University of Mysore

(Estd.1916)

M.Sc. GEOLOGY (EARTH SCIENCE)

Choice Based Credit System (CBCS)

UNIVERSITY OF MYSORE

DEPARTMENT OF STUDIES IN EARTH SCIENCE Manasagangotri, Mysuru-570006

Regulations and Syllabus
Master of Geology (M.Sc.)
(MSc. Two-year semester scheme)

Under
Choice Based Credit System (CBCS)

UNIVERSITY OF MYSORE
GUIDELINES AND REGULATIONS LEADING TO MASTER OF GEOLOGY
(M.Sc. TWO YEARS - SEMESTER SCHEME UNDER CBCS)

Programme Details

Name of the Department	:Department of Studies in Earth Science
Subject	: GEOLOGY
Faculty	: SCIENCE
Name of the Course	:MASTER OF SCIENCE IN GEOLOGY (M.Sc.)
Duration of the Course	:MSc. 2 years- divided into 4 semesters

Programme Outcomes

1. Demonstrate knowledge of physical and chemical properties of the lithosphere and hydrosphere (minerals, rocks, soils, and water); geologic time and earth history; and crustal materials and dynamics in the context of plate tectonics theory.
2. Demonstrate competence in fundamental geological skills including: mineral, rock and soil identification; interpretation of topographic maps, geologic maps, and various forms of imagery; construction of geologic maps and cross sections; three-dimensional conceptualization; and collection of organized field and laboratory data.
3. Demonstrate competence in quantitative data analysis including: the construction and reading of graphs; construction and use of spreadsheets; and application of mathematical skills (ranging from algebra to calculus) for analysis of geological systems.
4. Make critical and independent inquiry in the geosciences including: the ability to gather and evaluate peer-reviewed literature; identify a research question; design and conduct a research plan to collect laboratory and/or field data; and interpret research results.
5. Gain an understanding of the societal relevance of earth systems.
6. Effectively communicate ideas, research results, and interpretations using written, oral, and graphical design skills both on a formal and extemporaneous basis.

Programme Specific Outcome (PSO)

1. Demonstrate fundamental knowledge of the physical and chemical properties of the lithosphere and hydrosphere (minerals, rocks, soils, and water); geologic time and earth history; and crustal materials and dynamics in the context of plate tectonics theory.
2. Demonstrate skills in mineral, rock, and soil identification; interpretation of topographic and geologic maps; and interpreting and evaluating geological data, hypotheses and ideas.
3. Gain an understanding of the societal relevance of earth systems.
4. Effectively communicate this knowledge and these skills using written and/or oral methods.

M.Sc. DEGREE COURSE STRUCTURE AND SYLLABUS

First Semester							
Sl. No.	Code	Title of the Paper	Credit pattern in			Credit value	Teaching hours/ week
			L	T	P		
1	16541	Crystallography and Mineralogy	2	0	2	4	
2	16542	Geomorphology, Structure Geology & Surveying	3	0	1	4	
3	16543	Ore Geology	3	0	1	4	
4	16444	Marine Geoscience	2	0	0	2	
5	16445	Environment Geology	2	0	0	2	
6	16446	Climatology	2	0	0	2	

Second Semester							
Sl. No.	Code	Title of the Paper	Credit pattern in			Credit value	Teaching hours/ week
			L	T	P		
1	16551	Fuel Resources & Sequence Stratigraphy	4	0	0	4	
2	16552	Palaeontology	3	0	1	4	
3	16553	Igneous, Sedimentary and Metamorphic Petrology	3	0	1	4	
4	NULL	Minor Projects (FW & Technical Report)	0	0	4	4	
5	16454	Analytical Techniques in Geology	2	0	0	2	
6	16455	Soil & Water Conservation	2	0	0	2	
7	16456	Basics of Earth Science	4	0	0	4	

Third Semester							
Sl. No.	Code	Title of the Paper	Credit pattern in			Credit value	Teaching hours/ week
			L	T	P		
1	16561	Remote Sensing & GIS	2	0	2	4	
2	16562	Geochemistry & Petrogenesis	3	0	1	4	
3	16563	Indian Stratigraphy	3	1	0	4	

4	16564	Gemology	2	0	0	2	
5	16465	Mineral Economics	2	0	0	2	
6	16466	Engineering Geology	2	0	0	2	
7	16467	Industrial Mineral Resources	4	0	0	4	

Fourth Semester							
Sl. No.	**Code**	**Title of the Paper**	**Credit pattern in**			**Credit value**	**Teaching hours/ week**
			L	**T**	**P**		
1	16571	Exploration Geology & Mining Methods	3	0	1	4	
2	16572	Hydrogeology	3	0	1	4	
3	NULL	Major Project (Dissertation)	0	0	4	4	
4	16473	Precambrian Crustal Evolution	2	0	0	2	
5	16474	Crystal Growth & Materials	2	0	0	2	

FIRST SEMESTER

HARD CORE

COURSE-I: CRYSTALLOGRAPHY AND MINERALOGY [Course code – 16541]

You will have a basic insight to the inner structure of crystals, chemical bonding and classification. Theoretical and practical study of the most important rock forming minerals, where they are found, their quality and how they are formed; theoretical and practical insight to the most important processes that leads to the formation of the different types of magmatic and metamorphic rocks. Use of theory to understand the chemical and mineralogical differences between rocks formed in different tectonic environment and under different pressure-temperature conditions.

COURSE OUTCOME

- Students are able to understand the classification of minerals and how their chemical composition and structure influence this.
- Identify the commonest minerals and be able to say whether the rock is magmatic, sedimentary or metamorphic

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Crystallography: Form theory of Crystals, Projections, Derivation of 32 point groups. Zone and Zone Laws, Atomic and ionic radii, Bond length and measurements of Radius, Radius ratio and co-ordination polyhedra, Cordination Number, Pauling's Rules, Spheres in Closest packing, Packing Index. Voids in closest packing, Classification & Co- ordination of voids, Derivative Structures. Crystal Defects / Crystal Imperfections,

UNIT-II: Mineralogy: Structure, Chemistry, Paragenesis, optical and physical properties of Olivine, Garnet, Al_2SiO_5 group, Epidote, Pyroxene, Amphibole, Mica, Feldspar and Silica group of Minerals.

PRACTICAL-I : Crystallography: Determination of Grades of symmetry in Crystals and their projections. Determination of Axial Ratios and angle between the faces by using Stereonet.

PRACTICAL-II : Mineralogy: Identification of rock forming minerals. Determination of mineral formula based on mineral analysis. Plotting mineral compositions in a trilinear diagrams

COURSE-II : GEOMORPHOLOGY, GEOTECTONICS & SURVEYING [Course code – 16542]

The scientific study of the origin and evolution of topographic and bathymetric features created by physical, chemical or biological processes operating at or near the Earth's surface. Structural geology is the study of the deformation of the surface and subsurface of the Earth and other planetary bodies. This deformation reflects past changes in local and regional stress and strain, and can be used to reconstruct past crustal movements and dynamics. Surveying or land surveying is the technique, profession, art and science of determining the terrestrial or three-dimensional positions of points and the distances and angles between them. Surveying has been an element in the development of the human environment since the beginning of recorded history. The planning and execution of most forms of construction require it. It is also used in transport, communications, mapping, and the definition of legal boundaries for land ownership. It is an important tool for research in many other scientific disciplines.

COURSE OUTCOME

- Students are capable to understand why landscapes look the way they do, to understand landform history and dynamics and to predict changes through a combination of field observations, physical experiments and numerical modeling.
- Students will be able to describe and interpret geologic structures in unfamiliar geologic maps and aerial/satellite images, to construct cross sections, to infer geologic history from map and image data, and to interpret structures in the context of regional tectonic history.
- Students will be able to make appropriate observations of structures at different scales, ask relevant questions, collect and/or evaluate appropriate data, and make evidence-based interpretations about the processes and histories by which the rocks reached their present form.
- Students will be able to combine the tools and concepts of structural geology with other geologic and geodetic data sets to evaluate the context, setting, cause and risk of damaging earthquakes and associated hazards in a particular area and make related informed decisions.
- Gain the ability to use modern survey equipment to measure angles and distances.
- Gain a basic understanding of the principles and operation of the Global Positioning System.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: GEOMORPHOLOGY: Principles of Geomorphology, Relief orders of Earth. Exogenetic and endogenetic processes. Land forms formed through fluvial , glacial, Aeolian, coastal and karst geomorphic process. Principles of terrain classification – landscape and parametric divisions. Role of geomorphology in selecting sites Irrigation in arid and semi arid regions- advantages and reclamation processes, Interpretation of drainage patterns.

UNIT-II: ROCK DEFORMATION: Earth forces, Static and dynamic conditions, Mechanical characters of the rock. Kinds of Rock deformation: Mechanics of deformation. Relationship between Stress and Strain in rock compressive strength, tensile strength, Shear strength in rock;, Mechanics of Plastic deformation, Stress and strain ellipsoids. Behavior of minerals and rocks under deformation conditions. Stress strain relationship of elastic, plastic and viscous materials. Experimental studies of rock deformation, evidences of formal deformation. Uses of Mohr representation various stress conditions. Mohrs circle and Envelop. Modulus of Elasticity.

UNIT-III: FOLDS AND FOLDING: Single fold, fold system classification of folds. The distribution of strain in folds, mechanism of development of folds, types of folds. Fault and faulting: faulting terminology, Breccias and Mylonite. Slickensides**'**s and drag structures, classification: Genetic and Geometrical, types of faults. Recognition of fault in the field, uses of faults. Joints: classification and types of joints, joint sets and system, joint surfaces, relation of joints to other structures origin of joints. Unconformities, Plutons, Cleavage and Schistosity, Foliation: axial plane of foliations, origin of axial plane foliation, preferred orientation of layer silicates. Transposed foliation-Development of transposed foliation, Recognition of transposition. Lineation: slickenside striae, mineral lineations, pebbles, boulders, mullion and boudins, Origin of lineation.

PRACTICAL-I : Construction of geological cross-section, structural contour maps, Tracing of outcrops, Interpretation of underground structure from borehole data, solution to fault problems, use of stereographic projection in structural calculation, construction of rose diagram for structural data.
Chain survey, Compass survey, Plane table survey, Dumpy level survey, GPS survey, Total Station Survey.

REFERENCE:

1. Geomorphology by William D. Thornbury.
2. Modern Physical Geography by Arthur N. Strahler & Alan H. Strahler.
3. Applied Geomorphology by Hails.
4. Billings, M.P.(1978) Structural Geology – Prentice – Hall of India Private Ltd. New Delhi.
5. Suppe, J.(1985) – Principles of structural geology – Prentice – Hall.
6. Price, N.J. and Cosgrove, J.W. (1990) Analysis of Geologiucal Structure. Camb. Univ. Press.

7. Hobbs, B.E. Means D and Millions, P.F. (1976) an outline of structural geology. Press.
8. Ramsay, J.G. (1967) – Folding and fracturing of rocks. Mc.Graw Hills New Yark.
9. Badgley P.C. – Structural Geology for the exploration geologist.
10. Whitten, T- Structural Geology.
11. Ramsay, J.G. Structural Analysis of Metamorphic Tectonites.
12. Surveying and Levelling – Late T.P. Kanetkar and S.V. Kulkarni.
13. Surveying – Punmia.

COURSE-III : ORE GEOLOGY [Course code – 16543]

This course covers the distribution, geological setting and genesis of metalliferous mineral deposits. Factors controlling the formation of these deposits and the linkages with many other geologic processes covered in other courses are explored. Practical work involves mineralogy and study of a range of classic mineral deposits. Ore is natural rock or sediment that contains desirable minerals, typically metals that can be extracted from it. The grade of ore refers to the concentration of the desired material it contains. The value of the metal an ore contains must be weighed against the cost of extraction to determine whether it is of sufficiently high grade to be worth mining.

COURSE OUTCOME

Upon successful completion, students will have the knowledge and skills to:

1. Recognize common ore minerals in hand samples and under the microscope
2. Demonstrate familiarity with a wide range of mineral deposits, including recognising the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits
3. Relate overall geometry, zonation and alteration patterns of rock associations to specific classes of metallic mineral deposits.
4. Evaluate different processes of element enrichment by fluids and melts to from ore bodies.
5. Inform peer students and the wider public how understanding the formation of ore bodies is important in the current debates about global resources

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Ore – bearing fluids: magma, hydrothermal fluids, meteoric waters, seawaters, connate waters, metamorphic fluids. Depositional textures: exsolution, replacement, colloidal – colloform and open-space filling textures. Wall rock alteration: reaction between wall rocks and fluids, alteration assemblages and types of alteration. Paragenesis and zoning in mineral deposits. Classification of ore deposits. Deposits related to ultramafic-mafic rocks (layered intrusions, anorthosites, kimberlites, carbonates, komatiites). Deposits related to intermediate to felsic rocks (Iron deposits, porphyry Mo, pegmatites, granitic Tin and U, skarn deposits with typical examples).

UNIT-II: Deposits related to weathering – Nickel laterite deposits, Deposits related to clastic sedimentation: placer deposits – Witwatersrand gold and U deposits. Chemical sedimentation: phosphate deposits, evaporates, manganese nodules, Ore deposits related to subaerial (Epithermal gold – Au) and submarine volcanism (Kuroko Cu–Zn, Japan, BIFs). Ore deposits related to metamorphism, metallogenic provinces, Epochs and plate Tectonic – classification of ore deposits.

UNIT-III: Metallic deposits of India: Iron, Manganese, Copper, Chromium, Gold, Lead, Zinc and Bauxite deposits, Non-metallic deposits (Industrial minerals) – Minerals used as fertilizers, refractories, abrasives, pigments, ceramic and glass-making materials.

PRACTICAL: Optical methods in minerals: Determination of pleochroic scheme and optic sign in minerals. Birefringence. Identification of ore minerals based on optical properties: chromite, ilmenite, Ti-magnetite, hematite, pyrite, sphalerite, galena, chalcopyrite, covellite, Bornite, pyrrhotite, Arsenopyrite, Pyrolusite.

REFERENCE:

1. The geology of ore deposits-John M. Guilbert and charles. F.Park, Jr.W.H.Freeman & Co.,NewYork.1986.
2. Interpretation of ore textures - Bastin, E.S.
3. Economic Mineral deposits by Jenson and Bateman, A.M.
4. Ore microscopy -Cameraon, E.N.
5. Textures of the ore minerals - Edwards, A.B.
6. Ore deposits - Park, Jr. C.F.
7. Geology of Mineral deposiits - Smirnov, U.J.
8. The ore minerals and their intergrowths - Ramhor, Dr. Paul.
9. Ore Petrology - Stanton, R.L.
10. India's mineral resources – Sinha and Krishnaswamy, S.
11. Metallic and Industrial minerals - Lamey Carl, A.
12. Introduction to India's economic minerals - Sharma, N.L. & Ram . K.S.
13. A treatise on industrial minerals of India-Sinha, R.L.
14. Mineral deposits of India, Mukerjee 1999: Allied publications.

SOFT CORE

COURSE-IV : MARINE GEOSCIENCES [Course code – 16544]

This course explores the fundamentals of oceanography, and emphasizes the climatic and environmental importance of the oceans. It helps to understand the processes in the formation of ocean basins, the physical structure of the ocean and the atmosphere, the dynamics of ocean and atmospheric processes, and how they influence marine productivity and biology, and climate.

COURSE OUTCOME

- A student will understand and learn about the basic concepts of oceanography and marine geology with respect to geology as to enable them to work as a marine researcher.
- The students will equip themselves with knowledge and skills related to dealing with the physical and chemical components and phenomena related to oceanography and marine geology.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Introduction Marine Geology. Continental margins and ocean floors. Plate boundaries and movements. Sea-floor spreading and subduction zones. Classification of sub marine topography. Physiographic features of the ocean floor. Oceanographic exploration instruments. Seamounts. Submarine canyons. Mid-ocean ridges. Oceanic trenches. Physico- chemical characteristic of sea water. Depth-wise distribution of temperature, salinity and density of sea water. Marine life and marine environment.

UNIT-II: Ocean water Circulation. Factors and Mechanisms. Ocean Waves- their causes and distribution. Ocean Tides- their causes and effects. Oceanic Currents - their types, patterns of distribution and their significance. Tsunamis. Ocean sediment deposits- sources.-their Types and distribution. Marine natural resources. Types of marine mineral resources and their distribution. Marine energy resources. Marine Placer deposits. Manganese nodules and the methods of exploitation.

REFERENCE:

1. Maohotra,A K, Ocean Science and Technology
2. Tchernia,P, Descriptive regional oceanography
3. K.Siddhartha, Oceanography- A brief Introduction
4. Willam A Anikouchine and Richard W Stenberg, The world Ocean- An Introduction to oceanography
5. Cuchlaine A M King, Oceanography for Geographers
6. H V.Thurman, Introduction to oceanography
7. Willam A Anikouchine and Richard W Stenberg, The world Ocean- An Introduction to oceanography
8. Cuchlaine A M King, Oceanography for Geographers
9. H V.Thurman, Introduction to oceanography.
10. Marine Geology,James P. Kennett,Prentice-Hall, 1982 - Science - 813 pages
11. Marine Geology,H. Kuenen,Read Books, 01-Mar-2007 - Science - 592 pages

COURSE-V : ENVIRONMENTAL GEOLOGY [Course code – 16545]

The lecture part of the course begins with a brief overview of the earth's systems and processes. The succeeding discussion of natural hazards includes earthquakes, volcanoes, floods, and coastal zones allows for more focused discussions on processes, observations, and interpretations, which, as a whole, demonstrate the procedure of collecting, reducing, and interpreting data and applying models to better understand the interrelationships.

COURSE OUTCOME

- Students should be able to predict potential hazards for any given area by knowing basic inherent geologic materials and characteristics of a given area.
- Students should be able to both predict and analyze the impacts of the occurrence of a natural hazard in a given area.
- Students should be able to evaluate the compatibility of a given area to proposed uses of the land given the necessary geologic data.
- Students should be able to synthesize multiple data sets into a viable analysis of environmental impacts of both human-induced and naturally-occurring events.
- Students should be able to evaluate the validity of various reports and models concerning global changes, including global climate.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I:INTRODUCTION TO ENVIRONMENTAL GEOLOGY. MAN and environment. Earth**'**s system, Interactions among lithosphere, hydrosphere, atmosphere and biosphere. Geological process affecting the environment. Environmental hazards created by man**'**s **a**ctivities such as mining and industrial activities. Disasters Management,Environmental Risk Assessment, Environment hazard, Risk safety. Impact of climate on various earths systems, Flood hazard zonation mapping and risk analysis and relief aspects. Public perception of risk, risk communication. Environmental Impact Assessment. Causes of Environmental degradation. Environmental law and ethics.

UNIT-II: LAND POLLUTION: Water, land and soil pollution. Causes and effects of urban and industrialization. Land use planning and terrain evaluation for environmental management.. Solid Wastes and their methods of Management. Sewage sources and their treatment methods. **Marine pollution:** Causative factors – land based sources – marine based sources – types of pollution – oil spills – process of oil spill process and its effects on marine and continental environment. Global warming causes and its effects.

REFERENCE:

1. Environmental Geology – Peter TP Flawn
2. Environmental geosciences – Arthur H Strahler & Alan Strauler
3. Geology in Environmental planning- A.D. Howard & I.Ramson
4. Focus on Environmental Geology –R Turk
5. Environmental Science –S C Santra
6. Environmental geology by Waldia K.S

COURSE-VI : CLIMATOLOGY [Course code – 16546]

Consequences of global climate change already include: increased drought, heat waves, flood intensity, glacial retreat, and sea level rise. Solutions are needed to reduce human impact on our climate system and to respond to climate change impacts across sectors vital to humanity (food, water, health). This course examines climate change at global and local scales. Students explore climate challenges faced by local experts and create climate solutions modules or advocacy resources for a public event. They reflect on implications for future problem solving.

COURSE OUTCOME

- Students will analyze figures to understand natural and human-influenced drivers of our climate system and implications
- Students will be able to assess the credibility of scientific information
- Students will communicate locally-relevant climate change solutions to a non-science audience
- Students will make informed & responsible decisions with regard to our climate system.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Definition of Climate and weather. Climatology, its meaning, aims and methods. Climatology as distinguished from meteorology. The Climatic elements. Order of treatment of climatic elements. Earth's Atmosphere- Structure and properties of Atmospheric layers. Solar Climate and Physical Climate. Continental and Marine Climate. Temperature as a climatic element. Atmospheric Moisture, humidity, precipitation, and cloudiness. Types of clouds and Fogs. Major circulation of air as local winds. Atmospheric distribution of pressure. Climatic factors on Evaporation and Condensation. Factors influencing global climate. Dust content in air and principles of atmospheric visibility. Climatic zones and their subdivisions. Classification of climates,- Koppen's and Thornthwaite's scheme of climatic Classifications. Characteristics of various climatic zones.

UNIT-II: Changes of Climate- Natural factors- Geological and secular changes, periodic variations and Role of Anthropogenic activities in climatic changes with case studies. Climate Observations, stations and networks. Climate data management. Instruments and climatic measurements. Thermometers, barometers, hygrometers, rain and snow gauges, Sunshine recorders. Weather maps and charts. Extreme climatic events- Cyclones, Jet Streams, Western Disturbances, Ozone Depletion, Storms, Hurricanes and Tornadoes. Droughts. Elements of Weather forecast and methods. Global Climate Models. General Weather Systems of India. Monsoon systems. Green house effect,

REFERENCES:

1. Climatology: An Atmospheric Science, 2/e, Pearson Education India, 1993 - 423 p.
2. Encyclopedia of World Climatology,John E. Oliver, Springer Science & Business Media, 2008, 854 p.
3. Climatology, Majid Husain, Anmol Publications, 1994 - 376 p.
4. Advances in Meteorology, Climatology and Atmospheric Physics,Costas Helmis, Panagiotis T. Nastos,

Springer Science & Business Media, 2012 , 1278 p.
5. Remote Sensing Applications in Meteorology and Climatology, Robin A. Vaughan, Springer Science & Business Media, 2012, 480 p.
6. Applied Climatology: An Introduction, John F. Griffiths, Oxford University Press, Incorporated, 1976, 136 p.
7. Principles of climatology: a manual in earth science, Hans Hermann Neuberger, John Cahir, Holt, Rinehart and Winston, 1969, 178 p.
8. Climatology, an introduction, John E. Oliver, John J. Hidore, Merrill, 1984 , 381 p.
9. Global Physical Climatology, Dennis L. Hartmann, Academic Press, 1994, 411 p.
10. Weather, radar and Flood forecasting, Collings. V. K (1987) John Wiley and sons.
11. General Climatology, Crithfield. H. J, (1996) Prentice Hall, New Jersey.
12. Climatology by Miller, Austin A Publication: London Methuen and company 1961 . xii, 320p.
13. General climatology by Flohn,H[ed.Publication:Amsterdam Elsevier Publishing company 1969. xi, 266p.
14. Climatology by Miller, A. Austin Publication: London Methuen And Co 1938 . x, 304pp
15. Climatology by Haurwitz, Bernhard Publication: New York Mc Graw-Hill 1944 . xi, 409p.
16. Methods in climatology by Conrad, Victor Publication: Cambridge Harvard University 18. Press 1946 . xx, 228p.
19. Climatology by Kendrew, W G Publication: Oxford The Clarendon Press 1957 . xv, 400p.
20. Climatology by Blair, Thomas A Publication: New York Prentice-Hall 1942 . xvi, 484p.

II SEMESTER

HARD CORE

COURSE-I : FUEL RESOURCES & SEQUENCE STRATIGRAPHY [Course code – 16551]

Coal is largest storehouse of plant derived carbon and organic matter is a potential source of information on climate, tectonics and paleogeography which serves as a cheapest source of energy worldwide. Major objective of the course is to make students understand fundamentals of coal, coal forming environments and processes, coal: petrography, classification, analytical techniques of coal. Concept of macerals and its application in climate and paleogeography and coal seam correlation will be covered. Application of coal for various industries will be discussed. Understanding will be developed for coal as an unconventional source of energy viz. CBM and synthetic crude oil and its environmental impact. A student will understand and learn about the basic concepts of fuel resources and stratigraphy with respect to geology as to enable them to work as a Petroleum Geologist. To provide the student essential and basic concepts of Petroleum Geology and to study theprocess and the operations involved in Petroleum exploration. A combination of forcing viz. tectonics and subsidence, Eustacy and Sediment supply shape filling and evolutionary history of any sedimentary basin. Sequence stratigraphy and Basin Analysis deals with subdivision of sedimentary basins fills into genetic packages bounded by unconformities and their correlative conformities.

COURSE OUTCOME

- The students will be appraised about the origin, migration and accumulation of petroleum; it will also provide basic skills in prospecting, drilling and logging operation in oil exploration.
- The students will be capable about the origin of coal; It will also provide basic skills in prospecting, drilling and logging operation in coal exploration.
- The students will be trained to assess about the radioactive minerals and its prospecting and exploration.
- To understand fundamentals of coal, definition and coal forming sedimentary environments, effect of tectonics and sea-level changes on coal formation and its quality.
- To describe the basis of coal classification, concept of grade, type and rank in coal.

- To understand analytical techniques in coal and its importance in coal classification and utilization for various industries.
- To understand key concepts of Base level, Basin Accommodation Space, Eustatic and Relative Sea level change, Transgression/Regression and Stratigraphic cycle.
- To describe geometries of stratal surfaces, their terminations and key role in defining facies packaging
- To understand concepts of Systems Tracts, patterns of facies packaging within Systems Tracts and their bounding surfaces

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Definition and origin of coal. Stratigraphy of coal measures. Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Indian coal deposits.

UNIT-II: Origin, migration and entrapment of hydrocarbons. Characters and source and reservoir rocks. Structural, stratigraphic and mixed traps. Geographical and geological distributions of onshore and offshore petroliferous basins of India.

UNIT-III: Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods of prospecting and assaying of mineral deposits. Distribution of radioactive minerals in India. Nuclear waste disposal=geological constraints.

UNIT-IV: Introduction to Stratigraphy, branches of Stratigraphy. Terms and concepts of Sequence Stratigraphy and its relationship with other branches of Stratigraphy. Sedimentary basin analysis through sequence Stratigraphy. Out crop and subsurface procedures. Global sea level changes/ eustatic sea level. Applications of sequence stratigraphy in petroleum exploration with case studies

REFERENCE BOOKS:

1. Nuclear geology and Atomic mineral Resources – S.N. Virnave. Published by Bharati Bhawan 1995.
2. Mineral Resources of India – D.K. Banerjee. Published by the world press.
3. Radioactive minerals – R. Dhanaraju –2005 published by Geological Society of India.
4. Economic Mineral deposits – A.M. Bateman
5. Geology of Mineral deposits – Smirnov U.G.
6. Indian Mineral Resources – Krishna Swamy.S.
7. Introduction to India Economic Mineral deposits – Sharma, N.L. & Ram, K.S.
8. Basic Petroleum Geology – P.K.Link
9. Petroleum Stratigraphy – R.L.Breuner
10. World Oil Energy Economics – H.A.Kerklelin
11. Jaharia Coal Field – D.Chandra
12. Petroleum Formation and Occurrence – B.P. Tissot
13. Petroleum Geology – Levorsen
14. Sequence stratigraphy- BHP petroleum (America) Inc – Michael Yeaman, Lavy Holcomb, Gill Tailor 1990
15. Sequence stratigraphy – BP Exporation. Stockley Park UK Bridge London, Publn. Blackwell science
16. Sea Level Changes- An Integrated Approach Spl. Pbln.42, Barbara H.Lidz, Edtor of Spl. Publn. Oklahoma USA 1998
17. Sequence in Layered Rocks- Blatt Middleton & Humay
18. Sedimentary Petrology- Pettijhon

COURSE-II : PALAEONTOLOGY [Course code – 16552]

Palaeontologists study the fossils which have been preserved in the earth's crust by natural processes and are used to fingerprint a large chunk of the age of the earth in terms of time. Palaeontology encompasses study of micro-fossils, plant fossils, vertebrate and invertebrate fossils and their evolution. These aspects are fundamental not only to geology and stratigraphy but to inter-disciplinary fields of palaeobotany, palaeozoology and evolutionary biology.

COURSE OUTCOME

- The study of Palaeontology encompasses the aspects of the age of the earth, chronological arrangement of rocks and appearance and evolution of life through the geologic time.
- The knowledge of palaeontology would enable the students to understand the changes that occurred in the history of the earth and relate them to their field observations.
- The students will acquire skills of discovering and describing fossils and their taxonomic classification. They will also be introduced to interpreting paleoclimate and palaeoenvironment conditions.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I : Micro-Paleontology: Origin and Evolution of Life: Introduction of Microfossils; Classification of Microfossils; Separation of various Microfossils: Morphology, stratigraphic significance and applications of – Foramanifera, Ostracoda, Palynofossils, Acritarchs, Bryozoa, Chitinozoa, conodont, Scoleconodonds. Diatom, Radiolarians, Dinoflagellates and Nanoplanktons. Application of microfossils in fossil fuel exploration, paeoclimatic interpretation and maturation of sediments, Oxygen and Carbon Isotope studies on Fossils.

UNIT-II : Invertebrates: morphology, classification, paleo-ecology and evolutionary trends of porifera. Mollusca: Pelecypoda, Classification on the basis of dentition and dental formula, dental system with example. Class Cephalopoda suture pattern. Arthropoda: Class Trilobita, Echinodermata, Trace fossils – marine & terrestrial, Hemicardata: Class Graptozoa

UNIT-III : Vertibrates &Paleobotony: Vertibrate**s:** Evolution, classification and geological signigicance of – Fishes; Amphibian, Reptails, Mammals: Elephant, Horses and Man. Paleobotony: Techniques of spores and pollens analysis, Morphology, General classification of algae and stromatolies and their stratigraphic importance. Paleozoic, Mesozoic and Cenozoic plants – Bryophytes, pterdophytes, Gymnosperms and Angiosperms their stratigraphic significance.

PRACTICAL: Identification, Diagnosis and Geological distribution of the following Groups: Invertebrate – Brachipods – 5 genera, Cephalopoda: 5 genera, Pelecypoda: 5 Genera, Trilobita: 5 genera, Graptozoa: 2 Genera, Plant Fossils: 6 genera, Microfossils – Foraminifera: 8 genera, Ostracoda: 3 genera, Palynofossils: 6 genera. Problems on biostratigraphy & Palaeo-ecology.

REFERENCES:

1. Clarkson, E.N.K., 1998, Invertebrate Paleontology and Evolution, IV edition, publ., Blackwell
2. Stearn, C.W. & Carroll R. L. 1989, Paleontology-the record of Life, Publ. John Wiley.
3. Smith, A.B, 1994, Systematics and the Fossils Record-Documenting Evolutionary Patterns., publ., Blackwell
4. Prothero. D.R., 1998, Bringing Fossils to Life- An Introduction to Palaeontology., publ., Mc Graw Hill
5. D. J. Jones, 1956. Microfossils
6. F.T.Banner and A.R,Lord., Aspects of Micropaleontology
7. M.P.Glaessner, Principles of Micropaleontology
8. M.D,Brasier, 1955, Microfossils, publ.George allan and Wiley & Sons
9. Romer.A, Vertebrate Paleontology
10. Colbert, Introduction to Vertebrate Paleontology
11. Sukla., A.C & Misra S.P, 1975, Study of Paleobotany Vikar Publ. House

12. Sripad.N.Agashe, Palaeobotany
13. Maohotra, A K, Ocean Science and Technology
14. Tchernia,P, Descriptive regional oceanography
15. K.Siddhartha, Oceanography- A brief introduction
16. William A Anikouchine and Richard W Stenbegr; the world Ocean- An Introduction to oceanography
17. Cuchlaine A M King, oceanography for Geographers
18. H.V. Thurman, Introduction to Oceanography

COURSE-III : IGNEOUS, SEDIMENTARY AND METAMORPHIC PETROLOGY [Course code – 16553]

On completion of the course the students will have gained an understanding of the processes involved in the formation of igneous and metamorphic rocks, their textures, structures, classifications and their importance. Petrology is the science of rocks. The course will help the students to exhibit an improved and understanding of fundamental petrologic processes and common rock types.

COURSE OUTCOMES :

On completion of the course the students will have gained an understanding of the processes involved in the formation of igneous and metamorphic rocks, their textures, structures, classifications and their importance. Petrology is the science of rocks. The course will help the students to exhibit an improved and understanding of fundamental petrologic processes and common rock types.

- predict what suites of igneous and metamorphic rocks should be found in different plate tectonic settings
- explain magma differentiation and observations of layered mafic intrusions using a fractional crystallization model
- describe the types and relative abundances of phases in a rock based on observations from hand specimens and thin sections
- interpret the geologic history of rocks based on mineral assemblage and textures using both hand sample and microscope techniques
- use rock mineral assemblages and textures to constrain deformation history and P-T conditions
- integrate their research findings with those of peers in developing a consensus model that (a) explains mineral occurrences and interplay (micro- and macroscopic) in field samples, and (b) holds up to public scrutiny (as a consensus model and as individual components) at a departmental mini-poster symposium
- design and implement a field sampling campaign

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Igneous Petrology: IUGS and Chemical classification of Igneous rocks, Classification, texture and its petrogenetic significance, origin of Granite, Syenite, gabbro, and Layered Igneous complex , Kimberlite, Anorthosite, Carbonatite and Peridotite.

Mineralogy, classification, textural peculiarities and origin of Pegmatitie, Dolerite, Lamprophyre, Basalt, Rhyolite, Trachyte and Andesite . Add a note on their economic importance and Indian occurrence.

UNIT-II: Sedimentary Petrology: Aim, Scope and importance – Historical developmet- Relationship with other branches of geology. **Properties of Sedimentary rocks:** textures of sedimentary rocks, Sedimentary facies and environment. Diagenesis of sediments. **Classification and description of sedimentary rocks:** Gravels, Conglomerates, Sands and Sandstones, Argillite, Non-evaporates and Evaporates, Heavy mineral studies, Grain size parameter Modes and Mechanism controls of sedimentation, Stock's law, Primary Sedimentary structures, Tectonics and sedimentation. **Applications of sedimentary rocks**: in Petroleum Geology.

UNIT-III: Metamorphic Petrology: Introduction. Definition. Limits and agents of Metamorphism. Structure

and Texture of Metamorphic rocks- Types of metamorphism based on principal process (Orogenic, Hydrothermal, Burrieal, regional, fault zone, Prograde- Retrograde, progressive Retrograde). Regional and Contact Metamorphism of Peiltic and impure Calcareous rocks. Major metamorphic rocks. Metamorphism of mafic rocks. Protoliths and types- Zones of Metamorphism, Metamorphic reactions- Kinetics of metamorphism- Mineral assemblages equilibrium/Reaction Texture and geo-thermo barometry. Metamorphic Reactions. Characteristics of different grades and facies of metamorphism, Metasomatism and granitization, Migmatites. Plate tectonics and Metamorphic Zones. Paired metamorphic belts.

PRACTICALS: Mega & Microscopy Of Igneous Rocks - Identification and classification of Igneous rocks in hand specimens and thin Sections. Identification of microstructures and textures in igneous rocks. Significance of micro-textures in understanding magmatic and tectonic process.

Sedimentary petrology Practical: dentification of Sedimentary rocks in hand specimens and thins sections. Identification of Structures in Sedimentary rocks. Grain size analysis - sieving, analysis of roundness and sphericity by visual method

Meatamorphic Petrology Practicals: Megascopic and Microscopic identification of different types of metamorphic rocks and significance of structure and micro textures in understanding metamorphic and tectonic process.

REFERENCE:

1. Petrology of Igneous and Metamorphic rocks by **Hyndman**
2. Principles of of Igneous and Metamorphic rocks by **Anthony R. Philpotts.**
3. Igneous petrology by **Anthony Hall**
4. Petrology of Igneous and Metamorphic rocks by **Best.**
5. Sedimentary Petrology – Pettijohn
6. Petrography – An introduction to the study of rocks in thin sections – H Kowell, Williams and Turner.
7. Manual of sedimenraty petrology – Krumbein and Pettijohn.
8. Principles of sedimentation – Twenhefel.
9. Sequence in layered rocks – Shrock, R.R
10. Procedures in sedimentary petrology – R.E. Carvar
11. Origin of sedimenrary rocks – Blatt, Middleton and Hurray.
12. Microscope sedimenraty petrology – A.V.Carrozi.
13. Sand and Sand Stones – Pettijohn, Potter and Siever.
14. Petrology of Sedimentary rocks – R.L.Folk.
15. Hand book of subsurface geology – C.A. Moore
16. Marine geology and Oceanography of the Aretic seas- Yuonne Herman.
17. Petrography – An introduction to the study of rocks in thin sections – H Kowell,,Williams and Turner.
18. Migmatites - Ashworth.
19. Metamorphism - A. Methuen & Co.
20. Migmatites and the origin of granitic rocks - Mehnert K.R. Elsevier & Co.
21. Metamorphism and Metamorphic rocks - Miyashro, A. George, Allen and Unwin.
22. Petrogenesis of metamorphic rocks- Winkler, H.G.F. Springer, verly.

SOFT CORE

COURSE-IV : FIELD WORK AND TECHNICAL REPORT(Minor project) [NULL]

An opportunity to work on a 15 days minor project or Technical report in geosciences under the direct supervision of a faculty member in University/Institute or Government Organisation. Students will carry out data collection using field and/or laboratory studies, and complete a final report/presentation. Field studies, Laboratory studies / data processing, reference work and presentation of the report of the course.

COURSE OUTCOME

- To inculcate a culture of research and innovation at the postgraduate level so that the students are exposed to the nitty-gritty of the Scientific Research in their fields.
- The basic aim is to expose the students at an early stage to field and laboratory techniques and sophisticated instrumentation.

COURSE-V : ANALYTICAL TECHNIQUES IN GEOLOGY [Course code – 16454]

This course provides students with advanced training in analytical techniques. This will include a detailed theoretical background, practical training and a critical understanding of the laboratory-based techniques they will apply during their research projects. The course will deliver an in-depth examination of the specific analytical techniques relevant to their research projects.

COURSE OUTCOME

Upon successful completion, students will have the knowledge and skills to:

- Explain the theoretical aspects of key analytical techniques and instruments used in geochemistry, including but not limited to electron microscopy, X-ray diffraction, mass spectrometry and spectroscopy (including synchrotron techniques).
- Strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project.
- Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.
- Design an analytical work-flow to acquire data and achieve the research objectives of their project.
- Process data from the chosen instruments and demonstrate understanding of the limitations and quality of the data. Justify the approach taken to data processing.
- Write a clear and concise justification and description of the analytical techniques employed, suitable for publication in a scientific journal.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I : Introduction to instrumental methods of chemical analysis, Spectroscopy photometry and spectrophotometer, Infrared spectroscopy – FTIR. Atomic Absorption spectroscopy (AAS), and Inductively coupled Plasma (ICP-MS) analysis technique, Thermal analysis techniques – DTA, TGA, DSC etc., Electron Microscopy – SEM, TEM, AFM;, X-Ray powder diffraction techniques (XRD), X-ray Fluorescence (XRF) technique, Electro probe micro analysis technique, (EDAX, WDS).

UNIT-II Tutorial: Assignments/Seminar/Test/Discussion

REFERENCE:

1. Silicate analysis by Potts
2. Petrographic techniques by Hutchinson

COURSE-VI : SOIL & WATER CONSERVATION [Course code – 16455]

This course covers topics in soil and water management and conservation important to students of agricultural, viticulture, horticultural and environmental sciences. Processes that degrade the soil and water resources of India (e.g. erosion, salinity, alkalinity and as well as acidification, water repellence, and degradation of soil structure) are examined, and their measurement, avoidance and management discussed. There is a strong focus on quantitative theory and practice of measuring and managing soil water using commercially available technology, particularly in relation to interception, storage and movement of water in dryland and irrigated agro-ecosystems. Broader issues in soil and water conservation (e.g. State and Commonwealth legislation) are also covered.

COURSE OUTCOME

- How to solve quantitative problems in soil water management, specifically how to: *conduct simple calculations of water content, porosity, density and hydraulic conductivity. *Analyze and interpret data on infiltration, available water, and storage of water.
- The primary causes and consequences of a wide range of soil degradation problems, including soil acidity and alkalinity, erosion, salinity and and nutrient loss.
- The impact of soil management on soil organic matter, soil structural stability, water quality and other important soil properties.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Definition of Soil. Soil genesis and morphology. Factors of Soil Formation. Processes of Soil Formation. The Soil profile-Nature of Soil Profile.. Concept of Pedon and Landforms. Components and Composition of Soils. Physical Properties of Soils. Soil Structure. Chemical Properties of Soils. Soil pH. Soil Mineralogy. Ion-exchange Capacity of Soils. Soil Salinity. Acid Soils. Alkaline soils. Engineering properties of soils. Soil Moisture . Role of Nutrients in Soils . Soil Microbiology & Organic Matter. Soil testing and surveys. Soil Classification systems & Soil Taxonomy. Soil related problems. Soil pollution . Soil erosion-causes and effects. Soil loss measurements. Universal Soil Loss Equation and its application. Soil surface management and soil stabilization practices. Sediment traps. Soil conservation practices-Tillage methods. Biological soil conservation. Mechanical conservation works including terracing methods. Irrigation and Engineering Practices.

UNIT-II: Definition of water conservation. Water Conservation Practices. Water Resources in Watersheds and River Basins. Water Use and Consumption. Water management. Improving Drainage and reclaiming salt-affected soils. Technological options for drainage. Choice of method. Design principles. The effect of scale. Methods of Irrigation -modern techniques. In-situ conservation of soil water. Runoff management- Decreasing runoff amount(contour farming, strip cropping, contour barriers, vegetative hedges). Water Erosion Control practices. Reducing runoff velocity(slope management, waterways, diversion channels, engineering structures, etc). Flood control-Inundation methods and Flood diversion. Water storage- Small earth dams, Weirs, Sand dams. Losses of stored water- seepage/ evapotranspiration and its controlling methods.

REFERENCES:

1. Principles of Soil Conservation and Management- Humberto Blanco-Canqui, Rattan Lal, Springer, 16-Sep-2008 - 617 pages
2. Soil and Water Conservation Policies and Programs: Successes and Failures, Ted L. Napier, Silvana M. Napier, Jiri Tvrdon, CRC Press, 24-Nov-1999 - Technology & Engineering - 656 pages
3. Advances in Soil and Water Conservation, Francis J. Pierce,CRC Press, 01-Feb-1998 - Technology & Engineering - 300 pages

4. Soil and water conservation engineering, Richard K. Frevert, Glenn Orville Schwab, Wiley, 1966 - Nature - 683 pages
5. Soil And Water Conservation Handbook: Policies, Practices, Conditions, and Terms, Paul W. Unger,Haworth Food & Agricultural Products Press, 23-Oct-2006 - Political Science - 248 pages
6. Soil Erosion and Conservation,R. P. C. Morgan,John Wiley & Sons, 05-Feb-2009 - Science - 320 pages
7. Soil Erosion: Processes, Prediction, Measurement, and Control,Terrence J. Toy, George R. Foster, Kenneth G. Renard, John Wiley & Sons, 27-May-2002 - Science - 338 pages
8. Soil Erosion by Water: Some Measures for Its Control on Cultivated Lands, Food and Agriculture Organization of the United Nations,Food & Agriculture Org., 01-Jan-1965 - Nature - 284 pages
9. Water Conservation, Management and Analysis,Madireddi V. Subba Rao,Readworthy, 2011 - Water - 144 pages
10. Soil and Water Conservation Policies and Programs: Successes and Failures, Ted L. Napier, Silvana M. Napier, Jiri Tvrdon, CRC Press, 24-Nov-1999 - Technology & Engineering - 656 pages
11. A Practical Approach to Water Conservation for Commercial and Industrial Facilities, Mohan Seneviratne, Elsevier, 11-Jul-2007 - Technology & Engineering - 400 pages
12. Soil and Water Conservation in Semi-arid Areas, Issue 57, Norman Hudson, Food & Agriculture Org., 01-Jan-1987 - Arid regions - 172 pages

OPEN ELECTIVE

COURSE-VII : BASICS OF EARTH SCIENCE [Course code – 16456]

The students will understand the origin of our solar system and planets, including earth. The students are exposed to the Geological time scale and be able to appreciate the dynamics of earth evolution through time. The study of this paper strengthens students knowledge with respect to understanding the essentials of the structural dynamics of the earth. The course presents an understanding of the processes in action on the earth's surface and their impact on man and his institutions.

COURSE OUTCOME

- Students will apply skills such as inductive, deductive, and mathematical reasoning to solve Earth science problems.
- Students will integrate data from field work, laboratory measurements, library research, and / or their coursework to formulate or evaluate a geoscientific hypothesis.
- Students will apply mathematical models and analysis to quantitatively describe and predict the behavior of Earth phenomena.
- Students will acquire a solid foundation in statistical analysis and learn how to apply probabilistic reasoning to the Earth system, learning to discriminate between competing hypotheses based on factual evidence.
- Students will learn how to critically evaluate scientific information in visual and written forms.

PEDAGOGY for Course Delivery:

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: PHYSICAL GEOLOGY -Introduction to geology. Origin of the Earth. Age of the earth. Interior of the Earth. Geomorphic processes and cycles, Geological action of wind, water, glaciers. Volcanoes and earthquakes. Morphology of Oceans, Principles of Isostacy and uniformitarinism.

UNIT-II: STRUCTURAL GEOLOGY - Rock deformation. Earth forces. Folds and Foldings, Fault and Faulting, Joints, Cleavage, Unconformities, Concepts of plate tectonics, sea floor spreading and geosynclines.
UNIT-III: STRATIGRAPHY- Introduction, Definition of Stratigraphy, Branches of Stratigraphy and its relation with other branches of Geology, Principles of Stratigraphy- Law of Uniformatianism, Law of order of

superposition, Law of Faunal Succession. Geological Record and its nature Eon, Era, Period. Geological Time Scale. Classification of Standard Stratigraphic scale. Nomenclature and units-Litho, Bio and Chrono stratigraphic units, Correlation- Lithostratigraphic and Biostratigraphic

UNIT-IV: PALEONTOLOGY -Introduction, Definition of Paleontology, Classification of Plants, Invertebrate and Vertebrate fossils. Fossils-Tophonomy (Burial Law), Types of Fossilization, Mode of preservation- Mummification, Carbonization, Silification, Casts, Moulds, Tracks aind Trails. Applications of Fossils. General morphological characters and Geological age of the following Invertebrate and Plant Fossils: Brachiopoda, Cephalopoda, Pelecypoda and Trilobita. Plant fossils: Glossoptreis, Gangamopteris, Ptillophylum, Calamites and Lepidodendron

REFERENCES:

1. Physical Geology by Arthur Holmes
2. Structural Geology by Billings
3. General Geology By P.K. Mukerjee
4. Physical Geology By Strahler
5. Stratigraphic Principles and Practice-Weller
6. Stratigraphy-Kumberlein and Sloss
7. Paleontology of the Invertebrates-Tasch Publ.Jhon Wiley and Sons
8. Paleontology- Henry Wood
9. Fossils Plants- Arnold
10. The Elements of Paleontology Black,R.M Pub. Cambridge university press

THIRD SEMESTER

HARD CORE

COURSE-I : REMOTE SENSING AND GIS [Course code – 16561]

This course teaches students the fundamentals of Remote sensing and GIS, the use of ERDAS, ArcGIS and cartography with an emphasis on earth science. The course is centered around 8-9 lab exercises each taking 1-2 weeks with a significant final project. Students learn how to solve problems with GIS, communicate results, and troubleshoot GIS issues.

COURSE OUTCOME

- Solve problems using GIS from developing appropriate questions that have a spatial analysis component, to locating and acquiring appropriate data sets, and conducting the analysis in an organized and documented way.
- Communicating the results of the analyses with cartographically accurate and complete maps, and other audience appropriate maps, figures and reports.
- Apply techniques learned in class to consulting-style problems in a team environment
- Troubleshoot issues that arise in all stages of spatial problem solving by working with peers, using help files, and using online forums in a productive and appropriate manner.
- Competence in using the ERDAS and ArcGIS suite of software to solve a variety of problems.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: **Remote Sensing:** Fundamental concepts of Remote Sensing. Electromagnetic Spectrum. Principles of Aerial Photography, Photogrammetry and Remote Sensing. Energy Interactions with the matter and atmosphere. Black Body radiation. Sensors, Scanners and their capabilities, Platforms- Types of Platforms. Satellite Remote Sensing. Resolution and Types of Resolution. Method of Image Interpretation. Digital Image Processing. Indian Remote Sensing Satellites. Remote Sensing in Visible, Infrared Rays, Micro Wave and Thermal regions. Application of Remote sensing in Geological mapping, Mineral Exploration, Soil and water resources studies. Role of Remote Sensing in Flood hazard evaluation and disaster management.

UNIT-II: GIS: Definition of Geographic Information System. The nature of geospatial information and data representation. Cartography. Maps and spatial information. Cartographic symbology. GIS and its subsystems. Components of a GIS. Databases used in GIS. Data Structures: Relational, hierarchical and network. RDBMS. Data models used in GIS. Spatial data models. Vector data Model. Raster data Model. DEM. TIN. Vector and raster - advantages and disadvantages. Attribute data models. Topological relationaships of spatial data. Data Sources.GPS. Data input techniques. Digitization of maps and imageries; Coordinate transformation; Attribute data generation . Spatial data layers . Data retrieval and querying. Spatial analysis -Spatial overlay operations, buffering, trend surface mapping. Network analysis and proximity analysis; 3D models. GIS Modeling for decision support. Applications of GIS in earth's resources evaluation and management.

PRACTICAL: REMOTE SENSING: Visual and Digital interpretation of Reading of Topo maps. Visualization and Interpretation of Satellite Imageries. Interpretation and Demarcation of lithological Units. Interpretation Drainage patterns and water bodies. Interpretation and Measurement of Lineaments Interpretation of Geological Structures, Interpretation of land use/land cover. Interpretation of vegetation Interpretation of Mining and Mineralized zones **GIS:** Methods of digitizing geospatial data(toposheet/ satellite image). Methods of creating x,y,z data as database and preparing contour maps. Georeferencing co-ordinates in scanned topo sheets or maps and computing the the geometrical properties of digitized zones. Methods of using DEM files, analysing hydrological components, basins, slopes, aspects and other features. Carrying out different kinds of spatial analysis including, buffering, Proximity, split, clip and neighbourhood analysis. Application of GIS model for various spatial analysis.

REFERENCE:

1. Text book of Remote sensing and geographical Information system, 1st & 2nd Ed. By M. Anjireddy, BS Publications, Hyderabad
2. Remote sensing principles and Interpertations, 3rd edition, Floyd. F. Sabins
3. Applications of Remote sensing and GIS by H T Basavarajappa, Et. Al
4. Cartography: Visualization of Geospatial data – Menno-Jan Kraak and Ferjan Ormeling
5. Principles and application of Photogeology – Shiv N Pandey
6. Aerial photographic interpretation, Principles and applications - D.R.Leuder.
7. Photogeology - Miller, J.C.
8. Mannual of colour aerial photography -Ed. Smith, J.T.Jr.
9. Manual of photogrammetry - Ed: Morrie M.Thompson.
10. Manual of Remote sensing - Ed: Robert G Reeves.
11. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
12. Remote sensing in Geology - Parry S. Siegal & Alan. R.Gillespie
13. Manual of photographic interpretation - Ed: Colwell, R.N.
14. Principles of Remote Sensing – Patel Singh; SP publication
15. Digital Remote Sensing – Pritivish Nag M Kudrat ; Concept publication
16. Principles of GIS for land and resources assessment, Burrough, P.A., 1986, Oxford.
17. Introductory cartography, Campbell, 1984, Prentice Hall
18. Map data processing, Freeman and Pieroni, 1980, Academic Press.
19. An introduction to Geographical information systems: Ian Heywood et. al.
20. Geographical information systems and digital image processing – Muralikrishna 1999. Allied Publication
21. Fundamentals of remote sensing and Geoinformatics , by Anjireddy, Hyderabad ed. 1and 2.
22. Geographic Information Systems: An Introduction, 3rd Ed, Bernhardsen,John Wiley & Sons, 01-Jan-2007 - 444 pages
23. Geographic information systems and science, Paul Longley,Wiley, 13-Jul-2001 - Education - 454 pages
24. Geographic Information Systems for Geoscientists: Modelling with GIS, Graeme F. Bonham-Carter,Elsevier, 18-May-2014 - Science - 416 pages

25. Geographic Information Systems and Science, Paul Longley, John Wiley & Sons, 22- Mar-2005 - Science - 517 pages
26. Handbook on Geographic Information Systems and Digital Mapping,United Nations. Statistical Division, United Nations Publications, 2000 - Census - 197 pages
27. Introductory Readings In Geographic Information Systems,D J Peuquet, D F Marble,CRC Press, 16-Dec-2003 - Technology & Engineering - 371 pages
28. Geographic Information Systems (GIS) and Mapping: Practices and Standards, Issue 1126, Arnold Ivan Johnson, C. Bernt Pettersson, ASTM International, 01-Jan-1992 - Travel - 346 pages
29. Introduction to Geographic Information Systems,Kang-tsung Chang,McGraw-Hill Education, 16-Jan-2015 - Science - 448 pages
30. Fundamentals of Geographical Information Systems,Michael N. DeMers,Wiley, 2009 - Science - 443 pages
31. Textbook of Remote Sensing and Geographical Information Systems,Kali Charan Sahu,Atlantic Publishers & Dist, 01-Dec-2007 - 512 pages
32. Geographic Information System,B. Gurugnanam,New India Publishing, 09-Jun-2009 - Geographic information systems - 206 pages
33. Fundamentals of Geographical Information Systems,Michael N. DeMers,Wiley, 2009-Science - 443 pages

COURSE-II : GEOCHEMISTRY AND PETROGENESIS [Course code – 16562]

The course aims to give an introduction in how chemical principles are used to explain the mechanisms that control the large geological systems such as the Earth´s mantle, crust, ocean and atmosphere, and the formation of the solar system. They focus on chemistry of the natural world and the chemical evolution of the Earth over geological time. We will discuss practical and theoretical geochemistry, with an emphasis on how chemical principles are used to study Earth Sciences. The course is composed of three modules: (a) geochemical fundamentals; (b) natural and anthropogenically perturbed aspects of the Earth's hydrosphere and atmosphere and their interactions with rocks, sediments, soils and the biosphere and (c) the origin and evolution of Earth (crust-mantle-core) through nuclear and high temperature chemical processes.

COURSE OUTCOME

A successful student in this course should be able to:

- Demonstrate proficiency in common practical data handling skills in geochemistry & Petrogenesis.
- Plan and carry out appropriate mathematical strategies for solving geochemical problems;
- Synthesize the results of their problem-solving with other work in the form of short, well-organized articles;
- Have insight into the origins of earth**'**s atmosphere, oceans and rocks;
- Critique possible oversimplifications in geochemical models.
- To understand evolution of the early Earth from proto-planetary material and its differentiation to present day state.
- To describe the composition of the Earth´s main geochemical reservoirs.
- To explain element fractionation and how this can be used to understand geochemical processes.
- To apply radiogenic isotope signatures to trace the source of minerals, rocks and to date magmatic and metamorphic events.
- To understand how chemical weathering of minerals and rocks control the composition of sediments/soil and natural water

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Geochemistry: Basic concepts and scope of geochemistry, Age, origin and composition of the

universe with special reference to solar system, Geochemical classification of elements, primary differentiation of the earth, Meteorites- classification, composition and origin, Geochemical cycle, geochemical fractionation of trace and REE elements in magmatic process and its importance.

UNIT-II: Geochronology: Radioactive decay schemes, Radioactive dating, Radiogenic isotope systematics: U-Pb, Rb- Sr, K- Ar systematics. Stable isotopes: Carbon, Oxygen, Sulphur and Hydrogen.

UNIT-III: Petrogenesis: Genesis- properties- emplacement- crystallisation and differentiation of magmas. Bowens reaction series. Mechanism of magma diversification (differentiation)- partial melting, crystal fractionation, Thermogravitational diffusion, liquid immiscibility, vapour transport, vapour phase alterations magma mixing, exsolution phenomena, assimilation. Phase equilibria studies- Basic concepts -phase and component, phase rule, unary system with examples of P-T diagrams of water and Al_2SiO_5/ Silica, ternary system and binary system -Diop-An and Fo-Fa.

PRACTICALS: P-T calculations and construction of P-T diagrams. Petrochemical calculations- Niggli verte and Niggli base, CIPW norm calculation, Trilinear plots , construction of Variation/ Discriminant diagrams using major, trace and REE geochemistry data and interpretation. Isotopic age determination of rocks/minerals.

REFERENCES:

1. Geochemistry- William.M.White-Wiley black well publications
2. Introduction to carbon capture and sequestration- Berend Smit, Jeffrey.A. Reimer, CurtisM. Oldenburg and Ian.C.Bourg.
3. Rare earth element Geochemistry by Henderson
4. Geochemistry by Rankama and sahama
5. Petrologic Phase equilibria – W.G.Ernst
6. The Interpretation of Geological Phase diagrams - Ernest G Ehlers
7. Petrogenesis – Wilson
8. Solutions, Minerals and Equilibria – Garrels and Christ, 1966
9. Simulating the Earth- J.R. Holloway and B.J. Wood,1988
10. Basic analytical Petrography – Ragland, 1989
11. Principles of Igneous and Metamorphic Petrology by Antony R Philpotts, 1979.**1.**
12. Geohemical Thermodynamics by Darrell Kirk Nordstrom and James L. Munoz
13. Chemical Thermodynamics for earth scientists by Philip Fletcher, 1993
14. Chemical Fundamentals of Geology by Robin Gill.
15. Elementary Thermodynamics by B.J. Wood and D.G. Fraser, 1976
16. Equilibrium Thermodynamics by Roger Powell
17. Prinicples of Geochemistry – Brain Mason
18. Geochemistry by Anderson
19. Chemical Thermodynamics by Bruce H Mahan

COURSE-III : INDIAN STRATIGRAPHY [Course code – 16563]

The course isintended to familiarize the student with stratigraphic principles and nomenclature, major stratigraphic units, methods of stratigraphic correlation, depositional environments and tectonostratigraphic framework of various lithostratigraphic units of India spanning Archaean to Holocene, and mass extinction boundaries.

COURSE OUTCOME

On successful completion of the course, the student will be able to:

- Understand basic principles of stratigraphy, different types of stratigraphic units and how they are named.

- Know the crustal evolution during the Precambrian in peninsular India and how the biosphere responded to the Precambrian-Cambrian boundary events.
- Appreciate how plate tectonic movements separated India from contiguous landmasses and shaped the depositional basins of the Indian Phanerozoic, and what were their effects on climate and life.
- Learn about large igneous provinces and their role in mass extinction events and important mass extinction boundary sections.
- Gain knowledge on stratigraphy and sedimentation in India – Asia continental collision zone and Himalayan foreland basin.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: PRECAMBRIAN ERA – Introduction, Physical features, Physiographic features and Tectonic features of India. Brief studies on – Dharwar Craton, Baster Craton, Singhbhum Craton, Bundelkhand Craton and Aravalli Craton. A brief account on – Eastern Ghats Mobile Belt, Pandyan Mobile Belt and Satpura Mobile Belt. Precambrian of Himalaya. Proterozoic Sedimentary Basins - Bijawar and Sonari, Gwalior, Abujhmar, Papaghni sub- basin, Vindhyan, Chhattisgarh, Khariar, Ampani, Indravati, Sabri, Pranhita-Godavari, Cuddapah, Kaladgi and Bhima.

UNIT-II: PALEOZOIC ERA: Introduction, Tethyan Basin, Paleozoic Life, Trace fossils and Stromatolites. Precambrian/Cambrian boundary, pC/C boundary in Himalayan basins. Cambrian – Jammu and Kashmir, Himachal Pradesh, Tal Basins and Uttaranchal.Ordovician and Silurian - Jammu and Kashmir, Himachal Pradesh and Uttaranchal.Devonian - Jammu and Kashmir, Himachal Pradesh and Uttaranchal. Carboniferous - Jammu and Kashmir, Eastern Karakoram, Himachal Pradesh and Uttaranchal. Permian - Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Bhutan Arunachal Pradesh and Peninsular India-Cauvery Basin. Gondwana Supergroup – Introduction, Characteristics, Stratigraphy and Structure, Classification and Age, Life in Gondwana, Coastal Gondwana Basins, Gondwana in Extra- Peninsular India, Environmental of deposition and Economic Significance.

UNIT-III: MESOZOIC ERA – Introduction, Life of Mesozoic Era, Triassic - Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Rajasthan and Kutch. Permo-Triassic Boundary. Jurassic – Kutch, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Jharkhand and Bhutan. Cretaceous – Gujarat, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, East Coast, Trichinopoly, Narmada Basin, Lameta Formation, Jharkhand, Assam/Meghalaya, Andaman and Nicobar Islands. Cretaceous/Tertiary Boundary. Deccan Volcanic Province – Introduction, Regional Stratigraphy, Subprovinces, Volcano-Plutonic Complexes, Petrology and Petrogenesis, Inter-Trappean beds, Distribution and its age.

UNIT-IV: CENOZOIC ERA – Introduction, Distribution, Climate, Correlation, Fauna and Flora, Classification and Stratigraphy. Paleogene – Introduction, Fauna and Flora, Stratigraphy and Distribution. Neogene – Introduction, Fauna and Flora, Stratigraphy and Distribution. Quaternary – Introduction, Distribution, Quaternay climatic changes, Quaternary Sea level changes. Siwalik – Stratigraphy and Sedimentation, Distribution and Fauna of Siwalik. Geology of Offshore Basins. Morphology and Evaluation.

REFERENCES:

1. Geology of India Vol.1 & 2. M.Ramakrishnan and R Vaidyanatahan
2. Geology of India – Wadia, D.N., Mc Millan and Co.
3. Geology of India and Burma – Krishnan M.S. Higginbotham, Madras.
4. A hand book of the Geology of the Mysore State – B. Rama Rao, Bangalore press.
5. Precambrian Stratigraphy and Geochronology of the Peninsular India – Sarkar, S.N. Dhanbad Publishers.
6. Review papers on the Stratigraphy of India –Rec.Geol.Surv.India Vol.101, Part 2.1972Cretaceous Tertiary formations –Geol.Soc. India, seminar Vol. 1958.

7. Paleozoic of Himalayas. HPC publn.
8. Reconnaaissance Rb-Sr dating of the Precambrian of Southern Peninsular India- Crawford, A.R., J.G.S.I 1972. 117-126.

SOFT CORE

COURSE-IV : GEMMOLOGY [Course code – 16564]

Gemology is to give students all required knowledge about gemstones, their occurrences, their physical and chemical properties and the internationally employed scientific methods for the identification and grading of Gemstones.

COURSE OUTCOME

After the completion, of course, you will be able to analyze the market value of gems, gemstone quality, diamond and other precious gem stone identification.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Introduction to Gemology, classification of gemstones, detailed study of different physical and optical properties of minerals with special reference of to gem minerals. Physical- optical effects in gemstones. Colour and Cause of colour in gems, Colour enhancement in gems.

UNIT-II: Cutting and polishing of gemstones. A detailed study of important precious and semi- precious gem minerals, their characters and occurrences, World occurrences in general and Indian occurrences in particular (i)Precious varieties 1. Diamond 2. Gem corundum 3. Topaz
4. Emerald (ii) Semi-precious varieties Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems.

REFERENCES:

1. Gems and Gem industry in India-GSI Memoir 45- R.V Karanth.
2. Gem and Gem Minerals – EH Kvans and CB Slawsan
3. Encyclopedia of Minerals and Gem stones - Edited by Michael O' Don Oghal.
4. Precious stones - by Max-Bauer Vol. I and II. Publisher Dover publications Ink. New york.
5. Gems and precious stones- Simon and Schusters, Publ.Fire side book publishers.
6. Gems and precious stones- Cally Hall, the apple press publishers
7. Gemmological instruments-Peter.G.read, Butterworth publ.
8. Gem stone enhancement-Kurt Nassau, Butterworth publ.
9. Rutley's Elements of Mineralogy- by H.H. Read, CBS publication
10. Dana's Manual of Mineralogy
11. GEMS by R.Webster - Batter work and co. ltd., London
12. Gemstones - Herbert Smith - Published by Methuen co. Ltd., London
13. Introduction to Rock forming minerals-Deer, Howie and Zussman.
14. Physical Geology-P.K.Mukherjee
15. Geology of India-R.Vaidyanathan and M.Ramakrishnan
16. Geology of Karantaka-B.P.Radhakrishna
17. Mineral Resources of Karnataka-B.P Radhakrishna

COURSE-V : MINERAL ECONOMICS [Course code – 16465]

This course examines economic, legal, social and environmental factors affecting the mine cycle. It is presented in three sections. The first section, Mineral Economics, examines global metal markets and project economic evaluations. This section includes applications of mineral property valuation and risk management.

COURSE OUTCOME

Upon successful completion of the course, students will be able to

- Describe the importance and relevance of accurate economic forecasts and financing plans throughout the mine life cycle.
- Assemble cash flow information and determine the economic feasibility of a mineral project.
- Analyze the financial impact of risks associated with a mineral project and carry out cost-analysis calculations.
- Recognize sustainability perspectives related to the mineral industry and describe a project's impact on the economy, the environment and society.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Introduction and concepts of mineral economics. Peculiarities in mineral deposits. Concepts in mineral exploration and mineral resource estimation. Classification of Indian mineral resources. Role of mineral industry in national economy. Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption. National Mineral Policy. Mineral Concession Rules. Mineral legislation in India. Mineral production, processing, coproducts and byproducts. Mineral inventory. Consumption and substitution of minerals. Demand Analysis and market survey. Mineral conservation and environment. Mineral information system. Marine mineral resources and Law of Sea.

TUTORIAL: Assignments/Seminar/Test/Discussion

REFERENCE:

1. Mineral Economics by Truscot, John Wiley and Sons, Inc, 1987.
2. An introduction to mineral Economics – K.K.Chatterjee. publisher : - Wiley Eastern. 1993.
3. Mineral Economics : - R.K. Ssinha and N.L.Sharma. Oxford and IBH publication

COURSE-VI : ENGINEERING GEOLOGY [Course code – 16466]

To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures. The student will be educated on geological site investigations for engineering structures and will provide skills in geological mapping and making geotechnical measurements.

COURSE OUTCOMEs

- Develop understanding on impact of geological features on civil engineering projects.
- Identify the problems associated with different geological features on civil engineering structures and suggest alternatives.

- Able to understand the geological aspects of construction project.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I : Engineering properties of rocks. Rocks as construction material, Geological considerations in selecting sites for tunnels, bridges, Dams and reservoirs, highways, Reservoir sedimentation: Causes – effects-basin, channel and geological factors, climatic influence, monitoring- desilting methods.

UNIT-II : Geological investigation of landslides – hazards – hazards zonation mapping – stability analysis mitigation measures. Coastal Erosion: Causes of Coastal Erosion Near shore dynamics, erosion mechanisms-longshore drift, Effects of coastal erosion – Controlling methods – barriers groins, sea walls, Jetties and stone revetments. Geology of soils and elements of soil and soil mechanics.

REFERENCE:

1. Plate tectonics and crustal evolution – Condie,K.C.
2. Manual of Field geology – Compton.
3. Soil their Orgin, constitution and classification – Robinson G.W
4. Soils – Tambane and others
5. Nature and Properties of Soil- Harry O Buckmen Nylc C. Brady
6. Fundamentals of Soil Science – Miling, Truck and Forth. H.D(1984) John willey
7. Introduction to Physical Geology – Strahler, A.N – 1965 – Willey
8. Climatology – Stringer (1982) Surjeet Publication Soil Atlas of Karnataka, NBSSLUP Publication.

OPEN ELECTIVE

COURSE-VII : INDUSTRIAL MINERAL RESOURCES [Course code – 16467]

The course reviews the principal types of mineral resources, their distribution and genesis, with particular emphasis on deposits of metals. The first part of the course deals with the basic principles of ore deposits and methods for deciphering their genetic evolution. Following discussion of how deposits can be classified according to commodity and formation mechanisms, the most common types of deposits will be reviewed with respect to their main features and the geological environments in which they occur. The latter part of the course will focus on the underlying reasons for the distribution of ore deposits within a plate tectonic framework, and go on to discuss the economic principles of mining and the current character of the global metal mining industry and the sequence of events from the selection of areas for potential discovery of ore deposits, prospecting and development.

COURSE OUTCOME

- To be able to classify different minerals and rocks relevant to resources
- To be able to understand how and why different types of mineral deposits are formed
- To gain an insight into how environmental problems applicable to mineral deposits and exploitation of natural resources can be minimalized and, if possible, avoided
- Gain a deep knowledge within your own area of interest.
- To be able to identify certain minerals and rocks relevant to natural resources in hand specimens.
- To be able to explain how different types of mineral deposits can be found.

- To be able to evaluate different environmental measures applied to mineral deposits and exploitation of resources.
- To be able to work both independently and in collaboration with others.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Definition of a Mineral. Classification of Minerals – Rock forming minerals & Ore forming Minerals, Silicate and Non-Silicate minerals. Physical, Chemical and optical properties of Minerals.

UNIT-II: Description of Industrial Minerals: Gold, Silver, Coal, Copper, Diamond, Asbestos, Barite, Calcite, Diatomite, Feldspar, Gypsum, Kaolin, Mica, Silica, Talc, Zeolite,

UNIT-III: Minerals Used in Paint, Fertilizers, Pesticides, Abrasives, Refractories, Ceramics, Glass, Pharmaceuticals, Petrochemical and Nuclear Energy

UNIT-IV: Gem Minerals: (i) Precious varieties 1. Diamond 2. Gem corundum 3. Topaz 4. Emerald (ii) Semi-precious varieties Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems. Minerals Used in Civil work: Sandstones, Marbles, Granites, Sand and Gravel

REFERENCES:

1. Industrial Minerals and Thier Uses: a hand book and formulary. Ed. By Peter A Ciullo, Noyes Publications, 1996,
2. India's Mineral Resources by S. Krishnaswamy, Revised by R.K.Sinha, Oxford & IBH Publishing Co.PVT. LTD.

FOURTH SEMESTER

HARD CORE

COURSE-I : EXPLORATION GEOLOGY & MINING METHODS [Course code – 16571]

This course will introduce a series of geological and geophysical techniques that can be applied to determine the physical characteristics of the Earth's lithosphere, with direct application to the detection and mapping of mineral and energy resources in three dimensions. We will take a generic view, that economic concentrations of mineral and energy resources are geological anomalies that are defined by extreme localized enrichments (of specific elements, minerals, liquids, gases or heat) and are recognizable by steep gradients in a range of measurable geophysical properties. The course will be divided into modules covering geophysical exploration techniques commonly used in minerals and energy exploration, (gravity, magnetic, electrical, electro-magnetic and seismic surveys). We will examine the theoretical basis of each technique, the methods of data collection, presentation and analysis, and appropriate, geologically constrained, interpretation of the data. Students will explore an industry style data base and softwares with the aim of developing an exploration and targeting model for hydrocarbon resources.

COURSE OUTCOME

This course aims to introduce students to the techniques used to measure and map geologic, geophysical and geochemical characteristics of the lithosphere, with applications to mineral and energy exploration.

It also aims to provide students with the theoretical background to each technique (including its strengths and limitations), the methods of data collection, analysis and interpretation and an appreciation of the

exploration scenarios in which each technique may apply.

The anticipated knowledge, skills and/or attitude to be developed by the student are:

- Demonstrated proficiency in common practical skills in resource exploration.
- The scientific basis of mineral, energy and natural resource exploration.
- The generic characteristics of economic mineral and energy resources – geological, geophysical and geochemical anomalism.
- The geophysical techniques (seismic, gravity, magnetic, electrical and electro-magnetic)
- The geochemical techniques (sampling media, sampling strategies, analytical techniques)
- Field based data collection – sampling strategies
- Demonstrated understanding of the importance of data quality–collection, analysis, processes techniques

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: GEOLOGICAL EXPLORATION- Mode of occurrence of commercial-grade deposits of Fe, Mn, An-Ag-(W), Cu,Pb-Zn,Ti,Ni,Mo,Sn,Al,Pt - group. U-Th. Geological criteria for mineral prospecting. Indications of ore. Geological prospecting methods. Small and large scale geological mapping. Methods of geological exploration - exploratory grids, location and documentation of exploratory workings (pits, trenches underground workings), drilling, core logging. Sampling techniques and evaluation of grade. Mining terminology, methods of open cast, underground and alluvial mining.

Definition and scope of mineral processing, communition, crushers and classifiers. Froth flotation techniques of separation.

UNIT-II: GEOCHEMICAL EXPLORATION: Geochemical cycle, mobility of elements and geochemical anomaly. Mode of occurrence of trace elements. Primary dispersion patterns of deep seated origin, syngenetic and epigenetic. Geochemical rock surveys. Weathering and its products. Mobility of elements in the surficial environment and surficial dispersion patterns and forms. Anomalies in residual and transported over burden. Anomalies in waters and drainage sediments.

Uptake of mineral matter by plants. Biogeochemical anomalies and survey techniques. Vapour geochemistry.

UNIT-III: GEOPHYSICAL EXPLORATION: Geophysical anomalies, Electrical prospecting: Resistivity method, important electrode arrangements, instruments, interpretation and application of electrical methods in ground water investigation.

Magnetic prospecting: Magnetic properties of rocks and minerals, Earth's magnetic field, instrument and measurements, interpretation of magnetic anomalies.

Gravity prospecting: Earth's gravity field, regional and local gravity anomalies, instruments, interpretation of gravity anomalies.

Seismic prospecting: Elastic properties of rocks and minerals, refraction and reflection technique time-distance relation for horizontal interfaces, seismic instruments and records.

Radio metric methods: Radioactivity of rocks and minerals, instruments and measurements of radiation, Well logging: Different techniques of logging..

PRACTICAL: GEOLOGICAL EXPLORATION- Delineation of ore deposit based on exploration data. Classification of ore reserves. Economic evaluation of ore deposit. Preparation of technical report.

Gechemical Exploration: Geochemical methods in mineral exploration and choice of materials and methods. Interpretation of Geochemical maps for locating ore mineralization. Preparation of geochemical anomaly maps.

Geophysical exploration: Resistivity methods: Curve matching techniques and s-line method.

REFERENCE BOOKS

1. Introduction to geophysical prospecting - Milton B Dobrin
2. Exploration geophysics – Jakaosku J J
3. Outlines of geophysical prospecting - A manual for geologists – M B Ramachandra Rao
4. Geophysical Methods in Geology – P V Sharama

5. Exploration Geophysics for geologist and Engineers – Bhimasanakaran and Gaur
6. Principles of Applied Geophysics – D S Paransis
7. Introduction to Geophysics – C H Howel
8. Geochemistry in mineral exploration Rose, A.W Hawkes. H.E & Webb J.S. 1979. Academic press.
9. Principles of geochemical prospecting. Ginzburg. I.I. Petgamon Press, N.Y. London.
10. Biochemical methods of Prospecting - Malyuga, D.P.
11. Principles of Mining Geology, Arokiaswamy.
12. Geological prospecting and exploration – Kreiter,V.M.
13. Rock geochemistry in Mineral Exploration. G.J.S.Govett. Elsevier Publication. 1983.

COURSE-II : HYDROGEOLOGY [Course code – 16572]

Water is a basic life supporting system. The rise in global population and the quest for better living standard has greatly stressed the water resources. The course content primarily focuses on groundwater, which being easily available is amenable to greater exploitation. Thus this course aims to enable students to acquire knowledge about the physical and chemical attributes, occurrence, movement and exploration of the groundwater resources.

COURSE OUTCOME

The anticipated knowledge, skills and/or attitude to be developed by the student are:

- The students will learn about occurrence of groundwater, water bearing properties of formations, aquifer types and aquifer parameters.
- The course imparts knowledge about construction, design and development of water wells, aquifer parameter estimation and the science of groundwater flow under different conditions.
- The students will learn about the concepts of groundwater exploration in an integrated way and also understand about groundwater chemistry.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: VERTICAL DISTRIBUTION OF GROUNDWATER: Hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient. Classification of aquifers, Concepts of drainage basin. Water table fluctuations – causative factors, Preparation and interpretation of water table contour maps. Hydro-stratigraphic units, Groundwater provinces of India, Occurrence of groundwater in igneous, sedimentary and metamorphic rocks.

UNIT-II: THEORY OF GROUNDWATER FLOW, Darcy's Law and its applications, Determination of permeability in laboratory and in field, Types of wells, Drilling methods, construction, design, development and maintenance of wells, Specific capacity and its determination. Types of groundwater flow-Unconfined, confined, steady, unsteady and radial flow conditions. Aquifer parameter evaluation- Pumps tests – methods, data analysis and interpretation for hydrogeologic boundaries, Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods, Groundwater modeling – numerical approach and electrical resistance capacitance network.

UNIT-III: GROUNDWATER EXPLORATION: Geological – lithological and structural mapping, lineament Fracture trace analysis, Hydrogeological – lithological classification with respect of hydrologic properties, Hydrogeomorphic units, Location of springs Interpretation of satellite Data for water resources evaluation. Problems relating to occurrence and distribution of groundwater. Groundwater problems related to foundation work, mining, canals and tunnels, Problems of over exploitation and groundwater mining. Groundwater development in urban and rural area. Artificial recharge methods, Groundwater problems in arid regions and remediation. Groundwater balance and the methods of estimation. Groundwater legislation.

GROUNDWATER CHEMISTRY, Hydrogeochemistry physical, chemical and biological properties of water, Quality criteria for different uses, Water quality parameters. Graphical presentation of water quality data, Problems of arsenic and fluoride in groundwater, Saline water intrusion in coastal and island aquifers and its prevention.

PRACTICAL: Rainfall patterns of distribution, methods of preparing isohyetal map and thiessen polygon maps and interpreting volumes of rainfall. Methods of computing runoff volumes- manning coefficient- flow velocity and discharge calculations, wading method. Analysis water level fluctuation data-Preparation of water level fluctuation data-Preparation of water table contour maps and interpretation.Analysing pumping test data using Jacob's straight line method. Preparation of Iso-resisitivity maps and delineating groundwater potential zones. Interpretation of water quality data using numerical and graphical approaches.

REFERENCE:

1. Groundwater-C.F.Tolman
2. Groundwater Hydrology-D.K.Todd
3. Hydrology-S.N.Davis and R.J.M Dewiest
4. Groundwater studies-R.H.Brown and others
5. Groundwater Hydrology-Herman Bouver 6 .Hydrology-C.W.Fetter
7. Hand book of Applied hydrology-Van te Chew
8. Groundwater and wells-Hohnson Publications
9. Applied Hydrology-Chow M.Mays.Mac.Graw Hill Publication
10. Hydrology and wetland conservation-Gulam
11. Groundwater survey and inverstigation-Guatham Mahajan
12. Hydrology-Raghunath
13. Hydrogeology-Karanth
14. Ecology, Environment and Pollution – A Balasubramanian

COURSE-III : DISSERTATION [NULL]

An opportunity to work on a 30 days major project or Dissertation report in Earth science under the direct supervision of a faculty member in University/Institute or Government Organisation. Students will carry out data collection using field and/or laboratory studies, and complete a final report/presentation. Field studies, Laboratory studies / data processing, reference work and presentation of the report of the course.

COURSE OUTCOME

The anticipated knowledge, skills and/or attitude to be developed by the student are:

- To inculcate a culture of research and innovation at the postgraduate level so that the students are exposed to the nitty-gritty of the Scientific Research in their fields.
- The basic aim is to expose the students at an early stage to field and laboratory techniques and sophisticated instrumentation.

SOFT CORE

COURSE-IV : PRECAMBRIAN CRUSTAL EVOLUTION [Course code – 16473]

Introduces historical geology which deals with geologic time, fossils, stratigraphic principles, and the geologic history of the India. Develop broader perspective on relationship between crustal evolution, plate tectonics and metallogenic deposits.

COURSE OUTCOME

The anticipated knowledge, skills and/or attitude to be developed by the student are:

- Basis concepts of metallogenic epochs and provinces and their linkages with crustal evolution and plate tectonics.
- Familiarity about distribution of ore deposits in India.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: Geological time span. Early earth features. Mountain Building activity. Era- Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth. A magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts. Lithosphere and Mantle reactions. Origin of the crust. Lower crust-first continents. early continental crust. growth of crust- Mechanism of continental growth and its growth rate. Growth of Continents. Primary Atmosphere. Secondary Atmosphere. Oxygen in atmosphere- geologic indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory, outgassing. Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian.

UNIT-II: Precambrian mineral Deposits. Proterozoic life. oldest rocks. Continental foundation. Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of laurestia- Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia- grenville orogeny
– Proterozoic rifting. Mid-continent rift- snowball earth. Crustal provinces- Precambrian provinces of North America. Cratons of Americ- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of South Africa. Cratons- Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India.

REFERENCE:

1. Archaean Geology- C.S. Pichamuthu
2. Early Precambrian supracrustal of southern Karantaka-Memoir 112. Geol.Surv. Ind
3. Geology of Karantaka- B.P Radhakrishna
4. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
5. Geology of India and Burma- M.S Krishnan
6. Geology of India- M. Wadia
7. Crustal Evolution and Metalogeny in India- Sanib Chandra Sarkar and Anupendu Gupta

COURSE-V : CRYSTAL GROWTH AND MATERIALS SCIENCE [Course code – 16474]

The course covers the understanding of theories involves in crystal growth nucleation process and solution, melt and vapour growth techniques and Characterization tools. It is a theoretical lecture component and makes extensive use of examples and exercises to demonstrate the crystal growth methods and characterization.

COURSE OUTCOME

Students will learn about the fundamentals of

- Important crystal growth techniques like (Bridgman, Czochralski (Pulling method), solution growth, flux and hydrothermal methods, Physical Vapour and Chemical Vapour Transport.
- Understanding of various characterization techniques of a) Powder and Single crystal XRD b) FTIR, Raman, c) UV-Visible and PL, d) TG-DTG, DSC, microhardness and Chemical Etching.

PEDAGOGY

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application oriented assignments.
- Class room lectures will be supplemented with field related examples.

COURSE CONTENT

UNIT-I: CRYSTAL GROWTH: Introduction to crystal growth and growth phenomena. Crystal Growth methods- Melt (Bridgeman, Crystal pulling, Czochralski technique, zone melting) Verneuil process from solution, flux growth. CVT/CVD technique, Sol gel technique, Hydrothermal growth (low temperature, low

pressure, High temperature, high pressure). Sintering technique.

UNIT-II: MATERIALS SCIENCE: Nature and Properties of Materials. Structure of Solids. Bonding and structure in Materials, Imperfection in Materials, Linear defects, deformation, Planar defects, Volume defects, Diffusion, Mechanical, Thermal, Magnetic, Electrical & Optical properties of materials, Materials Selection, Material Processing, Synthesis & Design, Characteristics and uses of metals, Polymers, Glass, Ceramics, Composites, semi conductive and biological materials.