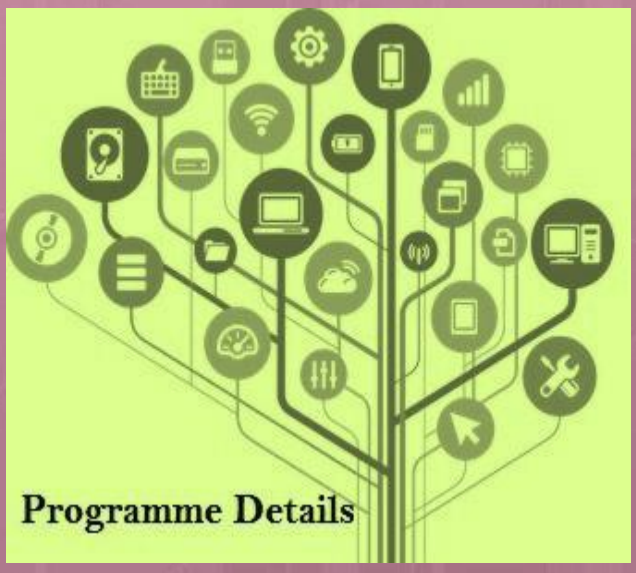
ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

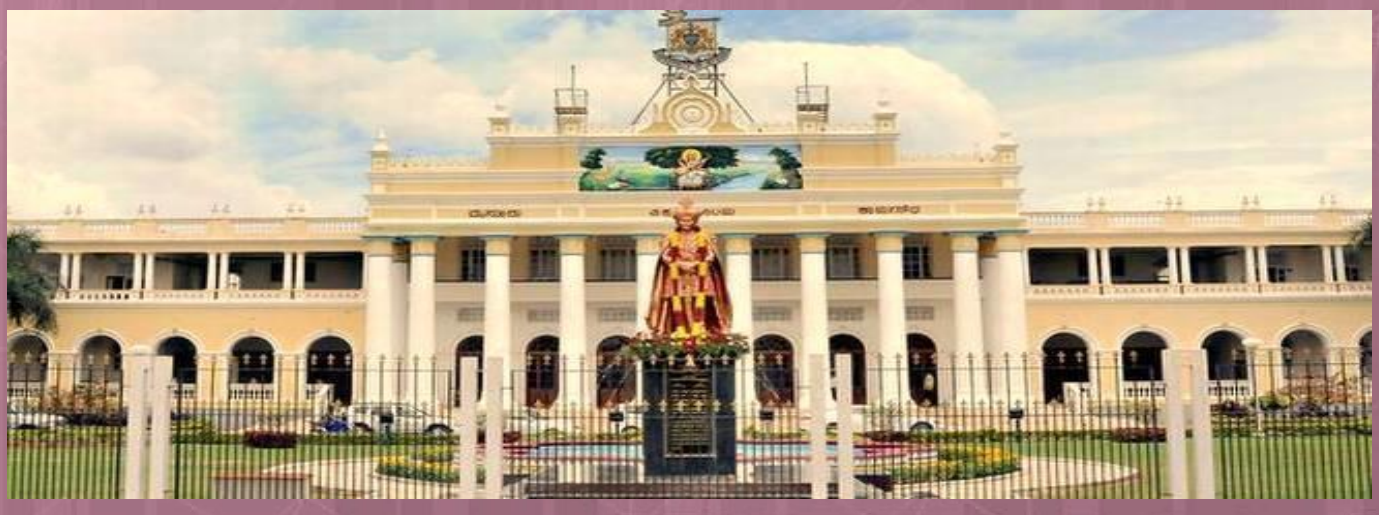
University of Mysore

(Estd.1916)

M.Sc. APPLIED GEOLOGY

Choice Based Credit System (CBCS)





UNIVERSITY OF MYSORE

Department of Studies in Earth Science
Manasagangotri, Mysuru-570006

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

Under
Choice Based Credit System (CBCS)

Prof. K.G. ASHAMANJARI
Professor
DOS in Earth Science
Manasagangothri, UOM
Ph: 0821-2419723
, Chair persm. BOS

UNIVERSITY OF MYSORE

GUIDELINES AND REGULATIONS LEADING TO MASTER OF SCIENCE IN APPLIED GEOLOGY (TWO - YEAR SEMESTER SCHEME UNDER CBCS)

Programme Details

Name of the Department	:	Department of Studies in Earth Science
Subject	:	Applied Geology
Faculty	:	Science and Technology
Name of the Programme	:	Master of Science in Applied Geology (M.Sc.)
Duration of the Programme	:	2 years course consisting of 4 semesters.

Programme Outcomes

Shall be able to:

1. Apply fundamental geological principles and concepts in theoretical, practical and vocational situations.
2. Solve geological problems using logical scientific methods and creative thinking.
3. Synthesize geological data on a range of spatial and temporal scales to make interpretations that allow for scientific uncertainty.
4. Communicate geological information concisely and accurately using written, visual and verbal means appropriate to the situation.
5. Employ new and established technologies to collect and interpret geological data, recognizing their strengths and limitations.
6. Acquire geological knowledge and expertise from a range of sources in a variety of situations.
7. Appreciate international perspectives on geoscience and recognize the importance of global standards for collecting and reporting geological data.
8. Recognize the need for sustainable use of Earth resources indigenously with constraints on environment protection and other community perspective on geological activities.

9. Work ethically and professionally alone and as part of a team, complying with applicable legislationandmanagingtimeandotherresourcesefficientlyandeffectively.

Programme Specific Outcome (PSO)

1. Demonstrate knowledge of: the geologic time and earth history; and crustal materials and dynamics in the context of plate tectonic theory.
2. Demonstrate competence in fundamental geological skills and quantitative analysis including interpretation of topographic and geological maps and cross-sections with basics of three-dimensional conceptualization and the ability to collect and interpret field and laboratory observations.
3. Effectively communicate knowledge and interpretation using written, oral and graphical skills both on a formal and extemporaneous basis.
4. Gain an understanding of the societal relevance of earth systems

Scheme of Examination and Details of Course Pattern for M.Sc. Degree Course (CBCS)

First Semester							
Sl. No.	Code	Title of the Paper	Credit pattern in			Credit value	Teaching hours/ week
			L	T	P		
1	16441	Advanced Palaeontology	3	0	1	4	
2	16442	Applied Hydrology	3	0	1	4	
3	16443	Fuel Resources & Sequence Stratigraphy	4	0	0	4	
4	16444	Marine Geoscience	2	0	0	2	
5	16445	Environmental Geology	2	0	0	2	
6	16663	Climatology	1	1	0	2	

Second Semester							
Sl. No.	Code	Title of the Paper	Credit pattern in			Credit value	Teaching hours/ week
			L	T	P		
1	16401	Advanced Mineralogy	2	0	2	4	

2	16403	Economic Geology	3	0	1	4	
3	16421	Stratigraphy Of India	3	1	0	4	
4		Minor Projects (Field Work & Technical Report)-FWTR	0	0	4	4	
5	16645	Analytical Techniques in Geology	1	1	0	2	
6	16455	Soil & Water Conservation	2	0	0	2	
7	16630	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	16461	Geo-Exploration & Mining Methods	3	0	1	4	
2	16462	Advanced Petrology	3	0	1	4	
3	16463	Geomorphology, Geotectonic & Surveying	3	0	1	4	
4	16464	Gemology	2	0	0	2	
5	16465	Mineral Economics	1	1	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	16471	Application of Remote Sensing And GIS	2	0	2	4	
2	16472	Geochemistry & Geochronology	3	0	1	4	
3		Major Project (Dissertation)	0	0	4	4	
4	16473	Precambrian Crustal Evolution	2	0	0	2	

FIRST SEMESTER

COURSE-I: ADVANCED PALAEONTOLOGY

It is a study of fossils preserved in the earth's crust by natural process, which is used as reference of large chunk of the relative age of the earth in terms of time. Palaeontology encompasses study of micro-fossils, plant fossils, vertebrate and invertebrate fossils and their evolution. These primary aspects are important not only to geology and stratigraphy but to inter-disciplinary fields of palaeobotany, palaeozoology and evolutionary biology.

COURSE OUTCOME

- The study of Palaeontology covers the aspects of the age of the earth, chronological arrangement of rocks and evolution of life through the geologictime.
- The knowledge of Palaeontology would enable the students to understand the changes that happenedinthecourseofhistoryoftheearthandrelatethemtotheirfieldobservations.
- The students will absorb skills of identifying and characterization of fossils and their taxonomic classification. They will also be introduced to interpretation of palaeoclimate and palaeoenvironment conditions.

PEDAGOGY

- Classroomteachingsupportedwithpresentationforenablingbetterunderstandingofthe subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: Origin and Evolution of Life; INVERTEBRATEANDVERTEBRATEFOSSILS
Invertebrates – Classification, morphology, evolutionary trends, paleoecology and stratigraphic distribution of the following groups – Brachiopods, Pelecypods, Cephalopods, TrilobitesandGraptolites.*Vertebrates*-Evolutionandgeologicalsignificanceofthefollowing
-Fish,AmphibiansReptiles,andMan.PLANT,-*Palaeobotany*-
Plantsthroughgeological ages – Precambrian Algae and Stromatolites; Paleozoic, Mesozoic and Cenozoic plants – Bryophytes,Pterdophytes,GymnospermsandAngiospermstheirstratigraphicsignificance.

Unit2: IntroductiontoMicrofossilsandMicropaleontology;ClassificationandApplications of Microfossils and micropaleontology; Separation of various Microfossils: Morphology, stratigraphic significance and applications of - Foraminifera, Ostracoda, Palynofossils, Acritarchs, Bryozoa,Chitinozoa, Conodont, Scoleconodonts, Diatom, Radiolarians, Dinoflagellates, and Nanoplanktons. Application of microfossils in fossil fuel exploration,

paleoclimateinterpretationandmaturationofsediments.OxygenandCarbonIsotopestudies onFossils.

Tutorial:1 Assignments/Seminar/Test/Discussion
Practical:1 Identification, Diagnosis and Geological distribution of the following Groups:Invertebrate – Brachipods – 5 genera, Cephalopoda: 5genera, 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, Palaeoecology and Interpretation of Seismic Profile.

References

1. Clarkson,E.N.K.,1998,*InvertebratePalaeontologyandEvolution,*IVedition,publ., Blackwell
2. Stearn,C.W.&CarrollR.L.1989,*Paleontology-theRecordofLife*,Publ.JohnWiley.
3. Smith,A.B,1994,*SystematicsAndTheFossilsRecord-DocumentingEvolutionary Patterns*., publ,Blackwell
4. Prothero.D.R.,1998,*BringingFossilstoLife-AnIntroductiontoPalaeobiology*.,publ., McGrawHill
5. D.J.Jones, 1956.*Microfossils*
6. F.T.Banner and A.R.Lord., *Aspects ofMicropaleontology*
7. M.P.Glaessner, *Principles ofMicropalaeontology*
8. M.D.Brasier, 1955, *Microfossils*, Publ.Georgeallan and Wiley &Sons
9. Romer.A, *VertebratePalaeontology*
10. Colbert, *Introduction to VertebratePalaeontology*
11. Sukla.,A.C&MisraS.P,1975,*StudyofPalaeobotany*VikarPubl.House
12. Sripad.N.Agashe,*Palaeobotany*
13. Maohotra,AK,OceanScienceandTechnology
14. Tchernia,P,Descriptiveregionaloceanography
15. K.Siddhartha, Oceanography- A briefIntroduction
16. WillamAAnikouchineandRichardWStenberg,TheworldOcean-AnIntroductionto oceanography
17. Cuchlaine A M King, Oceanography forGeographers
18. H V.Thurman, Introduction tooceanography

COURSE-II: APPLIED HYDROLOGY

Water is a basic life supporting system. The rise in global population and the quest for better living standard has put great stress on water resources. Course content primarily focuses on groundwater, which being easily available accounts for greater exploitation. Thus this course aims to enable students to acquire knowledge about the physical and chemical parameters, 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 groundwater occurrence, water bearing

properties of rocks, aquifer types and aquiferparameters.

- The course imparts knowledge about construction, design and development of water wells, aquiferparameterestimationandthescienceofgroundwaterflowunderdifferentconditions.
- The students will learn about groundwater exploration in an integrated way and also understand about ground water chemistry.

Pedagogy

- Classroomteachingsupportedwithpresentationforenablingbetterunderstandingofthe subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit-1: Methodsofanalyzingrainfall,runoff,infiltration,evaporationandtranspirationdata. Hydrological properties of rocks.Classification of aquifers. Groundwater distribution and Watertablefluctuations.Preparationandinterpretationofwatertablecontourmaps.Darcy's Law and its applications. Types of wells, Drilling methods, construction, design, development and maintenance of wells.Optimum yield, Specific capacity and its determination.

Unit-2: Theory of groundwater flow. Types of groundwater flow- Unconfined, confined, steady, unsteady and radial flow conditions.Aquifer parameter evaluation.Pumps tests – methods,dataanalysisandinterpretation.Influenceofhydrogeologicboundaries.Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods. Groundwater modeling – numericalapproachandelectricalresistancecapacitancenetwork.Salt-waterintrusionin coastal aquifers. Rock-Water Interaction and geochemical models. Modeling saltwater intrusion.

Unit-3: Groundwater Exploration: Geological – lithological and structural mapping. Role of lineament and fracture trace analysis. Hydrogeomorphic units.Problems relating to occurrence and distribution of groundwater.Methods of groundwater exploration. Groundwaterproblemsrelatedtofoundationwork,mining,canalsandtunnels.Problemsof over exploitation and groundwater mining.Groundwater development in urban and rural areas.Artificialrechargemethods.Groundwaterproblemsinaridregionsandremediation.Groundwaterbalanceandthemethodsofestimation.Groundwaterlegislation. FundamentalsofHydrogeochemistry.Physical,chemicalandbiologicalpropertiesofwater, Quality criteria for different uses, Methods of calculating Water qualityparameters. Graphical

presentation of water quality data. Problems of arsenic and fluoride in groundwater.**Practical: 1** 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. Analysiswaterlevelfluctuationdata-Preparationofwaterlevelfluctuationdata-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. GroundwaterHydrology-D.K.Todd
3. Hydrology-S.N.Davis and R.J.MDewiest
4. Groundwater studies-R.H.Brown andothers
5. Groundwater Hydrology-Herman Bouver6.Hydrology-C.W.Fetter
7. Hand book of Applied hydrology-Van teChew
8. Groundwater and wells-HohnsonPublications
9. Applied Hydrology-Chow M.Mays.Mac.Graw HillPublication
10. Hydrology and wetlandconservation-Gulam
11. Groundwater survey and inverstigation-GuathamMahajan
12. Hydrology-Raghunath
13. Hydrogeology-Karanth
14. Ecology, Environment and Pollution – ABalasubramanian

COURSE-III: FUEL RESOURCES & SEQUENCE STRATIGRAPHY

Coal is one of the largest fossil fuel derived from subsidence of vegetation. Carbon and organic matters are a potential source of information on climate, tectonics and palaeogeography. Major objective of the course is to make students understand origin of coal, petrography and its classification. 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. Sequence Stratigraphy is a combination of tectonics and subsidence, Eustasy, sediment supply and evolutionary historyofanysedimentarybasinandbasinAnalysisdealswithsubdivisionofsedimentary basinsfills into genetic packages bounded by unconformities and their correlative conformities. A student will understand and learn about the basic concepts of fuel resources with respect to sequence stratigraphy to work in the field of Petroleum

exploration. The study of natural radioactivity has experienced a substantial revival in recent years. The reason is the general increase in importance and popularity of all aspects of nuclear science, with this branch partaking of its share. The practical importance as raw materials for nuclear energy of uranium and thorium, which are the parents of most of the known natural radionuclides, has stimulated a study of the properties and occurrences of the later.

Course outcome

- The students will be appraised about the origin, migration and accumulation of petroleum; it willalsoprovidebasicskillsinprospecting,drillingandloggingoperationinoilexploration.
- The students will be capable about the origin of coal; it will also provide basic skills in prospecting, drilling and logging operation in coalexploration.
- 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, effectoftectonicsandsea-levelchangesoncoalformationanditsquality.
- Todescribethebasisofcoalclassification,conceptofgrade,typeandrankincoal.
- To understand analytical techniques in coal and its importance in coal classification and utilization for variousindustries.
- To understand key concepts of Base level, Basin Accommodation Space, Eustatic and RelativeSealevelchange,Transgression/RegressionandStratigraphiccyclicity.
- 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 boundingsurfaces
- The students will be appraised of identification, distribution, occurrence, importance of radioactive minerals and nuclear waster disposal

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE **CONTENT**

Unit1: Definitionandoriginofcoal.Stratigraphyofcoalmeasures.Fundamentalsofcoal petrology,peat,lignite,bituminousandanthracitecoal.Microscopicconstituentsofcoal.I ndian coaldeposits.

Unit2: Origin,migrationandentrapmentofhydrocarbons.Charactersandsourcea nd reservoirrocks.Structural,stratigraphicandmixedtraps.Geographicalandgeolog ical distributions of onshore and offshore petroliferous basins ofIndia.

Unit3: Mineralogyandgeochemistryofradioactiveminerals.Instrumentaltechnique sof detection and measurement of radioactivity.Radioactive methods of prospecting and assayingofmineraldeposits.DistributionofradioactivemineralsinIndia.Nuclearwa ste disposal and geologicalconstraints.

Unit 4: Introduction to Stratigraphy, branches of Stratigraphy. Terms and concepts of SequenceStratigraphyanditsrelationshipwithotherbranchesofStratigraphy.Sedimen tary basinanalysisthroughsequenceStratigraphy.Outcropandsubsurfaceprocedures.Glob al sea level changes/ eustatic sea level. Applications of sequence stratigraphy in petroleum exploration with casestudies

Reference Books:

1. NucleargeologyandAtomicmineralResources– S.N.Virnave.PublishedbyBharatiBhawan1995.
2. MineralResourcesofIndia–D.K.Banerjee.Publishedbytheworldpress.
3. Radioactiveminerals–R.Dhanaraju–2005publishedbyGeologicalSocietyofIndia.
4. Economic Mineral deposits – A.M.Bateman
5. Geology of Mineral deposits – SmirnovU.G.
6. Indian Mineral Resources – KrishnaSwamy.S.
7. IntroductiontoIndiaEconomicMineraldeposits–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. Sequencestratigraphy-BHPpetroleum(America)Inc– MichaelYeaman,Lavy Holcomb, Gill Tailor1990
15. Sequencestratigraphy– BPExporation.StockleyParkUKBridgeLondon,Publn. Blackwellscience
16. SeaLevelChanges- AnIntegratedApproachSpl.Pbln.42,BarbaraH.Lidz,EdtorofSpl. Publn. Oklahoma USA1998
17. Sequence in Layered Rocks- Blatt Middleton &Humay
18. Sedimentary Petrology-Pettijhon

COURSE-IV: MARINE GEOSCIENCE

This course explores the fundamentals of ocean science, and emphasizes the climatic and environmental importance of the oceans. It helps to understand the underlying mechanism in the formation of ocean basins, the physical structure of the ocean, the dynamics of ocean and its relation to 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 geologywithrespecttogeologyastoenablethemtoworkasamarineresearcher.
- 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 orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit-1:IntroductionMarineGeology.Continentalmarginsandoceanfloors.Plateboundaries and movements.Sea-floor spreading and subduction zones.Classification of sub marine topography. Physiographic features of the ocean floor. Oceanographic exploration instruments.Seamounts.Submarinecanyons.Mid-oceanridges.Oceanictrenches. Physicochemicalcharacteristicofseawater.Depth-wisedistributionoftemperature,salinity and density of sea water.Marine life and marineenvironment.

Unit-2: OceanwaterCirculation.FactorsandMechanisms.OceanWaves-theircausesand distribution.OceanTides-theircausesandeffects.OceanicCurrents-theirtypes,patternsof distributionandtheirsignificance.Tsunamis.Oceansedimentdeposits-sources.-theirTypes and distribution.Marine natural resources.Types of marine mineral resources and their distribution.Marine energy resources.Marine Placer deposits.Manganese nodules and the methods ofexploitation.

Reference:

1. Maohotra,AK,OceanScienceandTechnology
2. Tchernia,P,Descriptiveregionaloceanography
3. K.Siddhartha, Oceanography- A briefIntroduction
4. WillamAAnikouchineandRichardWStenberg,TheworldOcean-AnIntroductionto oceanography
5. Cuchlaine A M King, Oceanography forGeographers

6. H V.Thurman, Introduction tooceanography
7. WillamAAnikouchineandRichardWStenberg,TheworldOcean-AnIntroductionto oceanography
8. Cuchlaine A M King, Oceanography forGeographers
9. H V.Thurman, Introduction tooceanography.
10. MarineGeology,JamesP.Kennett,Prentice-Hall,1982-Science-813pages
11. MarineGeology,H.Kuenen,ReadBooks,01-Mar-2007-Science-592pages

COURSE-V: ENVIRONMENTAL GEOLOGY

The lecture part of the course begins with a brief overview of the earth's systems, processes andenvironmentalpollutionofdifferenttypes.Thesucceedingdiscussionofnaturalhazardsincludes 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,andinterpretingdataandapplyingmodelstobetterunderstandtheinterrelationships.

Course outcome

- Students should be able to predict potential hazards for any given area by knowing basic inherent geologic materials and characteristics of a givenarea.
- Studentsshouldbeabletobothpredictandanalyzetheimpactsoftheoccurrenceofa 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 geologicdata.
- 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 globalclimate.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1:Introduction to Environmental Geology. Man and environment. Earth's system,
Interactionsamonglithosphere,hydrosphere,atmosphereandbiosphere.Geologicalprocess
affectingtheenvironment.Environmentalhazardscreatedbyman'sactivitiessuchasmining and industrial activities. Disasters Management,Environmental Risk Assessment,
Environmenthazard,Risksafety.Impactofclimateonvariousearthssystems,Floodhazard zonation mapping and risk analysis and relief aspects.Public perception of risk,

risk communication.EnvironmentalImpactAssessment.CausesofEnvironmentaldegradation.Environmental law andethics.

Unit 2: 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.**Marinepollution:**Causativefactors–landbasedsources–marinebasedsources– types of pollution – oil spills – process of oil spill process and its effects on marine and continental environment. Global warming causes and itseffects.

Reference:

1. Environmental Geology – Peter TPFlawn
2. Environmentalgeosciences–ArthurHStrahler&AlanStrauler
3. GeologyinEnvironmentalplanning-A.D.Howard&I.Ramson
4. Focus on Environmental Geology –RTurk
5. Environmental Science –S CSantra
6. Environmental geology by WaldiaK.S

COURSE-VI: CLIMATOLOGY

Consequencesofglobalclimatechangealreadyinclude:increaseddrought,heatwaves,flood intensity, glacial retreat, and sea level rise. Solutions are needed to reduce human impact on our climatesystemandtorespondtoclimatechangeimpactsacrosssectorsvitaltohumanity(food,water, health). This course examines climate change at global and local scales. Students can exploreclimate challengesfacedbylocalexperts.Theyreflectonimplicationsforfutureproblemsolving.

Course outcome

- Students will analyze figures to understand natural and human-influenced drivers of our climate system andimplications
- Students will be able to assess the credibility of scientificinformation
- Students will communicate locally-relevant climate change solutions to a non-science audience
- Studentswillmakeinformed&responsibledecisionswithregardtoourclimate system.

Pedagogy

- Classroomteachingsupportedwithpresentationforenablingbetterunderstandingofthe subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit-1: Definition of Climate and weather. Climatology, its meaning, aims and

methods.Climatologyasdistinguishedfrommeteorology.TheClimaticelements.Orderoftreatment of climatic elements. Earth's Atmosphere- Structure and properties of Atmospheric layers.Solar Climate and Physical Climate.Continental and Marine Climate.Temperature as a climaticelement.AtmosphericMoisture,humidity,precipitation,andcloudiness.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.Dustcontentinairandprinciplesofatmosphericvisibility.Climaticzonesandtheir subdivisions.Classificationofclimates,-Koppen'sandThornthwaite'sschemeofclimatic Classifications. Characteristics of various climaticzones.

Unit-2: ChangesofClimate-Naturalfactors-Geologicalandsecularchanges,periodic variationsandRoleofAnthropogenicactivitiesinclimaticchangeswithcasestudies. Climate Observations,stationsandnetworks.Climatedatamanagement.Instrumentsandclimatic measurements.Thermometers,barometers,hygrometers,rainandsnowgauges,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 houseeffect,

References:

1. Climatology:AnAtmosphericScience,2/e,PearsonEducationIndia,1993-423p.
2. EncyclopediaofWorldClimatology,JohnE.Oliver,SpringerScience&BusinessMedia, 2008, 854p.
3. Climatology, Majid Husain, Anmol Publications, 1994 - 376p.
4. Advances in Meteorology, Climatology and Atmospheric Physics, Costas Helmis,PanagiotisT.Nastos,SpringerScience&BusinessMedia,2012,1278p.
5. RemoteSensingApplicationsinMeteorologyandClimatology,RobinA.Vaughan, Springer Science & Business Media, 2012, 480p.
6. AppliedClimatology:AnIntroduction,JohnF.Griffiths,OxfordUniversityPress, Incorporated, 1976, 136p.
7. Principlesofclimatology:amanualinearthscience,HansHermannNeuberger,John Cahir, Holt, Rinehart and Winston, 1969, 178p.
8. Climatology,anintroduction,JohnE.Oliver,JohnJ.Hidore,Merrill,1984,381p.
9. GlobalPhysicalClimatology,DennisL.Hartmann,AcademicPress,1994,411p.
10. Weather,radarandFloodforecasting,Collings.V.K(1987)JohnWileyandsons.
11. GeneralClimatology,Crithfield.H.J,(1996)PrenticeHall,NewJersey.
12. ClimatologybyMiller,AustinAPublication:LondonMethuenandcompany1961.xii, 320p.
13. GeneralclimatologybyFlohn,H[ed.]Publication:AmsterdamElsevierPublishing
14. company 1969 . xi,266p.

15. ClimatologybyMiller,A.AustinPublication:LondonMethuenAndCo1938.x,304pp
16. ClimatologybyHaurwitz,BernhardPublication:NewYorkMcGraw-Hill1944.xi, 409p.
17. MethodsinclimatologybyConrad,VictorPublication:CambridgeHarvardUniversity 18. Press 1946 .xx,228p.
19. ClimatologybyKendrew,WGPublication:OxfordTheClarendonPress1957.xv, 400p.
20. ClimatologybyBlair,ThomasAPublication:NewYorkPrentice-Hall1942.xvi,484p.

SECOND SEMESTER

COURSE-I: ADVANCED MINERALOGY

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 influencethis
- identify the commonest minerals and be able to say whether the rock is magmatic, sedimentary ormetamorphic

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: ***Crystallography***: Form theory of Crystals, Projections, Derivation of 32 point groups.ZoneandZoneLaws,Atomicandionicradii,Bondlengthandmeasurementsof Radius,Radiusratioandco-ordinationpolyhedra,CordinationNumber,Pauling'sRules, Spheres in Closest packing, Packing Index. Voids in closest packing, Classification & Coordinationofvoids,DerivativeStructures.CrystalDefects/CrystalImperfections
,

Unit2:*Mineralogy*:Structure,Chemistry,Paragenesis.ClassificationofMinerals.Optical

andphysicalpropertiesofOlivine,Garnet,Al2SiO5group,Epidote,Pyroxene,Amphibole, Mica, Feldspar and Silica group ofMinerals.

Practical 1: ***Crystallography***: Determination of Grades of symmetry in Crystals and their projections.DeterminationofAxialRatiosandanglebetweenthefacesbyusingStereonet.**Practical2:*Mineralogy:***Identificationofrockformingminerals.Determinationofmineral formulabasedonmineralanalysis.Plottingmineralcompositionsinatrilineardiagrams

COURSE-II: ECONOMIC GEOLOGY

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 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. Recognizecommonoremineralsinhandsamplesandunderthemicroscope.
2. Demonstrate familiarity with a wide range of mineral deposits, including recognizing 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 mineraldeposits.
4. Evaluatedifferentprocessesofelementenrichmentbyfluidsandmeltstoformorebodies.
5. Inform peer students and the wider public how the knowledge of formation of ore bodies is important in the current debates about globalresources

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: Ore – bearing fluids: magma, hydrothermal fluids, meteoric waters, seawaters, connatewaters,metamorphicfluids.Depositionaltextures:exsolution,replacement,colloidal

– colloformandopen-spacefillingtextures.Wallrockalteration:reactionbetweenwallrocks andfluids,alterationassemblagesandtypesofalteration.Paragenesisandzoninginminer al deposits. Classification of ore deposits. Deposits related to ultramafic-mafic rocks (layered intrusions,anorthosites,kimberlites,carbonates,komatiites).Depositsrelatedtointerme diate to felsic rocks (Iron deposits, porphyry Mo, pegmatites, granitic Tin and U, skarn deposits with typicalexamples).

Unit2: Depositsrelatedtoweathering– Nickellateritedeposits,Depositsrelatedtoclastic sedimentation: placer deposits – Witwatersrand gold and U deposits. Chemical sedimentation: phosphate deposits, evaporates, manganese nodules, Ore deposits related to subaerial (Epithermalgold–Au)andsubmarinevolcanism(KurokoCu–Zn,Japan,BIFs).Oredeposits relatedtometamorphism,metallogenicprovinces,EpochsandplateTectonic– classification of oredeposits.

Unit3: MetallicdepositsofIndia:Iron,Manganese,Copper,Chromium,Gold,Lead,Zi nc and Bauxite deposits, Non-metallic deposits (Industrial minerals) – Minerals used as fertilizers,refractories,abrasives,pigments,ceramicandglass-makingmaterials.

Practical: Opticalmethodsinminerals:Determinationofpleochroicschemeandoptics ign in minerals. Birefringence.
Identificationoforemineralsbasedonopticalproperties:chromite,ilmenite,Ti-magnetite, hematite,pyrite,sphalerite,galena,chalcopyrite,covellite,Bornite,pyrrhotite,Arsenop yrite, Pyrolusite.

Reference:

1. Thegeologyoforedeposits-JohnM.Guilbertandcharles.F.Park,Jr.W.H.Freemanand Co., New York.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. IntroductiontoIndia'seconomicminerals-Sharma,N.L.&Ram.K.S.
13. A treatise on industrial minerals of India-Sinha,R.L.
14. Mineral deposits of India, Mukerjee 1999: Alliedpublications.

COURSE-III: STRATIGRAPHY OF INDIA

Stratigraphy and Palaeontology, the two branches of Geology works together in discovering thesecretsofagefromrocksoftheearthcrust.Itallowsstudyingthecompositionandarrangementof layeredorstratifiedrocks.Palaeontologistsstudytheremainsofplantsandanimalswhichhavebeen preservedintheearth'scrustbynaturalprocesses.Withtheseobjectivesinminditbecomes pertinent to understand the basic concepts of Stratigraphy andPalaeontology.

Course outcome

- The study of stratigraphy and Palaeontology encompasses the aspects of the age of the earth, chronologicalarrangementofrocksandappearanceandevolutionoflifethroughthegeologic time.
- The knowledge of the concepts in stratigraphy, correlation, and paleontology would enable thestudentstounderstandthechangesthatoccurredinthehistoryoftheearthandrelatethem to their field observations and also, in understanding the framework of the stratigraphy of India.
- The students will be exposed to the principles of stratigraphy including order of superposition. They will also be able to identify primary sedimentary structure and their depositionalenvironments.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: ***Precambrian Era*** – Introduction, Physical features, Physiographic features and TectonicfeaturesofIndia.Briefstudieson– *DharwarCraton,BasterCraton,SinghbhumCraton, BundelkhandCraton and AravalliCraton.* A brief account on – *Eastern Ghats MobileBelt,PandyanMobileBeltandSatpuraMobileBelt.*PrecambrianofHimalaya. Proterozoic Sedimentary Basins - *Bijawar and Sonari, Gwalior, Abujhmar, Papaghnisubbasin,Vindhyan,Chhattisgarh,Khariar,Ampani,Indravati,Sabri,Pranhita-Godavari, Cuddapah, Kaladgi andBhima.*

Unit 2: ***Paleozoic Era***: Introduction, Tethyan Basin, Paleozoic Life, Trace fossils and Stromatolites. Precambrian/Cambrian boundary, pC/C boundary in Himalayan basins.*Cambrian–* JammuandKashmir,HimachalPradesh,TalBasinsandUttaranchal.*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.*GondwanaSupergroup* – Introduction, Characteristics, Stratigraphy and Structure, ClassificationandAge,LifeinGondwana,CoastalGondwanaBasins,GondwanainExtra - Peninsular India, Environmental of deposition and EconomicSignificance.

Unit3:*MesozoicEra*–Introduction,LifeofMesozoicEra,*Triassic*-JammuandKashmir, HimachalPradesh,Uttaranchal,Sikkim,RajasthanandKutch.Permo-TriassicBoundary.
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,AndamanandNicobarIslands.Cretaceous/TertiaryBoundary.*Deccan Volcanic Province* – Introduction, Regional Stratigraphy, Subprovinces, Volcano- Plutonic Complexes, Petrology and Petrogenesis, Inter-Trappean beds, Distribution and its age.

Unit 4: Cenozoic Era – Introduction, Distribution, Climate, Correlation, Fauna and Flora,

ClassificationandStratigraphy.*Paleogene*–Introduction,FaunaandFlora,Stratigraphyand Distribution.*Neogene*–Introduction,FaunaandFlora,StratigraphyandDistribution.
Quaternary–Introduction,Distribution,Quaternayclimaticchanges,QuaternarySealevel changes.Siwalik–StratigraphyandSedimentation,DistributionandFaunaofSiwalik. Geology of Offshore Basins.Morphology and Evaluation.

References:

1. Geologyof India Vol.1 & 2. M.Ramakrishnan and R Vaidyanatahan
2. Geology of India – Wadia, D.N., McMillan andCo.
3. Geology of India and Burma – Krishnan M.S. Higginbotham,Madras.
4. AhandbookoftheGeologyoftheMysoreState–B.RamaRao,Bangalorepress.
5. PrecambrianStratigraphyandGeochronologyofthePeninsularIndia–Sarkar,S.N. DhanbadPublishers.
6. ReviewpapersontheStratigraphyofIndia–Rec.Geol.Surv.IndiaVol.101,Part 2.1972CretaceousTertiaryformations–Geol.Soc.India,seminarVol.1958.
7. PaleozoicofHimalayas.HPCpubln.
8. ReconnaaissanceRb-SrdatingofthePrecambrianofSouthernPeninsularIndia- Crawford, A.R., J.G.S.I 1972.117-126.

COURSE-IV: MINOR PROJECTS (FW & TECHNICAL REPORT)

It is an opportunity to work on a 15 days minor project or Technical report in geosciences underthedirectsupervisionofafacultymemberinUniversity/InstituteorGovernmentOrganisation. 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 will be used for preparation 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 areexposedtothenitty-grittyoftheScientificResearchintheirfields.
- The basic aim is to expose the students at an early stage to field and laboratory techniques and sophisticated instrumentation.

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-V: ANALYTICAL TECHNIQUES IN GEOLOGY

This course provides students with advanced training in analytical techniques. This includes 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 synchrotrontechniques).
- Strategically plan analytical campaigns to apply various techniques to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' researchproject.
- Undertakethecorrectsamplepreparationandcharacterizationpriortoanalysisbythechosen techniques orinstruments.
- 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 andqualityofthedata.Justifytheapproachtakentodataprocessing.
- 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 orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit:1 Introductiontoinstrumentalmethodsofchemicalanalysis,Spectroscopyphotometry 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 2 Tutorial: Assignments/Seminar/Test/Discussion

Reference:

1. Silicate analysis byPotts
2. Petrographic techniques byHutchinson

COURSE-VI: SOIL & WATER CONSERVATION

This course covers topics in soil and water management and conservation important to students of agriculture, viticulture, horticulture and environmental sciences. Processes that degrade the soil and water resources of India (e.g. erosion, salinity, alkalinity as well as acidification, water repellence and degradation of soil structure) are examined, and their measurement, mitigation and management are 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,storageandmovementofwaterindrylandandirrigatedagro-ecosystems.Broaderissues insoilandwaterconservation(e.g.StateandCommonwealthlegislation)arealsocovered.

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.
- Theprimarycausesandconsequencesofawiderangeofsoildegradationproblems,including soil acidity and alkalinity, erosion, salinity and nutrientloss.
- The impact of soil management on soil organic matter, soil structural stability, water quality and other important soil properties.
- Where soil conservation and management fit into the broader context of the South Australian Natural Resource Management Act.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.

- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit-1: Definition of Soil. Soil genesis and morphology.Factors of Soil Formation.ProcessesofSoilFormation.TheSoilprofile-NatureofSoilProfile..ConceptofPedonand Landforms.Components and Composition of Soils.Physical Properties of Soils.Soil Structure.ChemicalPropertiesofSoils.SoilpH.SoilMineralogy.Ion-exchangeCapacity 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 Equationanditsapplication.Soilsurfacemanagementandsoilstabilizationpractices. Sedimenttraps.Soilconservationpractices-Tillagemethods.Biologicalsoilconservation. Mechanicalconservationworksincludingterracingmethods.IrrigationandEngineering Practices.

Unit-2: Definitionofwaterconservation.WaterConservationPractices.WaterResourcesin WatershedsandRiverBasins.WaterUseandConsumption.Watermanagement.Improving Drainage and reclaiming salt-affected soils. Technological options for drainage.Choice of method.Designprinciples.Theeffectofscale.MethodsofIrrigation-moderntechniques. In-situconservationofsoilwater.Runoffmanagement-Decreasingrunoffamount(contour farming, strip cropping, contour barriers, vegetative hedges). Water Erosion Control practices. Reducing runoff velocity(slope management, waterways, diversion channels, engineeringstructures,etc).Floodcontrol-InundationmethodsandFlooddiversion.Water storage- Small earth dams, Weirs, Sand dams. Losses of stored water- seepage/ evapotranspiration and its controllingmethods.

References:

1. PrinciplesofSoilConservationandManagement-HumbertoBlanco-Canqui,RattanLal, Springer, 16-Sep-2008 - 617pages
2. SoilandWaterConservationPoliciesandPrograms:SuccessesandFailures,Ted L. Napier, Silvana M. Napier, Jiri Tvrdon, CRC Press, 24-Nov-1999 - Technology & Engineering - 656pages
3. AdvancesinSoilandWaterConservation,FrancisJ.Pierce,CRCPress,01-Feb-1998- Technology & Engineering - 300pages
4. Soilandwaterconservationengineering,RichardK.Frevert,GlennOrvilleSchwab,

Wiley, 1966 - Nature - 683 pages
5. SoilAndWaterConservationHandbook:Policies,Practices,Conditions,andTerms,Paul W.Unger,HaworthFood&AgriculturalProductsPress,23-Oct-2006-PoliticalScience- 248pages
6. SoilErosionandConservation,R.P.C.Morgan,JohnWiley&Sons,05-Feb-2009- Science - 320pages
7. SoilErosion:Processes,Prediction,Measurement,andControl,TerrenceJ.Toy,George R. Foster, Kenneth G. Renard, John Wiley & Sons, 27-May-2002 - Science - 338 pages
8. SoilErosionbyWater:SomeMeasuresforItsControlonCultivatedLands,Foodand AgricultureOrganizationoftheUnitedNations,Food&AgricultureOrg.,01-Jan-1965- Nature - 284pages
9. WaterConservation,ManagementandAnalysis,MadireddiV.SubbaRao,Readworthy, 2011 - Water - 144pages
10. SoilandWaterConservationPoliciesandPrograms:SuccessesandFailures,Ted L. Napier, Silvana M. Napier, Jiri Tvrdon, CRC Press, 24-Nov-1999 - Technology & Engineering - 656pages
11. APracticalApproachtoWaterConservationforCommercialandIndustrialFacilities, MohanSeneviratne,Elsevier,11-Jul-2007-Technology&Engineering-400pages
12. SoilandWaterConservationinSemi-aridAreas,Issue57,NormanHudson,Food& Agriculture Org., 01-Jan-1987 - Arid regions - 172pages

COURSE-VII: BASICS OF EARTH SCIENCE

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 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 scienceproblems.
- Students will integrate data from field work, laboratory measurements, library research and / or their coursework to formulate or evaluate a geo-scientifichypothesis.
- Students will apply mathematical models and analysis to quantitatively describe and predict the behavior of Earthphenomena.
- 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 factualevidence.
- Students will learn how to critically evaluate scientific information in visual and written forms.

Pedagogy

- Class room teaching supported with presentation for enabling better

understanding of the subject.

- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit1:PhysicalGeology-
Introductiontogeology.OriginoftheEarth.Ageoftheearth.InterioroftheEarth.Ge omorphicprocessesandcycles,Geologicalactionofwind,water, glaciers.Volcanoes and earthquakes.Morphology of Oceans, Principles of Isostacy and uniformitarinism.

Unit2:StructuralGeology-
Rockdeformation.Earthforces.FoldsandFoldings,Faultand Faulting, Joints, Cleavage, Unconformities, Concepts of plate tectonics, sea floor spreading andgeosynclines.

Unit 3: Stratigraphy- Introduction, Definition of Stratigraphy, Branches of Stratigraphy and itsrelationwithotherbranchesofGeology,PrinciplesofStratigraphy- LawofUniformatianism,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,BioandChronostratigraphicunits,Correlation- LithostratigraphicandBiostratigraphic

Unit 4: Paleontology -Introduction, Definition of Paleontology, Classification of Plants, InvertebrateandVertebratefossils.Fossils-Tophonomy(BurialLaw),TypesofFossilization, Mode of preservation- Mummification, Carbonization, Silification, Casts, Moulds, Tracks aindTrails.ApplicationsofFossils.GeneralmorphologicalcharactersandGeologicalageof the following Invertebrate and Plant Fossils: Brachiopoda, Cephalopoda, Pelecypoda and Trilobita. Plant fossils: Glossoptreis, Gangamopteris, Ptillophylum, Calamites and Lepidodendron

References:

1. Physical Geology by ArthurHolmes
2. Structural Geology byBillings
3. General Geology By P.K.Mukerjee
4. Physical Geology ByStrahler
5. Stratigraphic Principles andPractice-Weller
6. Stratigraphy-Kumberlein andSloss
7. Paleontology of the Invertebrates-TaschPubl.Jhon Wiley andSons
8. Paleontology- HenryWood
9. Fossils Plants-Arnold
10. The Elements of Paleontology Black,R.M Pub. Cambridge universitypress

III SEMESTER

COURSE-I: GEO-EXPLORATION & MINING METHODS

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 genericview,thateconomicconcentrationsofmineralandenergyresourcesaregeological anomalies that are defined by extreme localised enrichments (of specific elements, minerals, liquids, gases or heat) and are recognisable by steep gradients in a range of measurable geophysical properties. The course will be divided into modules covering geophysical exploration techniques commonly used in mineralsandenergyexploration(gravity,magnetic,electrical,electro-magneticandseismicsurveys). We will examine the theoretical basis of each technique, the methods of data collection, presentation andanalysisandappropriategeologicallyconstrainedinterpretationofthedata.Studentsw illexplore an industry style data base and software's with an aim of developing an exploration and targeting model for hydrocarbonresources.

Course outcome

Thiscourseaimstointroducestudentstothetechniquesusedtomeasureandmapgeo logical, geophysical and geochemical characteristics of the lithosphere, with applications to mineral and energyexploration.

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 resourceexploration.
- The scientific basis of mineral, energy and natural resourceexploration.
- The generic characteristics of economic mineral and energy resources – geological, geophysical and geochemicalanomaly.
- Thegeophysicaltechniques(seismic,gravity,magnetic,electricalandelectro-magnetic)
- Thegeochemicaltechniques(samplingmedia,samplingstrategies,analyticaltechniqu es)
- Field based data collection – samplingstrategies
- Demonstrated understanding of the importance of data quality – collection, analysis, processestechniques.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.

- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: ***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.Geologicalcriteriaformineral prospecting.Indications of ore.Geological prospecting methods.Small and large scale geological mapping.Methods of geological exploration - exploratory grids, location and documentationofexploratoryworkings(pits,trenchesundergroundworkings),drilling,core logging.Sampling techniques and evaluation ofgrade.
Mining terminology, methods of open cast, underground and alluvial mining. Definitionandscopeofmineralprocessing,communition,crushersandclassifiers. Froth flotation techniques ofseparation.

Unit 2: ***Geochemical Exploration:*** Geochemical cycle, mobility of elements and geochemicalanomaly.Modeofoccurrenceoftraceelements.Primarydispersion patternsof deepseatedorigin,syngeneticandepigenetic.Geochemicalrocksurveys.Weathering andits 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 drainagesediments.
Uptakeofmineralmatterbyplants.Biogeochemicalanomaliesandsurveytechniques.Vapourgeochemistry.

Unit3:Geophysicalexploration:Geophysicalanomalies,Electricalprospecting: Resistivity method, important electrode arrangements, instruments, interpretation and application of electrical methods in ground waterinvestigation.
Magneticprospecting:Magneticpropertiesofrocksandminerals,Earth'smagnetic field, instrument and measurements, interpretation of magneticanomalies.

Gravityprospecting:Earth'sgravityfield,regionalandlocalgravityanomalies,instruments, interpretation of gravityanomalies.
Seismic prospecting: Elastic properties of rocks and minerals, refraction and reflection technique time-distance relation for horizontal interfaces, seismic instruments and records.
Radiometricmethods:Radioactivityofrocksandminerals,instrumentsandmeasurementsof radiation, Well logging: Different techniques oflogging.

Practical: ***Geological Exploration-*** Delineation of ore deposit based on exploration data. Classificationoforereserves.Economicevaluationoforedeposit.Preparationoftechnical report.
Gechemical Exploration: Geochemical methods in mineral exploration and choice of materialsandmethods.InterpretationofGeochemicalmapsforlocatingoremineralization. Preparation of geochemical anomalymaps.

Geophysicalexploration:Resistivitymethods:Curvematchingtechniquesands -line method.

REFERENCE BOOKS

1. Introduction to geophysical prospecting - Milton BDobrin
2. Exploration geophysics – Jakaosku JJ
3. Outlinesofgeophysicalprospecting-Amanualforgeologists–MBRamachandraRao
4. Geophysical Methods in Geology – P VSharama
5. Exploration Geophysics for geologist and Engineers – Bhimasanakaran andGaur
6. Principles of Applied Geophysics – D SParansis
7. Introduction to Geophysics – C HHowel
8. GeochemistryinmineralexplorationRose,A.WHawkes.H.E&WebbJ .S.1979. Academicpress.
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 inMineral Exploration. G.J.S.Govett. Elsevier Publication. 1983.

COURSE-II: ADVANCED PETROLOGY

Petrology is the science of rocks. It involves understanding of the processes involved in the formation of igneous and metamorphic rocks, their textures, structures, classifications and their importance.

The course will help the students to exhibit an improved and understanding of fundamental petrologic processes and common rock types.

Course outcome

- Predict what suites of igneous and metamorphic rocks should be found in different plate tectonicsettings.
- Explainmagmadifferentiationandobservationsoflayeredmaficintrusionsusinga fractional crystallizationmodel.
- Describe the types and relative abundances of phases in a rock based on observations from hand specimens and thinsections.
- Interpret the geologic history of rocks based on mineral assemblage and textures using both hand sample and microscopetechniques.
- Use rock mineral assemblages and textures to constrain deformation history and P-T conditions.
- Integratetheirresearchfindingswiththoseofpeersindevelopingaconsensusmode lthat(a) explainsmineraloccurrencesandinterplay(micro-andmacroscopic)infieldsamples,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 samplingcampaign

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: Igneous Petrology: Mineralogical and Chemical classification of Igneous rocks. Classification,originandpetrogeneticimportanceofGranite,Syenite,GabbroandLayered Igneous Complex, Kimberlite, Anorthosite, Carbonatites and Peridotite. Add a note on their economic importance and Indian occurrence. Classification and origin of Pegmatite, Dolerite,Lamprophyre,Basalt,Rhyolite,Trachyte,Andesite.Addanoteoftheireconomic importance and Indianoccurrence.

Unit 2: Sedimentary petrology: Aims and Scope of Sedimentology, Development growth and Prospects of Sedimentology in India, Sedimentary facies and environment. Detailed petrographic parameter of Gravels and Conglomerates, Sands and Sandstones, Shales, and Argillite, Limestone and Dolomite, Evaporites, Provenance studies, Heavy mineral studies, Grain size parameter Modes and Mechanism controls of sedimentation, Stock's law, Sedimentarystructures,Tectonicsandsedimentation,Cyclicsedimentspurposeandscopeof basinanalysis

Unit 3: Metamorphic Petrology: Definition, Factors and Limits of Metamorphism (Temperature,Pressure&types).FabricChanges,GeothermalGradient,MetamorphicFluids (recrystallization,pressure,anditstypeofpressure).StructureandTextureofMetamorphics- Terminology for high strain shear zones related structure and textures. Types of metamorphismbasedonprincipalprocess(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- Types of Metamorphic Reaction- PTX Conditions- Metamorphic rocks Components and Developments- Development of Metamorphic Mineral Nucleation- Mineral assemblages equilibrium/ReactionTextureandgeo-thermobarometry.MetamorphicReactions. Characteristicsofdifferentgradesandfaciesofmetamorphism.Metasomatismand

granitization. Migmatites.Plate tectonics and Metamorphic Zones.Paired metamorphic belts.

Practical: Identification of Igneous rocks in hand specimens and thin Sections.

Identificationofmicrostructuresandtexturesinigneousrocks.Significanceofmicrotextures in understanding magmatic and tectonicprocess.

IdentificationofSedimentaryrocksinhandspecimensandthinsections.Identificationof structures in Sedimentaryrocks.

Metamorphic:MegascopicandMicroscopicidentificationofdifferenttypesofmetamorphic rocks and significance of micro structures and textures in understanding metamorphic and tectonicprocess.

References:

1. Petrology of Igneous and Metamorphic rocks byHyndman
2. Principles of of Igneous and Metamorphic rocks by Anthony R.Philpotts.
3. Igneous petrology by AnthonyHall
4. Petrology of Igneous and Metamorphic rocks byBest.
5. Petrography–Anintroductiontothestudyofrocksinthinsections–HKowell,,Williams andTurner.
6. The Study of Rocks in Thin Sections- W.W.Moorhouse
7. Migmatites -Asshworth.
8. Metamorphism - A. Methuen &Co.
9. Migmatites and the origin of granitic rocks -Mehnert K.R. Elsevier & Co.
10. MetamorphismandMetamorphicrocks-Miyashro,A.George,AllenandUnwin.
11. Petrogenesis of metamorphic rocks- Winkler, H.G.F. Springer,verly.

COURSE-III: GEOMORPHOLOGY, GEOTECTONICS & SURVEYING

The study of the origin and evolution of topographic and bathymetric features created by physical, chemical or biological process on the Earth surface.Structural geology is the study of the deformation of the surface and subsurface of the Earth and other planetary bodies. This deformation reflectspastchangesinlocalandregionalstressandstrain,andcanbeusedtoreconstructpastcrustal movementsanddynamics.Surveyingorlandsurveyingisthetechnique,profession,artandscienceof 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 landownership.Itisanimportanttoolforresearchinmanyotherscientificdisciplines.

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 numericalmodeling.
- Studentswillbeabletodescribeandinterpretgeologicstructuresinunfamiliargeologicmaps

andaerial/satelliteimages,toconstructcrosssections,toinfergeologichistoryfrom mapand
imagedata,andtointerpretstructuresinthecontextofregionaltectonichistory.

- 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 earthquakesandassociatedhazardsinaparticulararеaandmakerelatedinformedd ecisions.
- Gaintheabilitytousemodernsurveyequipmenttomeasureanglesanddistances
- GainabasicunderstandingoftheprinciplesandoperationoftheGlobalPositioningSyst em

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: Rock deformation: Earth forces, Static and dynamic conditions, Mechanical

characters of the rock. Kinds of Rock deformation: Mechanics of rock deformation.
RelationshipbetweenStressandStraininrockcompressivestrength,tensilestrength,Shear strengthinrock;,MechanicsofPlasticdeformation,Stressandstrainellipsoids.

Unit2: FoldsandFoldings,FaultandFaulting,Unconformities,Plutons,Joints,Cle avageand Schistosity Lineation and Foliation, Mylonites andPseudotachyllites.

Unit 3: Principles of Geomorphology, 1st order, 2nd order Relief features of earth.
Geomorphicprocessesandlandforms.Depositionalanderosionallandformsdeve lopedasa result of fluvial , glacial, Aeolian, coastal and karst cycle . Terrain classification and
applications,Roleofgeomorphologistsinconstructionofirrigationprojectsinarid and
semi arid conditions and interpretation of drainage patterns.

Practical:Geotectonics-
Constructionofgeologicalcrosssection.,Structurecontourmaps,
Tracingofoutcrops,Interpretationofundergroundstructurefromboreholedata,S olutionto
faultproblems,Useofstereographicprojectioninstructuralcalculation,Construc tionofrose diagram for structuraldata.

Surveying:Chainsurvey,Compasssurvey,Planetablesurvey,Dumpylevelsurvey

,GPS survey, Total StationSurvey

Reference:

1. Billings,M.P.(1978)Structuralgeology–Prentice–
HallofIndiaPrivateLtd.New Delhi.
2. Suppe,J. (1985) – Principles of structural geology – Prentice –Hall.
3. Price,N.J.andCosgrove,J.W.(1990)AnalysisofGeologicalstructure.Ca
mb.Univ. Press.
4. Hobbs,B.E.MeansDandMillions,P.F.(1976)anoutlineofstructuralgeology.Wiley
5. Ramsay,J.G.(1967)–Foldingandfracturingofrocks.Mc.GrawHillsNewYork.
6. Badgley P.C. – Structural Geology for the explorationgeologist.
7. Whitten, T – StructuralGeology.
8. Ramsay, J.G. Structural Analysis of MetamorphicTectonites.
9. Thornbury, W.D – Principles ofGeomorphology
10. Dayal. P – A Text book ofGeomorphology
11. Surveying and Levelling – Late T.P. Kanetkar and S.V.Kulkarni.
12. Surveying –Punmia.
13. Geomorphology by William D.Thornbury.
14. Modern Physical Geography by Arthur N. Strahler& Alan H.Strahler.
15. Applied Geomorphology byHails.

COURSE-IV: GEMMOLOGY

Gemologyistogivestudentsallrequiredknowledgeaboutgemstones,theiroccurrences,their physical and chemical properties and the internationally employed scientific methods for the identification and grading ofGemstones.

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 orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit 1: Introduction to Gemology, classification of gemstones, detailed study of different

physicalandopticalpropertiesofmineralswithspecialreferenceoftogem minerals. Physical- optical effects in gemstones.Colour and Cause of colour in gems, Colour enhancement ingems.

Unit2: Cuttingandpolishingofgemstones.Adetailedstudyofimportantpreciousandsemi precious gemminerals,theircharactersandoccurrences,Worldoccurrencesingeneraland Indian occurrences in particular (i)Precious varieties 1. Diamond 2.Gem corundum 3. Topaz 4.Emerald(ii)Semi-

preciousvarietiesGarnets,Quartz,Lapislazuli,TurquoiseandOrganic gems.

References:

1. Gems and Gem industry in India-GSI Memoir 45- R.VKaranth.
2. Gem and Gem Minerals – EH Kvans and CBSlawsan
3. EncyclopediaofMineralsandGemstones -EditedbyMichaelO'DonOghal.
4. Preciousstones-byMax-BauerVol.IandII.PublisherDoverpublicationsInk.New york.
5. Gemsandpreciousstones-SimonandSchusters,Publ.Firesidebookpublishers.
6. Gems and precious stones- Cally Hall, the apple presspublishers
7. Gemmological instruments-Peter.G.read, Butterworthpubl.
8. Gem stone enhancement-Kurt Nassau, Butterworthpubl.
9. Rutley's Elements of Mineralogy- by H.H. Read, CBSpublication
10. Dana's Manual ofMineralogy
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 andZussman.
14. PhysicalGeology-P.K.Mukherjee
15. Geology of India-R.Vaidyanathan andM.Ramakrishnan
16. Geology ofKarantaka-B.P.Radhakrishna
17. Mineral Resources of Karnataka-B.PRadhakrishna

COURSE-V: MINERAL ECONOMICS

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. The second section covers Mining Law, legislation, environmental and socio-economic legislation. The third section introduces sustainability, addresses present and future mineral resource use and development in light of social and environmental factors. This also includes few case studies.

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 lifecycle.
- Assemblecashflowinformationanddeterminetheeconomicfeasibilityofamineralproject.
- Analyze the financial impact of risks associated with a mineral project and carry out cost- analysiscalculations.
- Indianlawsandlegislationsrelatedtomineralextractionandminingindustry.
- Recognize sustainability perspectives related to the mineral industry and describe aproject's impact on the economy, the environment andsociety.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit1: Introductionandconceptsofmineraleconomics.Peculiaritiesinmineraldeposits.Conceptsinmineralexplorationandmineralresourceestimation.ClassificationofIndian mineralresources.Roleofmineralindustryinnationaleconomy.Strategic,criticaland essential minerals. India's status in mineral production.Changing patterns of mineral consumption.NationalMineralPolicy.MineralConcessionRules.Minerallegislationin India.Mineralproduction,processing,coproductsandbyproducts.Mineralinventory. Consumptionandsubstitutionofminerals.DemandAnalysisandmarketsurvey. Mineral conservationandenvironment.Mineralinformationsystem.Marinemineralresourcesand Law ofSea.

Tutorial: Assignments/Seminar/Test/Discussion

Reference:

1. Mineral Economics by Truscot, John Wiley and Sons, Inc,1987.
2. AnintroductiontomineralEconomics–K.K.Chatterjee.publisher:-WileyEastern. 1993.
3. MineralEconomics:-R.K.SsinhaandN.L.Sharma.OxfordandIBHpublication

COURSE-VI: ENGINEERING GEOLOGY

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 suggests 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

- Developunderstandingonimpactofgeologicalfeaturesoncivilengineeringprojects.
- Identify the problems associated with different geological features on civil engineering structures and suggestalternatives.
- Able to understand the geological aspects of constructionproject.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit:1 Engineering properties of rocks. Rocks as construction material, Geological considerations in selecting sites for tunnels, bridges, Dams and reservoirs, highways, Reservoirsedimentation:Causes–effects-basin,channelandgeologicalfactors,climatic influence, monitoring-desiltingmethods.

Unit:2 Geological investigation of landslides – hazards – hazards zonation mapping – stabilityanalysismitigationmeasures.CoastalErosion:CausesofCoastalErosion Nearshore dynamics,erosionmechanisms-longshoredrift,Effectsofcoastalerosion–Controlling

methods–
barriersgroins,seawalls,Jettiesandstonerevetments.Geologyofsoilsand elements of soil and soilmechanics.

Reference:

1. Plate tectonics and crustal evolution –Condie,K.C.
2. Manual of Field geology –Compton.
3. Soil their Orgin, constitution and classification – RobinsonG.W
4. Soils – Tambane andothers
5. Nature and Properties of Soil- Harry O BuckmenNylc C.Brady
6. FundamentalsofSoilScience –Miling,TruckandForth.H.D(1984)Johnwilley
7. Introduction to Physical Geology – Strahler, A.N – 1965 –Willey
8. Climatology–
Stringer(1982)SurjeetPublicationSoilAtlasofKarnataka,NBSSLUP Publication.

COURSE-VII: INDUSTRIAL MINERAL RESOURCES

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 sequenceofeventsfromtheselectionofareasforpotentialdiscoveryoforedeposits,prospe ctingand development.

Course outcomes

- To be able to classify different minerals and rocks relevant toresources
- Tobeabletounderstandhowandwhydifferenttypesofmineraldepositsareformed
- To gain an insight into how environmental problems applicable to mineral deposits and exploitationofnaturalresourcescanbeminimalisedand,ifpossible,avoided
- Gain a deep knowledge within your own area ofinterest.

- To be able to identify certain minerals and rocks relevant to natural resources in hand specimens.
- Tobeabletoexplainhowdifferenttypesofmineraldepositscanbefound.
- To be able to evaluate different environmental measures applied to mineral deposits and exploitation ofresources.
- Tobeabletoworkbothindependentlyandincollaborationwithothers.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit1: DefinitionofaMineral.ClassificationofMinerals–
Rockformingminerals&Ore forming Minerals, Silicate and Non-Silicate minerals. Physical, Chemical and optical properties ofMinerals.
Unit2: DescriptionofIndustrialMinerals:Gold,Silver,Coal,Copper,Diamond,Asbestos,
Barite,Calcite,Diatomite,Feldspar,Gypsum,Kaolin,Mica,Silica,Talc,Zeolite,
Unit3: MineralsUsedinPaint,Fertilizers,Pesticides,Abrasives,Refractories,Ceramics, Glass, Pharmaceuticals, Petrochemical and NuclearEnergy

Unit 4: Gem Minerals: (i) Precious varieties 1. Diamond 2.Gem corundum 3.Topaz 4.Emerald(ii)Semi-preciousvarietiesGarnets,Quartz,Lapislazuli,TurquoiseandOrganic gems. Minerals Used in Civil work: Sandstones, Marbles, Granites, Sand and Gravel
References:
1. IndustrialMineralsandThierUses:ahandbookandformulary.Ed.ByPeterA Ciullo, Noyes Publications,1996,
2. India'sMineralResourcesbyS.Krishnaswamy,RevisedbyR.K.Sinha,Oxford&IBH Publishing Co.PVT.LTD.

FOURTH SEMESTER

COURSE-

I:APPLICATIONOFREMOTESENSINGANDGIS

This course teaches students the fundamental principles 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 spatialanalysis
component,tolocatingandacquiringappropriatedatasets,andconductingtheanal

ysisinan organized and documentedway.

- Communicatingtheresultsoftheanalyseswithcartographicallyaccurateandcompletemaps, and other audience appropriate maps, figures andreports.
- Applytechniqueslearnedinclasstoconsulting-styleproblemsinateamenvironment
- Troubleshoot issues that arise in all stages of spatial problem solving by working with peers, usinghelpfiles,andusingonlineforumsinaproductiveandappropriatemanner.
- CompetenceinusingtheArcGISsuiteofsoftwaretosolveavarietyofproblems.
- Exposure and experience writing basic Python scripts, and an understanding of basic computer programmingconcepts.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit1:RemoteSensing: BasicPrinciplesofRemoteSensing.EnergyInteractions withthe Atmosphere.RadiationandBlackBodyradiation.TypesofRemoteSensing,Sensors.
Scanners and their capabilities. Platforms- Types of Platforms, Satellite Remote Sensing. Satellite Data Products- their Characteristics.Resolution and Types of Resolution.Data products and IRS Satellites.Digital Image Processing.Remote Sensing in Indian Scenario.RemoteSensinginVisible,InfraredRays,MicroWaveandThermalregions.Applicationof RSinGeomorphology,LithologicalMapping,Structuralmapping,Hydrogeological studies and Mineral Exploration.Remote Sensing for Disaster Management.Global Satellite Data Sources and uses.Hyperspectral Data and theiruses.

Unit 2: GIS: Definition of Geographic Information System. The nature of geospatial informationanddatarepresentation.Cartography.Mapsandspatialinformation.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 datamodels.VectordataModel.RasterdataModel.DEM.TIN.Vectorandraster-

advantages and disadvantages. Attribute data models. Topological relationaships of spatial data.Data Sources.GPS. Data input techniques. Digitization of maps and imageries; Coordinatetransformation;Attributedatageneration.Spatialdatalayers.Dataretrieval and querying.Spatialanalysis-Spatialoverlayoperations,buffering,trendsurfacemapping. Networkanalysisandproximityanalysis;3Dmodels.GISModelingfordecisionsupport.Applications of GIS in earth's resources evaluation andmanagement.

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

Practical:GIS: Methodsofdigitizinggeospatialdata(toposheet/satelliteimage). 2.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 spatialanalysis.

Reference:

1. TextbookofRemotesensingandgeographicalInformationsystem,1st&2nd Ed.ByM. 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:VisualizationofGeospatialdata–Menno-JanKraakandFerjanOrmeling
5. Principles and application of Photogeology – Shiv NPandey
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: MorrieM.Thompson.
10. Manual of Remote sensing - Ed: Robert GReeves.
11. Theoryofpatternrecognitionandmodernforecasting -V.KarpinandWrightPattern.
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; SPpublication
15. Digital Remote Sensing – Pritivish Nag M Kudrat ; Conceptpublication
16. Principles of GIS for land and resources assessment, Burrough, P.A., 1986,Oxford.
17. Introductory cartography, Campbell, 1984, PrenticeHall
18. Map data processing, Freeman and Pieroni, 1980, AcademicPress.
19. An introduction to Geographical information systems: Ian Heywood et.al.
20. Geographicalinformationsystemsanddigitalimageprocessing– Muralikrishna1999. AlliedPublication
21. FundamentalsofremotesensingandGeoinformatics,byAnjireddy,Hyderabaded.1and 2.
22. GeographicInformationSystems:AnIntroduction,3rdEd,Bernhardsen,JohnWiley& Sons, 01-Jan-2007 - 444pages

23. Geographicinformationsystemsandscience,PaulLongley,Wiley,13-Jul-2001- Education - 454pages
24. GeographicInformationSystemsforGeoscientists:ModellingwithGIS, GraemeF. Bonham-Carter,Elsevier, 18-May-2014 - Science - 416pages
25. GeographicInformationSystemsandScience,PaulLongley,JohnWiley& Sons,22- Mar-2005 - Science - 517pages
26. HandbookonGeographicInformationSystemsandDigitalMapping,Unit edNations. StatisticalDivision,UnitedNationsPublications,2000-Census-197pages
27. IntroductoryReadingsInGeographicInformationSystems,DJPeuquet,DFM arble,CRC Press, 16-Dec-2003 - Technology & Engineering - 371pages

28. GeographicInformationSystems(GIS)andMapping:PracticesandStand ards,Issue 1126, Arnold Ivan Johnson, C. BerntPettersson, ASTM International, 01-Jan-1992 - Travel - 346pages
29. IntroductiontoGeographicInformationSystems,Kang-tsungChang,McGraw-Hill Education, 16-Jan-2015 - Science - 448pages
30. FundamentalsofGeographicalInformationSystems,MichaelN.DeMers, Wiley,2009- Science - 443pages
31. TextbookofRemoteSensingandGeographicalInformationSystems,K aliCharanSahu,Atlantic Publishers &Dist, 01-Dec-2007 - 512pages
32. GeographicInformationSystem,B.Gurugnanam,NewIndiaPublishing,0 9-Jun-2009- Geographic information systems - 206pages
33. FundamentalsofGeographicalInformationSystems,MichaelN.DeMers, Wiley,2009- Science - 443pages

COURSE-II: GEOCHEMISTRY & GEOCHRONOLOGY

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 courseiscomposedofthreemodules:(a)geochemicalfundamentals(b)naturalandanthropogenically 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 chemicalprocesses.

Course outcome

A successful student in this course should be able to:

- Demonstrate proficiency in common practical data handling skills in geochemistry. **Geochronology** &Petrogenesis.
- Planandcarryoutappropriatemathematicalstrategiesforsolvinggeochemicalproblems;
- Synthesize the results of their problem-solving with other work in the form

of short, well- organizedarticles;

- Have insight into the origins of earth's atmosphere, oceans androcks;
- Critique possible over simplifications in geochemicalmodels.
- To understand evolution of the early Earth from proto-planetary material and its differentiation to present daystate.
- To describe the composition of the Earth´s main geochemicalreservoirs.
- 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 metamorphicevents.
- To understand how chemical weathering of minerals and rocks control the composition of sediments/soil and naturalwater
- Carbon flux studies to understand the role of geological processes in release of carbon to the atmosphere.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.

COURSE CONTENT

Unit1:Geochemistry: Earthinrelationtosolarsystemanduniverse,Cosmicabundanceof elements,Geochemicalclassificationofelements,Primarydifferentiationoftheearth.
Composition of the planets and meteorites, Structure and composition of earth and distributionofelements.Geochemistryofhydrosphere,biosphereandatmosphere.Carbon captureandsequestrationstudies.RoleoftraceandREEinmagmaticprocesses.
Geochemical principles in rock cycle (geochemical cycle).

Unit 2: Geochronology: Radioactivity and radioactive decay schemes. Radiometric dating, importanceofPbandNdisotopesingeologicalprocesses.Radiogenicisotopesystematics: U-Pb, Rb-Sr,Sm-NdandC^{14}systematics.Stableisotopes:Carbon,Oxygen,Hydrogenand Sulphur.

Unit 3: Petrogenesis: Steady state geotherms, Phase, phase diagram, phase rule, Unary systemwithexamplesofwaterandAl2SiO5,binary(Diop-AnSystem&Fo-Fasystem)and ternary system. Properties of magma, critical point and super critical fluids, congruent and incongruentmelting,eutecticcrystallisation,partialmelting,miscibilityandimmiscibilityin solidsandliquids,peritecticpoint,perthitesandantiperthites.Exsolutionphenomena. Nucleationanddiffusionprocessesinigneous,metamorphicandsedimentaryenvironments. Redox reactions and Eh-Ph diagrams and theirapplications.

Practicals:P-TcalculationsandconstructionofP-Tdiagrams.Petrochemicalcalculations- Niggliverte and Niggli base, CIPW norm calculation, Trilinearplots , construction of Variation/ Discriminant diagrams using major, trace and REE geochemistry data and interpretation. Isotopic age determination ofrocks/minerals.

References:

1. Geochemistry- William.M.White-Wiley black wellpublications
2. Introductiontocarboncaptureandsequestration-BerendSmit,Jeffrey.A.Reimer, CurtisM. Oldenburg andIan.C.Bourg.
3. Rare earth element Geochemistry byHenderson
4. Geochemistry by Rankama andsahama
5. Petrologic Phase equilibria –W.G.Ernst
6. The Interpretation of Geological Phase diagrams - Ernest GEhlers
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. PrinciplesofIgneousandMetamorphicPetrologybyAntonyRPhilpotts,1979.**1.**
12. Geohemical Thermodynamics by Darrell Kirk Nordstromand James L. Munoz
13. Chemical Thermodynamics for earth scientists by Philip Fletcher,1993
14. Chemical Fundamentals of Geology by RobinGill.

15. Elementary Thermodynamics by B.J. Wood and D.G. Fraser,1976
16. Equilibrium Thermodynamics by RogerPowell
17. Prinicples of Geochemistry – BrainMason
18. Geochemistry byAnderson
19. Chemical Thermodynamics by Bruce HMahan

COURSE-III: MAJOR PROJECT (DISSERTATION)

An opportunity to work on a 30 days major project or Dissertation report in Earth science underthedirectsupervisionofafacultymemberinUniversity/InstituteorGovernmentOrganisation. 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 thecourse.

Course outcome

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

- Toinculcateacultureofresearchandinnovationatthepostgraduatelevelsothatthes tudents areexposedtothenitty-grittyoftheScientificResearchintheirfields.
- Thebasicaimistoexposethestudentsatanearlystagetofieldandlaboratorytechniq uesand sophisticatedinstrumentation.

COURSE-IV: PRECAMBRIAN CRUSTAL EVOLUTION

Introduceshistoricalgeologywhichdealswithgeologictime,fossils,stratigraphic principles, and the geologic history of the India. Develop broader perspective on relationship between crustal evolution, plate tectonics and metallogenydeposits.

Course outcome

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

- Basisconceptsofmetallogenyepochsandprovincesandtheirlinkageswithcrustal evolution and platetectonics.
- Familiarity about distribution of ore deposits inIndia.

Pedagogy

- Class room teaching supported with presentation for enabling better understanding of the subject.
- Application orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.
- **COURSECONTENT**
- **Unit1:**Geologicaltimespan.Earlyearthfeatures.MountainBuildingactivity.Era-Breaking
- upofPangea-thePrecambrian-Hadean,Archean,Proterozoic,StructureoftheEarth.A
- magmaofOcean-CompositionofearlyCrust-SolidifyingBasalt.Theearthhotspotandfluid
- basalts.LithosphereandMantlereactions.Originofthecrust.Lowercrust-firstcontinents.
- earlycontinentalcrust.growthofcrust-Mechanismofcontinentalgrowthanditsgrowthrate.
- GrowthofContinents.PrimaryAtmosphere.SecondaryAtmosphere. Oxygenin atmospheregeologic
- indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates andDetrital
- uraniniteandPyrites,DecreasingHeatinPrecambrianTime.paleosols– Biological indicators.
- Oceanprevailingtheory,outgassing.LifeinArcheanProterozoicorogeny.Earth-Moon
- system. Plate tectonics in thePrecambrian.
- **Unit2:**PrecambrianmineralDeposits.Proterozoiclife.oldestrocks.Continentalfoun dation.
- DistributionofPrecambrianrocks.Proterozoictectonics.Proterozoicassemblyoflaur estia-
- Proterozoicoxygenrocks.atmosphere-PrecambrianassemblyofRodinia-

grenvilleorogeny

- –Proterozoicrifting.Mid-continentrift-snowballearth.Crustalprovinces-Precambrian
- provincesofNorthAmerica.CratonsofAmeric-hadeanCrust.ArcheanandProterozoic.
- Shieldareas-CanadianShield.Archeanrocks.GreenstonebeltofSouthAfrica.Cratons-
- OriginofCratons,RiftValleys,Mobilebelts,ArcheanmineralResourcesandProterozoic
- Sedimentary Basin inIndia.
- **Reference:**
- 1. Archaean Geology- C.S.Pichamuthu
- 2.EarlyPrecambriansupracrustalofsouthernKarantaka-Memoir112.Geol.Surv.Ind
- 3. Geology of Karantaka- B.PRadhakrishna

- 4.GeologyofIndia(Volume1and2)-R.VaidyanathanandM.Ramakrishnan
- 5. Geology of India and Burma- M.SKrishnan
- 6. Geology of India- M.Wadia
- 7.CrustalEvolutionandMetalogenyinIndia-SanibChandraSarkarandAnupenduGupta

Crystal Growth & Materials Science

Thecoursecoverstheunderstandingoftheoriesinvolvesincrystalgrowthnucleatio nprocess 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 andcharacterization.

Course outcome

Students will learn about the fundamentals of

- Important crystal growth techniques like (Bridgman, Czochralski (Pulling method), solution growth,fluxandhydrothermalmethods,PhysicalVapourandChemicalVapourTr ansport.
- Understandingofvariouscharacterizationtechniquesofa)PowderandSinglecrystalX RD
  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 orientedassignments.
- Class room lectures will be supplemented with field relatedexamples.
-

COURSE CONTENT

UNIT1:CRYSTALGROWTH:Introductiontocrystalgrowthandgrowthpheno mena. CrystalGrowthmethods-Melt(Bridgeman,Crystalpulling,Czochralskitechnique,zone melting) Verneuil process from solution, flux growth. CVT/CVD technique, Sol gel technique,Hydrothermalgrowth(lowtemperature,lowpressure,Hightemperature ,high pressure). Sinteringtechnique.

UNIT2:MATERIALSSCIENCE:NatureandPropertiesofMaterials.Structure ofSolids. Bonding and structure in Materials, Imperfection in Materials, Linear defects, deformation, Planar defects, Volume defects, Diffusion, Mechanical, Thermal, Magnetic, Electrical & Opticalpropertiesofmaterials,MaterialsSelection,MaterialProcessing,Synthesis &Design,
Characteristicsandusesofmetals,Polymers,Glass,Ceramics,Composites,semico nductive and biologicalmaterials.