/Third semester	**3 CH**
Grand Total		**90 CH**
Furthermore the following non-credit course will be taken by the student:		
1. Yuva Sanskar, 2. N.C.C./ N.S.S/ Sports/ Yoga (of which one is to be opted)		

PSO of the Program:-

PSO1: The Master of Science program in Applied Geology offers an interdisciplinary post-graduate degree in Applied Geology to understand the nature and characteristics of different branches of Geology, thus educating students for success as a geo-scientist in the government sector, public sector, private sector, research institutes, or further pursuit of Doctoral studies. Students are being prepared to assume responsible positions in industry or government agencies.

PSO2: Enabling the students to analyse the relationships among different branches of Geology to demonstrate content knowledge appropriate to professional career goals; frame novel questions or problems in geology and determine the data required to answer them; collect high-quality geologic data using standard techniques and begin to develop state-of-the-art methods

PSO3: Perform procedures to apply theoretical, conceptual and observational knowledge to the analysis and interpretation of geologic data through hands-on laboratory practice, field studies, preparation of maps and charts

PSO4: Apply the basic concepts learned by the students to execute them by compiling critique geologic literature pertinent to original research; communicating geologic knowledge, and findings and interpreting reports in academic, scientific institutions and industrial organizations.

PO of the Program:-

PO1:Identifying and understanding phenomena, assumptions of Geotectonics, Structural Geology, Mineral optics etc. branches of Geology that require and frame out critical thinking. The students learn geologic field mapping, exploration techniques for economically useful Earth material, statistical analysis of the data, computer techniques and software, microscopy, fossil identification, groundwater behaviour and environmental issues related to Planet Earth. This master'sprogramme enables to understand the spatial and temporal relationships between Earth processes and products, and the development and evolution of Earth spheres (Lithosphere, Hydrosphere, Atmosphere and Biosphere). The student will be able to assess Geo-hazards including earthquakes, floods, landslides, tsunamis and volcanic eruptions and mechanisms for mitigating the damages.

PO2:Students will be made aware of varied geoscience technologies and will be able to present, and document in person and through electronic media in English and in one Indian language (Odia/Hindi etc.)

PO3: Students are trained to learn to mediate disagreement, make liaisons and work in a team while working as geo-scientists in government sectors, public sectors, private sector research institutes etc.

PO4: Demonstrate qualities to be prepared to become an entrepreneur, which enables them to venture intotheir own Geo-consultancies and mining lease, industries (cement, ceramic, mineral industries etc.).

PO5: Make the students identify different value systems, understand the moral dimensions and accept responsibility in their workplace.

PO6: Understand the environmental issues about mining and mineral-based industries and sustainable development. Understand and assess the natural hazards, their preparedness, consequences, mitigation measures etc.

PO7: Acquire the ability to engage in independent and lifelonglearning in the field ofgeotechnological changes vis-à-vis socio-technological changes.

Course- AG-C-411, GL-C-411 (4CH)

Objectives of the course:

This course aims 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.General geology part can givean idea about endogenetic process operating inside the earth and its resultant land forms.

Expected outcome:

The said courses will make the students to understand about crystal chemistry and the interior of earth.

CO: 1

Understand the basic concept of crystal structure, its relation to mineral constitution and its role in crystal geometry.

Understand the fundamentals of Earth System Science.

CO: 2. Analyse various concepts of Physical Geology & Crystallography and understand them through casestudies

CO: 3. Apply the theoretical knowledge in understanding earth elements through hands-on laboratory practice

CO: 4 Execute field studies to verify the theoretical knowledge gained in the course.

a) Crystallography

Hermann-Mauguin symbol, zones and zone axis, ionic radii, coordination number, crystal irregularities,Symmetry and symmetry elements, Miller Indices, zonal relations, lattice network. Bravi's lattices; Description of Six crystal systems w.r.t. their axial relationships, symmetry elements & various forms present, Twin crystals and laws of twining, types of twining in crystal systems; Stereographic crystal projections, X-ray study of crystals by different methods

Objectives and expected outcome: In this unit, the structure and differentcrystal types are mentioned. The pupil can identify the crystals from the X-ray study.

b) 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, Earthquake (cause, types), vulnerability of Odisha to earthquake, Hypothesis of Isostasy(Pratt's hypothesis, Airy's hypothesis, Heiskanenhypothesis)

Books recommended:

1. Phillips, F. C. (1977)An Introduction to Crystallography,Longman Higher Education, page no. 1-295.
2. Evans, R. C.(1939)An Introduction to Crystal chemistry, 2ndedition, Cambridge University Press, page no.1-410.
3. Dana, E. S.(2006)A Text Book of Mineralogy, CBS; 4 edition page no.1-156.
4. Dexter Perkins (2002) Mineralogy, Prentice-Hall of India, New Delhi
5. Kerr, P. F.(1977)Optical Mineralogy,McGraw-Hill College; 4 edition page no.1-492.
6. Beloussov, V. V.(1974)Basic Problems in Geotectonic, McGraw-Hill Book Company page no.1-312.
7. Valdiya, K. S.(1985)Aspects of Tectonics, McGraw-Hill Education page no.1-304.

Course- AG-C-412, GL-C-412 (4CH)

Objectives of the course:

The objective of this paper is to offer basic knowledge ofthe different spheresof the earth such as the atmosphere; hydrosphere and lithosphere. The meteorology part will provide a general knowledge of a range of atmospheric phenomena and applications. The marine geology course provides an introduction to the world's oceans, a basic understanding of the physical, chemical

and biological aspects of these oceans and various geological processes that are going on in the oceans.

Expected outcome:

This paperwill provide quality scientific and technical education with an increased focus on research and innovation in the fields of earth sciences and environment to cater to the needs of the country.

CO: 1
Understand the elements of oceanography, weather and climate, various types of natural hazards (causes, consequences, mitigation measures) and sources of renewable energy.
CO: 2. Analyse various concepts of Oceanography, Meteorology &Environmental Geologyand understand them through case studies
CO: 3. Apply the theoretical knowledge in understanding various phenomena through preparation of weather charts and maps.
CO: 4 Execute field studies to verify the theoretical knowledge gained in the course.

a) Meteorology

Weather and Climate; Structure and chemical composition of the atmosphere, Heat budget of the earth; Temperature and pressure belts of the world; Atmospheric circulation; jet streams and theireffect on Indian monsoon; Planetary and local winds; Cloud formation and precipitation processes, Types and distribution of precipitation; Air masses (Source Region, Classification, its effect on world weather), fronts (general characteristics, frontogenesis, classification).

b) Environmental Geology and Marine Geology:

Renewable and non-renewable natural resources,Harnessing solar energy, its merits and limitations, solar devices: solar cooker, solar water heater, solar cells, wind energy (wind flour mill, windmill pump), Hydroelectricity, Tidal energy, Environmental problem due to mining activities and their mitigation, Sustainable mining, conservation of minerals. Natural hazards-Earthquakes, volcanic eruptions, landslides, tornados, floods, and coastal erosion
Ocean Bottom Relief - continental shelf, continental slope, continental rise and abyssal plains. marine sediments and their classification (Lithogenous, Biogenous, Hydrogenous, Cosmogenous), sea water density, salinity (role of salinity and distribution of salinity), marine resources and their utilization (biotic resources and mineral resources of the ocean floor)

Books Recommended:

1. Trewarta,G. T. (1968)An introduction to Climate, McGraw-Hill; Fourth Edition, page no 1-408.
2. Menon, P. A. (2005) Way of The Weather,National Book Trust, India, page no. 1-109.
3. Miller, A., and Thompson, J. C. (1983)Elements of Meteorology,Merrill Pub Co; Subsequent edition page no. 1-448.
4. Hobbes, J. E. (1980)AppliedClimatology,Butterworth-Heinemann,page no.1-222.
5. Valdiya, K. S. (2004)Environmental Geology-Indian context, Orient Blackswan Private Limited - New Delhi page no.1-240.
6. Trujillo, A, Thurman, H (2019)Essential of Oceanography, Pearson, 13th Edition. Page no. 1-551
7. Keller, E. A. (2010)Environmental Geology, Pearson; 9 edition page no. 1-624.

Course- AG-C-413, GL-C-413 (4CH)

Objectives of the course:

In these units, 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 minerals with their possible varieties and their occurrence in different types of rocks as a combining unit.

CO:1. Understand the basic properties (physical, optical and chemical) of minerals, its classification and uses.

CO: 2. Analyse various concepts of optical phenomena with mineral identification
CO: 3. Apply the theoretical knowledge ofmineral structure and properties through hands-on laboratory practice
CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

a) Mineralogy

Silicate structures, atomic substitution, Isomorphism, polymorphism and pseudo-morphism.; Study of important silicate groups:Olivine, Pyroxene, Amphibole, Feldspar, Silica, Garnet, Alumino- silicates, Mica, Feldspathoids and Clay minerals. Study of oxides, sulphides, sulphates, phosphates, carbonates, halides and native elements.

b) Optical mineralogy

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 colonoscopic (convergent light) set-up.

Books recommended:

1. Dana, E. S. (2006)A Text Book of Mineralogy, CBS Publishers & Distributors; 4th edition, page no.1-156.
2. Dexter Perkins (2002) Mineralogy, Prentice-Hall of India, New Delhi
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, Mineralogical Society 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.

Course- AG-C-414, GL-C-414 (4CH)

Objectives of the course:

In this course, different types of earth features and their causative geological agents have been described. The students can analyse the type of agents that have shaped a particular zone of the earth's surface.

Expected outcome:

In this course, 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.

CO: 1 Understand the basic concepts of Geomorphology and Remote Sensing
CO: 2. Analyse various concepts of remote sensing concerningthe management of various Earth resources and understand them through case studies
CO: 3. Apply the theoretical knowledge in understanding various themes and preparing maps through hands-on laboratory practice
CO: 4 Execute field studies to verify the theoretical knowledge gained in the course.

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;Physiographic divisions of India, Tectonic geomorphology.

b) Geostatistics and Remote Sensing

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.

Fundamentals of computers, Benefits of Remote Sensing over conventional method of resource survey. Components of Remote Sensing System. Electromagnetic Radiation (EMR), Nature and generation of EMR; Effects of atmosphere on EMR and its interaction with rocks minerals vegetation, water, soil etc. Platform, Role of the platform in Remote Sensing, Types of platforms with their specific uses. Fundamental properties of sensors and their functions. Basic features of different types of sensors in use, RS data products, Principles of RS data analysis and their application.

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, Page1-784.
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.
6. Anji Reddy, M. (2006) Geoinformatics for Environmental Management, BS Publications, Hyderabad,page no. 1-435.

Course- AG-C-415, GL-C-415 (2 CH)

(Practical Corresponding to Course No. AG. C.411 and AG. C.412)

CO: 1. Understand the various crystal classes and meteorological phenomena.
CO: 2. Analyse various concepts of crystallography with crystal identification
CO: 3. Apply the theoretical knowledge in crystal structure through hands-on laboratory practice and preparation of weather charts. Apply different statistical tools to solve geological problems
CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

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

Sample statistics, Histogram, frequency curve, Cumulative frequency curve. Application of statistics to geological problems

Preparation of scatter diagram, histogram, and pie-diagram; Computer application in solving geological problems

Analysis of meteorological data and preparation of maps

Viva and Practical record

Course- AG-C-416, GL-C-416 (2 CH)

(Practical Corresponding to Course No. AG. C.413 and AG. C.414)

CO: 1. Understand various mineral groups and elements of remote sensing.
CO: 2. Analyzeconcepts of mineralogy, optical mineralogy concerning mineral identification
CO: 3. Apply the theoretical knowledge of mineralogy and remote sensing through hands-on laboratory practice and preparation of thematic maps
CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

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, and geomorphic models.Visual interpretation of aerial photographs and satellite imageries.

Course- AG-C-417, GL-C-417 (2 CH)

Environmental Studies and Disaster management

Details of the syllabus will be covered by the concerned department.

Semester II

Course- AG-C-421, GL-C-421 (4CH)

Objectives of the course:

In these units, the students can know the characteristic properties of initial rocks (those formed from molten material known as igneous rocks) 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.

CO: 1. Understand the basic concepts of igneous rocks, their classification, formation and petrogenesis.

CO: 2. Analyse various concepts of igneous petrologyabouttheir identification

CO: 3. Apply the theoretical knowledge in the process of classification, identification and formation through hands-on laboratory practice

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

a) Igneous Petrology - A (Principles of Igneous rock formation)

Concept of magma and its generation, Primary and secondary magma, correlation of magma genesis and plate tectonics, Crystallization behaviour of uni-component magma; bi-component magma showing the solid solution, eutectic and peritectic relationships.Reaction principles and Bowen's reaction series. Variation diagrams, Magmatic differentiation, assimilation; Global consanguineous association;Spatio-temporal variation of Geothermal Gradient. Genesis, properties, emplacement of magmas. Phase equilibrium studies of simple systems, the effect of volatiles on melt equilibria. Magma-mixing, -mingling and -immiscibility.

b) Igneous Petrology - B (Classification and petrogenesis igneous rocks)

Classification of igneous rocks- mineralogical, chemical and tabular classification with special reference to IUGS classification; Petrology and geotectonic evolution of granites, basalts, andesites, syenite, ultramafics, anorthosites and carbonatite.

Books Recommended:

1. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson
2. Turner, F. J. and Verhogen (2002) Igneous and Metamorphic Petrology, CBS; 2 edition page no. 1-185.
3. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
4. Best.(2002) Igneous and Metamorphic Petrology, Wiley-Blackwell; 2 edition, page no. 1-752.
5. Mc Birney, A. R.(2006) Igneous Petrology Jones & Bartlett Learning; 3 edition, page no. 1-550.
6. Hall, A. (1996) Igneous Petrology, Prentice Hall; 2 edition page no. 1-568.
7. Gupta, A. K.(2007) Igneous Rocks, Narosa Pub Housepage no. 1-450.
8. Tyrell, G. W.(1926)The Principles of petrology,Chapman and Hall; New edition page no. 1-364.

Course- AG-C-422, GL-C-422 (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 knowledgeon 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.

CO: 1. Understand the basic concepts of metamorphic and sedimentary rocks, their classification, formation and petrogenesis.

CO: 2. Analyse various concepts of metamorphic and sedimentary petrology about their identification

CO: 3. Apply the theoretical knowledge in the process of classification, identification and formation of metamorphic and sedimentary rocks through hands-on laboratory practice

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

a) Sedimentary Petrology:

Processes of formation of sedimentary rocks; Texture and structures (mechanical, chemical and biogenic of sedimentary rocks, Classification and description of Sandstone, Shale and Limestone; Depositional environments - Marine, Estuarine, Lacustrine and Eolian, Concept of sedimentary facies.

b) Metamorphic Petrology:

Concept of metamorphism; Types, causes and agents of metamorphism; Metasomatism; Texture and structure of metamorphic rocks, Concept of equilibrium and mineralogical phase rule. Mineral paragenesis, Graphic (ACF, AKF and AFM) diagrams and their application. Classification of metamorphic rocks, concept of zones, grades and facies. Plate tectonics and metamorphism; Important metamorphic rocks of India - KhondaIite, 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,pageno. 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&MetamorphicBelts, Springer, page no. 1-492.
6. Bhaskar Rao, B. (1986)Metamorphic Petrology, 1st Edition CRC Press, page no. 1-190.

Course- AG-C-423, GL-C-423 (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 and relative age of rocks. They shall have the knowledge of the mechanism of formation of continents, sea and mountain ranges.

CO: 1. Understand the basic concepts of metamorphic and sedimentary rocks, their classification, formation and petrogenesis.

CO: 2. Analyse various concepts of metamorphic and sedimentary petrology in relation to their identification

CO: 3. Apply the theoretical knowledge in the process of classification, identification and formation of metamorphic and sedimentary rocks through hands on laboratory practice

CO: 4. Execute field studies so as to verify the theoretical knowledge gained in the course.

CO: 1. Understand the basic concept of Structural Geology and Geotectonics

CO: 2. Analyse various concepts of Structural Geology to depict the deformation and tectonic history of the earth and to understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding various phenomena and preparing structural maps through hands-on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

a) Structural Geology

Concept of stress and strain; Elastic, plastic and brittle deformation. Classification and genesis of fold, fault, shearzone, joint, foliation, lineation and unconformities andrecognition of the above structures in the field. Tectonites, Effects of fold, fault and unconformity on outcrop pattern.

b) Geotectonics

Continental drift hypothesis(Wegener's concept of drift theory**)**and its supporting evidence (geometric, structural, palaeontological, lithological, stratigraphical, glaciological, climatic, paleomagnetic evidence)Concept of seafloor spreading, Rift valley, Mid-oceanic ridges, Island arcs, Plate tectonics (Plate boundaries and Triple Junction), concept of Wadati–Benioff zone, Triple junction, Hot spots.

Books Recommended:

1. Billings, M. P.(1972)Structural Geology, Pearson College Div; 3 editions, page 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.
5. Valdiya, K. S. (1985)Aspects of Tectonics, McGraw-Hill Educationpage no. 1-304.
6. Condie, K. C.(1989)Plate tectonics and Crustal development, Pergamon; 3 edition, page no. 1-504.

Course -AG-C-424, GL-C-424 (2CH)

a) Practical corresponding to Course GL-C-421 and GL-C-422

CO: 1. Understand various rock types

CO: 2. Analyse various concepts of petrology to rock identification

CO: 3. Apply the theoretical knowledge of petrology through hands-on laboratory practice and preparation of various diagrams.

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

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 a rose diagram drawn from supplied data.

Practical Record and Viva

Course – AG-C-425, GL-C-425 (2CH)

CO: 1. Understand various concepts of Structural Geology.

CO: 2. Analyse various concepts of structures aboutrock types

CO: 3. Apply the theoretical knowledge of structures through hands-on laboratory practice and preparation of structural and base maps

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

Practical Corresponding to Course GL-C-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.

Report on geological mapping,Viva and Practical Record

Course- AG-C-426, GL-C-426 (4 CH) Seminar and Field Report.

Interdisciplinary Course (IDC)- GL-C-427 (4CH)
(General Geology, For other Departments)

CO: 1. Understand the fundamentals of the Solar System & Origin of Earth.

CO: 2. Internal structure of the earth and ideas on earthquakes and volcanoes

CO: 3. Brief ideas on the Isostasy and Weathering process.
CO: 4. Home assignments on the above topics.

Unit-I

General characteristics of the solar system, Origin of the earth(cataclastic and evolutionary hypotheses), Age of the earth.

Unit-II

Internal constitution of earth, Earthquakes and Volcanoes

Unit-III

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

Books Recommended:

1. Mukherjee P.K.(1931) A text book 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 and Distributors.

Semester –III

Course- AG-C-511, GL-C-511 (4CH)

Objectives of the course: In this course, the students can know the characteristic properties, origin, movement and types of groundwater.**T**he students can also know the requirements of geology for the construction of various engineering structures such as bridges, tunnel etc.

Expected outcome:

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

CO: 1 Understand the basic concepts of groundwater geology and Engineering Geology

CO: 2. Analyse various aspects of groundwater and engineering structures concerning various rock types and understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding various aspects through physicochemical analysis and preparation of maps through hands-on laboratory practice

CO: 4 Execute field studies to verify the theoretical knowledge gained in the course.

a) Hydro-geology

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.

Geological, Geophysical and Geochemical methods of groundwater exploration; Role of remote sensing in groundwater exploration;Types of water wells and methods of construction; Design, development, maintenance and revitalization of wells;

Physical and chemical properties of water; Quality criteria for different uses; Graphical presentation of groundwater quality data, Ground water quality with special reference to Odisha.

b) Engineering Geology

Engineering properties of rocks and soil, Mohr circle and failure theories, Rock Quality Designation. Geological investigation of the dam site, reservoir site, tunnels and bridges, Rock slope stability;Properties and selection of construction material.

Books Recommended:

1. Todd, D. K. (2015) Groundwater 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) Groundwater 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. Kesavulu, C. (2018), Text Book of Engineering Geology, Laxmi Publications Pvt Ltd, Third edition, Pagr no. 1-488.
7. Jager and Cook, (2012) Fundamentals of Rock mechanics, Wiley India Pvt. Ltd; Fourth edition, pages no 1-488.

Course- AG-C-512, GL-C-512 (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.

CO: 1 Understand the basic concepts of formation and exploration of mineral deposits and geochemistry.

CO: 2. Analyse various aspects of formation mechanism concerning various ore deposits and understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding various economic mineral deposits through phase diagrams and hands-on laboratory practice

CO: 4 Execute field studies to verify the theoretical knowledge gained in the course.

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

b) Theories of Mineral Formation, Mineral exploration and Surveying

Processes of formation of economic minerals; Controls of ore localization; Metallogenic provinces and epochs; Geological, geophysical and geochemical methods of prospecting; Principles of sampling, assaying, drilling, and core logging. Chain and Compass, Plane Table and Theodolite survey, GPS survey.

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.

Course- AG-C-513, GL-C-513 (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.

CO: 1 Understand the basic concepts of ores and industrial minerals.

CO: 2. Analyse various aspects of ores and industrial mineral deposits such as genesis, distribution, mode of occurrences, uses and understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding and identifying various ores and industrial mineral deposits through phase diagrams and hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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.

Course- AG-C-514, GL-C-514 (4CH)

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

Expected outcome:

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

CO: 1 Understand the basic concepts of coal, petroleum and nuclear minerals.

Understand the different provisions of mineral economics, and environmental and mining laws.

CO: 2. Analyse various types of coal, petroleum and nuclear minerals such as genesis, distribution, mode of occurrences, and uses and understand them through case studies.

AnalyseNational Mineral policy, and environmental and mining laws.

CO: 3. Apply the theoretical knowledge in understanding and identifying various coal types and nuclear mineral deposits through hands-on laboratory practice

CO: 4 Execute field studies to verify the theoretical knowledge gained in the course.

a) Fossil Fuels, Nuclear Minerals and Mineral economics

Mode of occurrence, genesis and Indian distribution of Coal and Petroleum. Mode of occurrence, genesis and Indian distribution ofNuclear Minerals. Need and methods of resource evaluation and reserve calculation of economic mineral deposits. National Mineral Policy. Strategic, essential and critical minerals.

b) Environmental Laws and Mining Laws

Mining Legislations- Relevant sections/rules for restoration of Environmental Mines Act 1952, The Mines Rules 1955, The Mines and Minerals (Development and Regulation) Act 1957; The Coal Mines Regulations 1957, The Metalliferous Mines Regulations 1966, The Mineral Conservation and Development Rules, 1988, The Mineral Concession Rule, 1960

Environmental Act- Salient features of The Water Act, 1974 (Area of Jurisdiction, Constitution of Pollution Control Broads, Power and Function of Central and State Boards); The Air Act, 1981 (Area of Jurisdiction, Constitution of Pollution Control Broads, Power and Function of Central and State Boards); The Water Cess Act, 1977, The Environment Protection Act, 1986 (Powers of Central Government)

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.

Course- AG-C-515, GL-C-515 (2CH)

Practical Corresponding to Course No. GL-C-511 and GL-C-512

CO: 1. Understand various rock aquifer properties, engineering properties of soils and rocks and surveying.

CO: 2. Analyse various aquifer parameters about groundwater and engineering structure

CO: 3. Apply the theoretical knowledge of hydrology and engineering geology through hands-on laboratory practice, preparation of various diagrams and conducting surveying.

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

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

Engineering geological problems.

Blowpipe analysis of mineral powder and titration methods to determine the composition of minerals.

Chain and Compass, Plane Table and Theodolite survey. GPS survey

Viva and Practical record

Course- AG-C-516, GL-C-516 (2CH)

Practical Corresponding to Course No. GL-C-513 and GL-C-514

CO: 1. Understand various ores and industrial minerals.

CO: 2. Analyse various concepts of economic geology about their economic properties.

CO: 3. Apply the theoretical knowledge of economic geology through hands-on laboratory practice and preparation of various maps and flow charts.

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

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, magnctite, pyrite, galena, chromite, chalcopyrite, pyrolusite and psilomelane etc.) under reflected light. Flow charts of mineral beneficiation. Maps showing the distribution of mineral and ore deposits.

Viva and Practical Record

Course- AG-C-517, GL-C-517 (4CH)

Entrepreneurship Development Program

Details of the syllabus will be covered by the concerned department.

Semester-IV

Course-AG-C-521, GL-C-521 (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 interpretPalaeoenvironment, Palaeobiodiversity, Palaeoclimate, Palaeovegetation, Palaeoecology, Palaeolandscape etc.

CO: 1. Understand the basic concepts of the evolution of life.

CO: 2. Analyse various aspects of fossil science (vertebrate, invertebrate, plant, spore, pollen and microfossils)about their identification

CO: 3. Apply the theoretical knowledge of classification, identification, evolution and morphology through hands-on laboratory practice

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

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, and Graptolites.

b) Paleobotany, Paleopalynology,Vertebrate Paleontology and Micropaleontology

Classification of plant fossils; Gondwana flora of India, stud*y of Glossopteris, Gangamopteris, Verebraria, Nilsonia*and*Ptylophyllum,* Basic concepts of paleopalynology.

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.

Course - AG-C-522, GL-C-522 (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.

CO: 1. Understand the basic concepts of principles of stratigraphy.

CO: 2. Analyse various aspects of chronology concerning their lithology, fossil contents and economic importance.

CO: 3. Apply the theoretical knowledge of stratigraphic correlation through hands-on laboratory practice.

CO: 4. Execute field studies to verify the theoretical knowledge gained in the course.

a) Precambrian Stratigraphy

Principles and code of stratigraphic nomenclature. Standard geological time scale, Stratigraphic correlation; Indian stratigraphy- geological evolution of Archean Craton

(Dharwar, Bastar, Singhbhum-Odisha); Proterozoic mobile belts Eastern Ghats Mobile Belt, Central Indian Tectonic Zone, North Singhbhum Mobile Belt;StratigraphyofVindyan basin, Cuddaph basin and Chhattisgarh basin. Proterozoic rocks of Himalayan belt.

b) Phanerozoic Stratigraphy

Cambrians of Peninsular area; Paleozoic rocks of Extra Peninsular area; Phanerozoic stratigraphy of India: Spiti,Kutch, Narmada, Trichinopoly, Siwaliks. Deccan Traps, Tertiary rocks of Assam, Siwaliks, Quaternary stratigraphy of India

Books Recommended:

1. Ramakrishnan,M. and Vaidyanadhan,R.(2008)GeologyofIndiaVolumes1& 2, Geological society of India, Bangalore.
2. Weber. (2004)Principles of Stratigraphy, Wiley-Blackwell; 1 edition page no. 1-340.
3. Krumbein and Sloss. (1951)Stratigraphy and sedimentation, San Francisco, CA: W. H. Freeman & Company,page no. 1-497.
4. Dunbar. C. O. (1960)Historical Geology, Wiley; Chapman & Hall, page no. 1-500.
5. Krishnan, M. S. (2009)Geology of India and Burma, CBS; 6 editionpage no. 1-536.
6. Wadia. D. N. (1975)Geology of India, McGraw Hill Education India Pvt Ltd; 4 editionpage no. 1-560.
7. Ravindra Kumar (1998) Historical Geology and Stratigraphy of India, NEW AGE; First edition, page no. 1-268.

Course – AG-C-523, GL-C- 523 (4CH)

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

Course -AG-C-524, GL-C-524 (2CH)

Practical Corresponding to Course GL-C-521 and GL-C-522

CO: 1. Understand the basic concepts of principles of Palaeontology and Stratigraphy.

CO: 2. Analyse various branches of palaeontology chronology in relation to identifications of fossils (vertebrate, invertebrate, plant, spore, pollen and microfossils)

CO: 3. Apply the theoretical knowledge of morphology of fossils for identification through hands on laboratory practice.

CO: 4. Execute field studies to fossil sites so as to verify the theoretical knowledge gained in the course.

Identification 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

Course –AG-C-525, GL-C- 525 (2CH)

Practical Corresponding to Course AG. E. 523 and dissertation/ field Report.

Course- AG-C-526, GL-C-526 (4CH)

Project

Course- AG-C-523, GL-C- 523 Elective (any one)

i) Geoinformatics

CO: 1. Understand the basic concepts of Remote Sensing and GIS.

CO: 2. Analyse various aspects of Remote Sensing and GIS in relation to image classification and image interpretation

CO: 3. Apply the theoretical knowledge of Digital image processing and GIS through hands on laboratory practice using aerial photographs and satellite imageries.

CO: 4. Execute field studies so as to verify the theoretical knowledge gained in the course.

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 LongmanPage 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 WileyPage no.1-911.

ii) Digital image processing and Geographic information system

CO: 1. Understand the basic concepts of Digital image processing and GIS.

CO: 2. Analyse various aspects of Remote Sensing and GIS in relation to image classification and image interpretation

CO: 3. Apply the theoretical knowledge of Digital image processing and GIS through hands on laboratory practice.

CO: 4. Execute field studies so as to verify the theoretical knowledge gained in the course.

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

CO: 1 Understand the basic concepts of origin, mode of occurrence, classification and distribution of coal and its petrology.

CO: 2. Analyse various aspects of coal such as genesis, distribution, mode of occurrences, uses and understand them through case studies.

CO: 3. Apply the theoretical knowledge in understanding and identifying various coal types and macerals through hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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 editionPage 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

CO: 1 Understand the basic concepts of Isotope Geology.

CO: 2. Analyse various aspects of Isotope Geology such as atomic structure, radioactivity and application of isotopes in geological studies and to understand them through case studies.

CO: 3. Apply the theoretical knowledge in understanding isotopes through hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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

CO: 1 Understand the basic concepts water resources and their management

CO: 2. Analyse various aspects of water resource management with reference to various their types and understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding various aspects through physicochemical analysis and preparation of maps through hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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

CO: 1

Understand the facets of environmental management and various types natural hazards (causes, consequences, mitigation measures) and energy resources.

CO: 2. Analyse various concepts of environmental geology and natural hazards and understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding various phenomena through preparation of maps.

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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

CO: 1. Understand the basic concepts of Micropalaeontology and palaeobotany

CO: 2. Analyse various aspects of fossil science (plant, spore, pollen and microfossils) in relation to their identification

CO: 3. Apply the theoretical knowledge of classification, identification, evolution and morphology through hands on laboratory practice

CO: 4. Execute field studies so as to verify the theoretical knowledge gained in the course.

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 paleogeographic maps, identification of plant fossils.

Books reconimended:

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:

CO: 1 Understand the basic concepts of ores with special emphasis on their genesis.

CO: 2. Analyse various aspects of ore deposits such as genesis, distribution, mode of occurrences, uses and understand them through case studies

CO: 3. Apply the theoretical knowledge in understanding and identifying various ore deposits through phase diagrams and hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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 & their classification scheme, Immiscible liquid segregation, Ores in felsic rocks: End-stage processes during felsic magmatism and their ore genetic significance; Hydrothermal fluids, plurality of sources, Wall rock alteration,Clastic sedimentation and heavy mineral concentration – placerdeposits, Chemical sedimentation – banded iron-formations.Fluid inclusion studies,

Stable isotope studies, Stratiformand stratabound ores, Ores and metamorphism, cause and effect relations. PGE deposits, Modern analogues of ore-formingprocesses – the VMS–SEDEX deposits

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 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.
6. Robb, L(2005) Introduction to Ore-Forming Processes, Blackwell Publishing company, Australia, page no.1-372
7. Misra, Kuala.C (2000) Understanding Mineral Deposits, Kluwer Academic Publishers, page no,1-845.

ix) Clay Mineralogy & Soil Geology

CO: 1 Understand the basic concepts of Pedology.

CO: 2. Analyse various aspects of soil science such as soil Chemistry, classification of soils. Soil types, soil erosion, soil conservation. soil pollution and prevention

CO: 3. Apply the theoretical knowledge in understanding and identifying various soil types through diagrams and hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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 diagenesis 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

CO: 1 Understand the basic concepts of conservation of mineral resources.

CO: 2. Analyse various aspects of mineral resource management such as mineral exploration, ore reserve estimation, National Mineral Policy etc.

CO: 3. Apply the theoretical knowledge in understanding and identifying various economic mineral deposits through phase diagrams and hands on laboratory practice

CO: 4 Execute field studies so as to verify the theoretical knowledge gained in the course.

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 essentia1 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,BiblioLife, page no. 1- 212.

Question pattern

Section A

Fill in the blanks (one mark question: 20 numbers) 1x20

Section B

Long question 4 numbers: 15 marks each 15x4