GEOLOGY

PG - Syllabus

Code	Papers	Credit	Marks
Semester - I			
GEO-PG-C101	MineralogyandIgneousPetrology	4	100
GEO-PG-C102	SedimentaryGeology&BasinAnalysis	4	100
GEO-PG-C103	Hydrology	4	100
GEO-PG-C104	Geochemistry	4	100
Total		**16**	
Semester- II			
GEO-PG-C201	StructuralGeology	4	100
GEO-PG-C202	MetamorphicGeology	4	100
GEO-PG-C203	StratigraphyofIndia and Palaeontology	4	100
GEO-PG-O204	GeospatialAnalysisand applications	4	100
Total		**16**	
Semester - III			
GEO-PG-C301	OreGeologyand MineralEconomics	4	100
GEO-PG-C302	Geologyof FossilFuels	4	100
GEO-PG-O303	EnvironmentalGeologyand Geo-statistics	4	100
GEO-PG-E304	MineralExploration,Miningand SurveyingTechniques	4	100
GEO-PG-E305	AppliedRiverScience	4	100
GEO-PG-E306	IsotopeGeology	4	100
Total		**16**	
Semester -IV			
GEO-PG-C401	Geomechanics	4	100
GEO-PG-E402	Geodynamicsand TectonicGeomorphology	4	100
GEO-PG-E403	Geophysics	4	100
GEO-PG-E404	CryosphericScience	4	100
GEO-PG-E405	Micropaleontology	4	100
GEO-PG-E406	Oceanography	4	100
GEO-PG-C407	Dissertation	4	100
Total		**16**	

SemesterI

GEOL-PG-C101:Mineralogyand Igneous Petrology

UnitI:Mineralogy

Types ofbondingin minerals
Chemicalcompositionand unitcellcontent.
Isomorphism.Solidsolution and
differenttypesofpolymorphictransformations.Silicatestructure.
2componentdiagrams.SolidSolution.
Development ofintergrowths,zoningand twinning.
Structure,P-
Tstabilities,paragenesisandmodeofoccurrenceofsilicates,oxides,carbonates,phosphates,sulphidesandh
alides.

MineralOptics:Behavioroflight in isotropic,uniaxialand biaxialcrystals.Interferencefigures.Universalstage. Introductiontospectroscopicstudyofminerals.ApplicationofX-rayDiffraction,EPMAandSEM-EDX.Calculation ofmineralformulafromchemicalanalysis.

UnitII:Igneous Processes

Crystallizationofmagmaandtheirrepresentationsinphasediagrams(binarysystemandternarydiagrams)

Partial melting, fractional crystallization, contamination and assimilation fractionalcrystallization.

Geochemicalcharacteristics ofigneous rocksasPetrogeneticindicators. Geologicalcontrols andapplication ofmajor,traceand Rareearthelements inpetrogenesis.Quantitativeapproachtopartialmeltingandfractionalcrystallizationusingdifferenttypesoftraceelements.

Concept ofmantlemetasomatism androle offluids in magmageneration. MagmatisminGlobalTectonicScenario.Magmatismini. ConstructivePlateMargins,ii.DestructivePlateMargins, iii. WithinPlateMagmatism. Archaean&ProterozoicCrustalEvolution.TTG Suites.

UnitIII:IgneousRockClassification

Granites and theiroriginI-,S-,A-typegranites. Pegmatites,theirnature,occurrence and petrogenesis.Alkalinerocks andtheirorigin. Anorthositesand theirpetrogenesis.Lamprophyres and their petrographyand origin.Ultramaficandlayeredrocks,natureandorigin.Carbonatites,petrographyand theirpetrogenesis.Kimberlites andtheirorigin. Lunarrocks.

Unit IV: Practical

Field based practicalforsample/Datacollectionandin-situ study.Studyofigneousrocksand textures usingpolarizingmicroscope,Calculation ofmineralformulas.

Exercises relatedto partialmeltingand fractionalcrystallization

Estimation ofε values,modelages and plottingofisochronsofthe various datasuites.Plottingand interpretationoftraceelement andREEcharacteristics ofigneous rocks.

PowderXRDanalysisofmineralsanddeterminationofunitcellparameters,identificationofunknownminerals bysearch-matchmethods.

Suggested Readings:

MarjorieWilson, 1989. Igneous petrogenesis

Cox,KG,Bell,JDandPankhurst,RJ,1993.TheInterpretationofIgneousRocks.Chapman&Hall,London

Philpotts,ARand Ague, JJ.2009. Principles ofIgneous and MetamorphicPetrology.2ndEditionWinter, JD, 2001. Anintroduction to Igneous and Metamorphicpetrology,PrenticeHallRollinson,HR2007.Usinggeochemicaldata-evaluation,presentationandinterpretation.2ndedition.LongmanScientific&Technical

Putnis,Andrew 1992. Introduction to MineralSciences,CambridgeUniv.Press.

Deer,W.A.,Howie,R.A.&Zussman,J.2002.Rockformingminerals.Vol.1to5.Longmans,London.

GEOL-PG-C102:SedimentaryGeology&BasinAnalysis

UnitI:SedimentaryRocks:StructureandClassification

Natureand origin ofsedimentaryrocks composition and classificationEarth surfaceprocesses.

Texture&Classificationofsediments.Sedimenttransportin differentsystems.

Sedimentarystructuresand theirgeneticsignificance andimportancein rock record.

Biogenicstructures.Diagenesis.

Palaeocurrentanalysis:Vectorpropertiesandpalaeocurrent,scalarpropertiesandpalaeocurrent,presentation andinterpretation ofpalaeocurrent data.

UnitII:SedimentaryEnvironment Concepts ofsedimentaryenvironmentEnvironmentalparameters and controls.

Classification ofenvironments:ClasticandChemical.Facies model andenvironmentalreconstruction.

GlacialEnvironment.

Alluvialenvironment(Braided,Meandering).Marginalmarine and Neriticenvironment.

Deltaicmodels(Fluvial,wave),coastal(interdeltaic)model– barrierislandsandlagoons,tidalchannels,tidaldeltas andEstuaries.

Deepmarinesedimentation:Slopeand Basin-floor fans (PointandLinesource).

Carbonatesedimentationmodel.Geometryofcarbonateplatforms;Ramp,Rimmedshelves,Isolatedplatform, Reefs.

Cyclicsediments:Allokinetic and Autokineticcontrols.Roleofenvironmentalanalysis in petroleumexploration.

UnitIII:Basin Analysis

Definitionand scope ofbasinanalysisIntroductionto SequenceStratigraphy.

Basinmappingmethods:structureandisopachcontouring,lithofacies maps.Geohistoryanalysis.Thermalhistory, PorosityandBurialdepth.

Regionalandglobalstratigraphiccycles.

Tectonicclassificationandevolution ofsedimentarybasins.

SubsidenceandThermalhistoryofdivergentmarginbasins,convergentmarginbasins,transformandtranscurrentfaultbasins,basinsdevelopedduringcontinentalcollisionandsuturingandcratonicbasins.

Review ofIndianSedimentarybasins.

Unit IV: Practical

Fieldbasedpracticalforsample/datacollection andin-situ study.

Identification and studyofsedimentaryand Digenetic rocksinhand specimenand thinsections.Analysis of Sedimentarystructures and determination ofpaleocurrentdirections.

Preparation ofFencediagram,Paneldiagram,Interpretation.Preparation ofisopachandpaleocurrentmaps andbasinanalysis.Problems on porosityandburialdepthdetermination.

Suggested Readings:

Principles ofSedimentologyand Stratigraphy, 2006. SamBoggs(Jr.), PrenticeHall

SedimentaryEnvironments:Processes,FaciesandStratigraphy:(1996)H.G.Reading.BlackwellPublishers

CarbonateSedimentology:M.E.Tuckerand V.P.Wright (1990), Blackwell.SedimentaryBasins:GeraldEinsele(2000), Springer

Facies Models revisited:H.W.Posamentier and R.G.walker(2006),SEPMPrinciples ofsedimentarybasinanalysis:A.D.Miall (1999), SpringerSedimentologyand Stratigraphy:

GaryNichols (2009),Wiley-Blackwell

GEOL-PG-C103:Hydrology

UnitI:Fundamentals ofHydrology
Origin of Water&Hydrologiccycle and
itscomponentsSurfacewater and groundwaterinteraction.
Classification ofaquifers.
Hydrologicalpropertiesof rocks -
specificyield,specificretention,porosity,hydraulicconductivity,transmissivity,storagecoefficient.
Unconfined,confined,steady, unsteadyand radialflow conditions.Pumpingtests.Flow
nets.Watertablefluctuations- causativefactors,conceptof barometricand tidalefficiencies.Evaluation
ofaquiferparameters usingThiem,Theis,JacobandWaltonmethods.
Theory ofgroundwaterflow,Bernoulli'sequationand its
applications.Hydraulichead.Potentiometricsurfaceandpotentialsurface.Darcy's law.

UnitII:Ground waterexploration
Geological,Meterologicaland Geophysicalmethods.
Application ofRemotesensingin ground water exploration.HydrogeomorphicmappingTypes
ofwells.Welldevelopmentand design.
Groundwaterquality-physicalandchemicalpropertiesofwater,HillandPiperandDurovdiagrams and
Chebotarebsequence.

UnitIII:Application ofHydrology
Rain waterharvestingandArtificialrechargemethods
Groundwatercontaminationandsalinewaterintrusionincoastalandotheraquifersanditsprevention.
Groundwaterproblemsandmanagementrelatedtomining,foundationworkofcanals,tunnels.Problems
ofoverexploitation
Conjunctiveuse ofground waterand
surfacewaterHydrogeologyofaridZones of India
Ground waterprovinces of India- theiraquifercharacteristics.

Unit IV: Practical
Fieldbasedpracticalforsample/datacollection andin-situ
study.Decipheringofhydro-geologicalboundaries on
watertablecontourmapsAnalysis ofHydrographs
Determinationofpermeability.
GroundwaterqualitystudyusingTrilinear(Hill-Piper), C-S diagrams
etc.Problems on radialflow toa well inconfined
andunconfinedaquifersExercises on stepdrawdowntest
Determinationofaquifer parameters usingTheisandJacob's
methodsCalculation ofsaltwaterencroachmentincoastalaquifers
ElectricalresistivitysurveysforaquiferdelineationAppli
cation ofAquachem,Modflow,etc

Suggested Readings:
Fetter,C.W., 2001, AppliedHydrogeology,PrenticeHallInc., N.J.Fitts,
C.R., 2006. GroundwaterScience,Academic Press.
Freeze,R.A. and Cherry, J.A., 1979. Groundwater,EnglewoodCliffs,New Jersey: Prentice-Hall.Raghunath,H.M.,2007,ThirdEdition,GroundWater,NewAgeInternationalPublishers,NewDelhi.
Mansell,M.G., 2003.Rural andUrbanHydrogeology, ThomasandTelford

Bryirely,GandFryirs,K.2005.Geomorphologyandrivermanagement.BlackwellPub.Vanoni,V.A., 2006. SedimentationEngineering,ASCE,Manual.
Davie, T., 2008. Fundamentals ofhydrology.RoutledgePublications.
Knighton,D., 1998. Fluvialforms and processes: Anew perspective.ArnoldPubs.Richards.K., 2004. Rivers:Forms and processes inalluvialchannels.BlackburnPress.Julien,P.Y., 2002. RiverMechanics.CambridgeUniversityPress.

GEOL-PG-C104:Geochemistry

UnitI:Fundamentals ofGeochemistry
Origin and abundance ofelements inthe solarsystem andin theEarthGeochemistryofatmosphere,hydrosphere and lithosphere.
Geochemicalclassification ofelements.
Properties ofLILE,HFSE and RareEarthElements.
Conceptof freeenergy,activity,activitycoefficient,fugacityand equilibriumconstant,thermodynamics ofideal,non-idealand dilutesolutions.
Principles ofionic substitution inminerals.GeochemicalCycle.Cycles ofC-H-O-Nand Sulfur.

UnitII:GeochemicalReactions
Concept ofsimpledistributioncoefficients andexchangereactiondistributioncoefficientsElementpartitioningin mineralassemblages anditsuse in thepressure-temperatureestimation.Chemistryofnaturalwaters.MineralstabilityinEh-pHdiagram.Elementalmobilityinsurfaceenvironment.
Oceansandatmosphere:theircompositions,evolution,steadystate,andglobalmassbalance.Rockwaterinteraction:congruentandincongruentdissolution,redoxreactions,ionicstrengthofelectrolytesolutions.Debye-Huckeltheory.

UnitIII:IsotopeGeochemistry
Theoryand mechanismofdecay
Abundances ofunstablenuclides inearth,core,mantle,crust,oceans and different rocktypes;Mass spectrometer:Instrumentation,chemicalseparation,isotopedilutionandratioanalysis.Methodsofdating:Isochronmethod,model/mineralages,Fissiontrack,40Ar-39Ar,UandThdisequilibrium,choncordiamethod, 14C, BeandAl.
Interpretationand geologicalsignificance ofages.
IsotopesystematicofK-Ar,Rb-Sr,Sm-Nd,U-Th-Pbinigneous,metamorphicandsedimentaryrocks.
Stableisotopes ofoxygenand hydrogen, carbon, nitrogen and sulphur.Fractionation ofstableisotopesinlithosphere,hydrosphereandatmosphere.Stableisotopegeothermometryand geobarometry.
ApplicationofIsotopesinmineralexploration,petroleumexploration,paleo-climateevaluation,health andenvironmentalaspects.

Unit IV: Practical
Introductionto geochemicalanalyticalmethods.Flamephotometer,XPS,XRF,AAS,ICP-MS,XRD.Preparation ofSolution A&Solution B.
Plottingand interpretationofGeochemicalData ofvarious rocks suites.Calculations ofModelages,ε values, and isochronforradioactiveisotopepairs.Determinationoffractionationusingstableisotoperatios.

Suggested Readings:

Faure,G. (1986). Principles of IsotopeGeology. John Wiley
Dickin,A.P. (2005). RadiogenicIsotopeGeology,CambridgeUniversityPressDoe,
B.R. (1970) Leadisotopes.SpringerVerlag
Faure,G. and Powell,J.L.(1972) StrontiumIsotopeGeology.SpringerVerlag

SemesterII

GEOL-PG-C201:StructuralGeology

UnitI:Introduction to RockMechanics

Stressatapointinasolidbody:3-DStressTensor;Homogeneousandheterogeneousstress:stress functions.Conceptofdeformation:distortion,rotation,dilatationetc.
Analysisofhomogeneousdeformation:strainellipsesofdifferenttypesandtheirgeologicalsignificance.Conc ept ofstress-straincompatibility.
Mohrdiagrams forstress and strain andtheiruse.
Behaviourofrocksunderstress:elastic,plastic,viscousandvisco-elasticresponsesandtheirgeologicalsignificance.Concept ofcontinuousanddiscontinuous media.
Mechanicsofrock fracturing:fractureinitiationand propagation.Coulomb'scriterionandGriffith's theory; Crack linkage and theirimportance.
Effect ofstrengthanisotropyonfracturing;Role offluid inrock fracturing.

UnitII:DeformationalStructures

Folds ,Foldinterferenceandsuperposedfolds.
Straindistributionin a foldedlayer and its significance.
Evolution ofaxialplanarandtransectedcleavageswith folds;fold-relatedlineations.Balancedcross sections andconstructions offolds.
Faults and Joints:Mechanics offaulting:Anderson's theoryand its limitations.Complexgeometryofnormal, strikeslipand thrustfaults withnaturalexamples.Palaeostressanalysisusingfault-slip data.
Geometricanalysesofjoints– mesofractureanalyses.

UnitIII:StructuralAnalysis

DuctileShearZones &their significancein continentalcrustalevolution andmetallogenyShear/faultzonerocks:mylonite,cataclasiteandpseudotachylyte;
Kinematics offlow in a shearzone.Microstructures associatedwith Shear zones.
Dislocationanddiffusioncreep,strainhardeningandsofteningmechanisms,latticepreferredorientation andsuperplasticity.
Crustaldeformation:Deformationbehaviorofquartzo-feldspathicrocks.Brittle-plastictransitionand seismicbehavior ofthe uppercrust.
Plateconvergenceand continentaldeformation.
Transpressionaland Transtensionaltectonics:Indianand overseas examples.StructuralAnalysis.
Introductionto ExperimentalStructuralGeology:
HighP-Texperiments with rock samples:basicconceptsand importantexamples.
Analogmodeling of deformationalstructuresandits geologicalimportance:conceptofexperimentalscaling.

Unit IV: Practical

Fieldbasedpracticalforsample/datacollection andin-situ study.
Problems relatedto practicalstrainmeasurement(Rf-φ method, Frymethod etc.)Construction ofbalancedcross-sections.

Analysis and interpretation of geologicalmapsofvarious complexities.
Stereographictechniques:contourdiagramsandorientationanalysesoffoliationandlineationdata forregionalstructuralgeometry.
Laboratorydemonstrations ofanalogmodelingexperiments.

Suggested Readings:

Bayly, B., 1992. Mechanics in StructuralGeology,Springer.
Davis,G.H.andReynolds,S.J.,1996.StructuralGeologyofrocksandregions,JohnWiley.andSons.
Ghosh,S.K.,1993.StructuralGeology:Fundamentalsandmoderndevelopments,PergamonPress.
Leyson,P.R.andLisle,R.J.,1996.StereographicprojectiontechniquesinstructuralGeology,CambridgeUniversityPress.
Passhier, C. andTrouw, RAJ, 2005. Microtectonics.Springer,Berlin.
Pollard,D.D.and Fletcher,R.C., 2005. Fundamentalsofstructuralgeology,CambridgeUniversityPress.
Ramsay,J.G.andHuber,M.I.,1983.TechniquesofModernStructuralGeology:Vol.I&II.AcademicPress
Ramsay, J. G., 1967. Foldingand FracturingofRocks, McGraw-Hill BookCompany,New York.Rowland,S.M.,Duebendorier,E.andSchiefelbein,I.M.,2007.Structuralanalysisandsynthesis:a laboratorycourse in structural geology,BlackwellPub.
Suppe, J.,ThePrinciplesofStructuralGeology, Prentice-Hall, Inc.,New Jersey, 1985.Twiss, R.J. andMoores,E.M., 2007. StructuralGeology.Freeman.
VanderPluijm,B.A.andMarshak,S.,2004. Earth structure:an introduction to structuralgeologyand tectonics,W.W.Norton&CompanyLtd.

GEOL-PG-C202:MetamorphicGeology

UnitI:Fundamentals ofMetamorphicProcesses

Natureand scope ofmetamorphism
Types ofmetamorphism.Metamorphictextures.
Fundamentals ofthermodynamics ofhomogeneousand hetrogeneous systems.Nucleation andcrystalgrowth in metamorphism.
Metamorphicparagenesis.
Advantages and limitations ofMetamorphicfacies classification.
Mineralogicalchangesduringprogressivemetamorphismofpelitic,calcareousandmaficrocksand control ofbulkcomposition onmetamorphicassemblages.

UnitII:CompositionalPlotsand Projectiveanalysis Construction andinterpretation ofACF, AKFand AFM diagrams.Schrienmaker'srule andconstruction ofpetrogeneticgrid.
P-Tdiagrams,Psuedo-sections.Orogenicprocessesandmetamorphism.Relationshipbetweendeformation andmetamorphism.
Metamorphicdifferentiation,geothermobarometery,compositionalzoningandP-T-tpaths,andtheirtectonicsignificance.

UnitIII: Tectonics and Metamorphism GlobalTectonicContext of MetamorphismRoleoffluids in metamorphism.

Metasomatism,Granitization,Migmatities,PairedMetamorphiczones,Ultra-hightemperatureand Ultra-highpressuremetamorphism.InvertedMetamorphicsequences.
Time-scales ofmetamorphism andimplications on thermalhistoryofthe crust.

Unit IV: Practical
Fieldbasedpracticalforsample/datacollection andin-situ study.
Introductiontointerpretationofmetamorphicassemblagestexturesinrelationtofabricelements.Introductiont o relevantsoftwares.
Cationcalculationusingexcelspreadsheet,
Use ofpetrogeneticgridandcompositionalplots,
Constructionofschreinemakersbundlesinnon-degenerateanddegenerate3-componentsystems.Geothermobarometriccalculations.

Suggested Readings:
Philpotts,A.R.&Ague,J.J.2009.Principlesofigneousandmetamorphicpetrology.CambridgeUniversityPres s.
Bucher K.and MartinF. 2002. PetrogenesisofMetamorphicrocks.Springer-VerlagPublication.VernonR. H.andClarkeG.L.2008. PrinciplesofmetamorphicPetrology.CambridgePublication.
SpearsF.1993.MetamorphicPhaseEquilibriaandPressure-Temperature-TimePaths.AGUPublication
John D.Winter 2001. AnIntroductionto Igneous and MetamorphicPetrology.PrenticeHallInc

GEOL-PG-C203:Stratigraphy ofIndiaand Palaeontology

UnitI:StratigraphicCodes and ofIndian Straigraphy
Code ofstratigraphicnomenclature
Conceptofstratotype,typesofstratotype.Globalstratotypesectionandpoint(GSSP).GeomagneticPolarityTi me Scale(GPTS).
1.StratigraphyofGondwanasedimentaryunits.2.Traps:Deccan,Rajmahal,SylhetandRajahmundryTrapsan dtheircorrelations.3.MarineMesozoicsofcoastalIndiavizCretaceousofTrichinapalliandJurassicofKutch.4. StratigraphicBoundaryStatus:Precambrian-Cambrian,Permo-Triassic,Cretaceous-Tertiary,Neogene-Quaternary.5.PhanerozoicsofExtraPeninsula**:**Spiti,KashmirandSaltRange.6.Lithostratigraphyofdifferen tsedimentarycyclesvis-à-vismajorgeologicandtectoniceventsoftheHimalayas.7.LithostratigraphyofSiwalikSediments.
8.TertiaryformationsofKutchandAssam-Arakan geologicalprovinces.9.PrecambrianbeltsofIndia(SouthIndia,CentralIndia,Rajasthan,EasternGhat,Singhb hum-Orissa):Agecorrelations,metamorphism,tectonicsandevolution.10.Archean-ProterozoicboundaryprobleminIndia.11.ConceptofPrecambriansupercontinents12.ImportantProterozoic basinsofPeninsularIndia:Sedimentation,correlation and evolution.

UnitII:Introduction to Micro-Palaeontology
Introductionto various groups ofmicrofossils
Techniquesofseparationofmicrofossilsfromdifferenttypesofsedimentaryrocks.ForaminiferaandOstracod a-theirmorphology,orientations,growth,reproduction,ecologyandpalaeoecology,classification,evolutionar ytrendsandstratigraphicdistribution.Conodonts-Morphology,classification,biologicalaffinityandstratigraphicdistribution.Applicationofmicropaleontolo gyin fossilfuelexploration,and paleoclimate.
Introductionto palynologyand Palaeobotany.

UnitIII:VertebrateandInvertebratePalaeontology

SignificanceanddistributionofMollusca,trilobites,brachiopodsgraptolites,foraminiferaandammonoids.
VertebratePalaeontology:Characteristicfeaturesofvertebrates-
Skeletalelementsoftheirfossilremarks.Originofvertebratesandtheirgeneralevolutionarypatterns;outlinecl assificationofvertebrates.Classificatorycharactersanddivisionsofthevertebrate;Agnathans,Fishes,Amphi bia,Reptilia,Aves and Mammalia.
EvolutionofmammaliandentitionPhyllogenyofEquids,ProboscidsandHominids.Origin,evolutionandexti nctionoflife.
Dinosaurs and theirextinction.

Unit IV: Practical

Fieldbasedpracticalforsample/datacollection andin-situ
study.Techniques ofseparationofmicrofossils frommatrix.
Studyof Morphologyofimportant foraminifera,Ostracoda,Vertebrate and Invertebratefossils.

Suggested Readings:

Bignot,G.,1985. Elementsof micropalaeontology;Microfossils,their
geologicalandpalaeobiologicalapplications,Graham&Trotman,London,UnitedKingdom.
Braiser,M.D., 1980. Microfossils,GeogrgeAllenandUnwinPublisher.
Hasllett,S.K.,2002.QuaternaryEnvironmentalMicropalaeontology,OxfordUniversityPress,New York.
Jones, R.W., 1996. Micropaleontologyin Petroleumexploration,ClarendonPress
Oxford.KennettandSrinivasan,1983. NeogenePlanktonicForaminifera:A
phylogeneticAtlas,HutchinsonRoss,USA.
Sinha,D.K.,2007.Micropaleontology:ApplicationinStratigraphy
andPaleoceanography,AlphaScienceInternational,Oxford&NarosaPublishingHousePvt.Ltd.Delhi.
Naqvi,S.M Geologyand Evolution
ofIndianPlateGeologyof India.GeolSoc ofIndia
KrishnanaM.S.Geologyof India and Burma

GEOL-PG-O204:GeospatialAnalysis and applications

UnitI:Concept of Geospatialanalysis

Principles ofremotesensing.
The nature and generation of electromagneticradiation.Spectralbands,resolutionandreflectancecurves,interactionofEMRwithatmosph ere,rocks,mineralsandsoil,vegetationandwater.Sensorsystems andplatforms.
Aerialremotesensing,aerialphotography,propertiesofaerialphotographs,elementsofphotointerpretation.
Interpretationofgeographical,geomorphological,structuralandlithologicalfeaturesfromaerialphotographs .
Radar remotesensing.Satelliteremotesensing:LANDSAT,SPOT andIRS systems.Introductionto digitalimageprocessing.
Applications:RemotesensinginGeologicalmapping,MineralExploration,GroundwaterExploration,Petrol eumExploration,EngineeringGeologyand Environmentalstudies.

UnitII: 3D Analysis

Displaying&Exploringthedata,convertingthedata,usingananalysismask,coordinatesystemandcreating3D model,surfaceanalysis-creatingcontours,slopedatesets,aspectdatasets,

hillshadedatasets&viewdatasets,calculationofstraightlinedistanceandcostweightdistance,performingshortestpathetc.
Introductionto DecisionSupportSystems,Multicriteriaanalysis usingGIS.
ApplicationforEnvironmentalImpactassessment,LandUsePlanningand Hazardmitigation.Quantitativemodels in RemoteSensing
Canopyreflectancemodellingand estimation ofbiophysicalvariables.Soil and Snow reflectancemodelling,TopographiccorrectionmethodsChangedetectionanalysis.

UnitIII:Introduction to GIS
GeographicalInformationSystem:IntroductionandDefinitionsTechnologyand concepts;Components ofGIS;Developments inGIS.GISdata modelling,dataanalysis – Overlay,DEMand DTM.
Topologicalmodelling;Spatialoperations,Mapintegration,Multi-criteriaevaluation.
StepsinaGISproject:Identificationofprojectobjectives,Creationofprojectdatabase,Analysisofdata, and Dataintegration, andPresentation ofmapoutput.
Overview ofGIS softwares,viz.ArcGIS,ILWIS, ENVIS, Geomaticaand MapINFO.

Unit IV: Practical
TestingofStereovisionandexaminationofstereoaerialphotographundermirrorstereoscope.Spectralsignatureandanalysesthegivensetof SpectralreflectancecurvesforWater,SoilandVegetationwithinvisibleand nearinfraredwavelength.
StudyandidentificationofmajorGeomorphologicfeaturesonstereoaerialphotographunderMirrorstereoscope.
Study of givenFalseColor Composite(FCC)and interpretingvariousGeomorphologicterrain/features.
DigitalEnhancement ofImages asaid forgeologicalinterpretation.HandlingofRSand GISsoftwares.

Suggested Reading:
Rajiv Gupta&MukeshKumarRohil, 'ComputingAspects of GeographicalInformationSystems'
ThomasMLillesand,andRralphWKiefer;"RemotesensingandImageInterpretation",JohnWiley&Sons, 1994, 3rded.
MichaelF.Worboys,"GIS: A ComputingPerspective",Taylor&Francis Ltd; 1995, firsted.

SemesterIII

GEOL-PG-C301:OreGeologyand MineralEconomics

UnitI:Fundamentals ofOreGeology
OreMinerals
Oretextureand structure.
Development ofore minerals in openspaceandpolycrystallineaggregates.Endogenous,Exogeonus processes andTransformationProcesses ofOreformation.Crustalevolutionand metallogenesis.
Fluidinclusions andtheirapplications.

UnitII:PetrologicalOreAssociation
Petrologicaloreassociation-considerationwithreferenceto distinct oretypes

Oreassociatedwithultramaficandrelatedmaficplutonicrocks:Sudbury_typeFe-Ni–Cusulphides,apatiterich andTi-V bearingmagmetites.Fe-Ti oxides andanorthosites
Oresassociatedwithfelsicplutonicrock:porphyrydepositofCu,Mo.Greisen&SkarndepositofWand Sn.Various Pegmatoiddeposit.
Oresassociatedwithacid/maficvolcanicrocks,includingthoseingreenstonebelts:Kambaldatype,Kurokotyp e and Cypruss Types ofores.
Strataboundoredepositassociatedwithnonvolcanic,MetaSedimentaryrocks,Kupferschiefer,Rhodesia– Katanga,BrokenHill.
McArthur,Mississippivalleytype,Witwatersrandtype,Bogironmanganeseoresironstone,Bandediron formation.
Manganese ores. Orthoquartzite-clay association, Jaspilite and volcanic association,metamorphosedmanganeseores.ColoradoPlateautype U-V ores,Surficialdeposits.
Lateritoidand Karstdeposit ofFe,Mn,Al, and Ni.
PlacerdepositofGold,Tin,Tungsten,monazite.oxidationandsupergineenrichmentsulphideenrichment.
Oceanfloordeposit ofMn,Ni-Cu-Co.

UnitIII:MineralEconomics
Importance ofMineralsinNationalEconomyCurrent NationalMineralPolicy.
Classificationsofmineralresources–IMM,JORC,SAMERC,ISPandUNFCschemes.Basicpattern ofMineraleconomyand changingmineralrequirements.
Concepts ofstrategicMinerals
Worldresources ofminerals and production ofimportantmineral.
Developing substitutetocoverinternalshortage,productioncost& itsrelationtomineralinshortsupply.
Internalcontrols (monopolies and cartel), traderestriction andproductionincentives.Importance ofsteel&Fuels in ModernEconomy.
Impact ofatomicEnergyoverconventionalfuels.
Conservation ofnon renewable&associatedRenewableresources.

Unit IV: Practical
Fieldbasedpracticalforsample/datacollection andin-situ study.
Introductiontooremicroscopy:Conceptofreflectedlightmicroscopyanddescriptionofopticalproperties ofore minerals.
Oremicroscopicstudyofimportant oxidemineralsandcomplexminerals.Oremicroscopicstudyofimportant sulfideminerals.
Texturalandmicro-structuralfeatures ofore mineralassemblages.DeterminationofParagenetic orderofthe oreminerals.
Characterization ofFluidInclusions.
AppliedOremicroscopy:Particlesize measurement and applicationsin the liberationcharacteristics ofcomplexmineralassemblages formineralbeneficiationandin otherareas.

Suggested Readings:
Barnes,H.L., 1979. GeochemistryofHydrothermalOreDeposits,John Wiley.Evans,A.M., 1993. Ore Geologyand IndustrialMinerals,Blackwell.
Guilbert, J.M.and Park,Jr.C.F., 1986. The GeologyofOreDeposits.Freeman.
Klemm,D.D. and Schneider, H.J., 1977.Timeand Strata Bound OreDeposits.SpringerVerlag.Stanton,R.L., 1972. OrePetrology,McGraw Hill.
Mookherjee,A., 2000. OreGenesis– A HolisticApproach.AlliedPublisher.CraigJ.R. andVaughan,D.J. 1994. OreMicroscopyand OrePetrography

McKinstry,H.E. 1962. MiningGeology(2nd Ed.) Asia PublishingHouse.Clark, G.B.
1967.Elements ofMining. 3rd Ed. JohnWiley&Sons.
Arogyaswami,R.P.N. 1996 Courses in MiningGeology. 4th Ed. Oxford-
IBH.Chatterjee,K.K. 2008 AnIntroductionTo MineralEconomics

GEOL-PG-C302:Geology of FossilFuels

UnitI:CoalGeology

Coal and its properties
Differentvarietiesand ranks ofcoal.Origin
ofcoal.
Typeofdepositionalprocesses.Coalificationprocess and its
causes.Introductionto OrganicPetrologyand OrganicGeochemistry.
Sedimentscloselyassociatedwithcoal(coalballs,tonsteins,seat-earths,under-clays,fire-claysand soils).
CoalPetrography:Lithotypes,microlithotypesandmacerals:theirphysical,chemicalandopticalproperties.A
pplications ofcoal petrography
Maceralanalysis ofcoal: Mineral and organicmatter in
coal.Proximateand ultimateanalyses.
Industrialevaluation ofcoal characteristics withreference
tocoalclassification.Methods ofcoal prospectingand estimation ofcoalreserves
Geologyand coal petrographyofdifferentcoalfieldsof India.
Usesofcoalforvariousindustriese.g.carbonization,liquefaction,powergeneration,gasificationand coal-
bedmethaneproduction.

UnitII:PetroleumGeology

Origin ofpetroleum
Petroleum:its differentstates
ofnaturaloccurrence.Basicconcepts
ofpetroleumgeochemistry.
Maturation ofkerogen;Biogenic andThermaleffect.Distribution
ofPetroleumin space andtime.
Introductiontomigrationofoilandgas:geologicframeworkofmigration;shortandlongdistancemigration,pri
maryandsecondarymigration;geologicfactorscontrollinghydrocarbonmigration;forces
responsibleformigration,migration routes andbarriers.
Oilfieldwater-charactersand classifications.
Reservoirrocks:generalattributes andpetrophysicalproperties.
Classification&Characterization ofreservoirrocks-
ClasticandCarbonatereservoirs.Hydrocarbontraps:definition;classificationofhydrocarbontraps-
structural,stratigraphicandcombination;time oftrapformationand timeofhydrocarbonaccumulation.
Cap rocks- definition andgeneralproperties.
PetroleumGeologyofimportantIndianbasins (offshore and
onshore).Introductionto oil and gasexploration.

UnitIII:Coal Bed Methaneand Gas Hydrates

Coal bedmethane: Coalbedmethanegenerationandaccumulation.
Geologicaland petrographicinfluenceson
coal,Poregeometry,Micropore,Mesoporeandmacropore,cleatsystem.
Sorption – principles,sorptionisotherms– types and interpretation.
CO2,CH4andN2adsorption–
desorption,hysterisis,Langmuirisotherm,Swellingofcoalmatrixisothermconstruction.
CH4contentdetermination in coalseams.

Potentialcoal bed basins andproduction,hydraulicfracturingofcoal seams,CBM exploration.In-situgasification.Introductionto shalegas.Carbondioxide sequestration.
Gas Hydrate:Gas hydrate,occurrence andorigin;structure ofgas hydrate.Types of gas hydrate.GeologicalsettingofHydrate.Stabilityofgas hydrates.Gas hydratereservoir.Volume ofgas in hydrate.Inhibitors.
Geologicalexploration ofgas hydrate.Prospectandpotentialities ofgas hydrate in India.

Unit IV: Practical
Fieldbasedpracticalforsample/datacollection andin-situ study.Megascopicidentificationofdifferentvarieties ofcoal.
Identification ofmacerals and minerals undertransmittedlightandreflectedlight.Reflectancemeasurements and rank determinationofcoal.
Locationof coalfieldsongeographicalmaps withcommentsaboutqualityofcoal, seamformationcurve.
Estimation ofcoal reserve.
Interpretationofgeologicstructures fromsurfacegeologicalmapsand boreholedata;
Preparationofstructurecontourandisopachmapsofreservoirfaciesanddrawingoil/watercontactfromboreholedata.
Calculation ofoil reserves in definedstructure.

Suggested Readings:
CoalGeology:LarryThomas, 2002, Wileyand Sons.
Coal:it'scomposition,analysis,utilisationand valuation: E.E.Somermier2008,
McGrawHillPetroleumGeology:F.K.North, 1986, AllenandUnwin
PetroleumFormationandOccurrence:B.P.TissotandD.H.Welte1978,Publisher:Springer-Verlag
Elements of petroleumGeology: R.C. Shelley1998, Academic press
PetroleumDevelopmentGeology:P.A.Dickie,1986,Publisher:PennwellPublishing,Tulsa,Oklahoma
Petroliferousbasins ofIndia:Publisher:KDMIPE,ONGC, 1986

GEOL-PG-O303:Environmental Geology and Geo-statistics

UnitI:Introduction to EnvironmentalGeology
Changes in theenvironmentcaused bygeologicalactivities ofmanInorganic andorganiccontaminants.Drinkingwaterstandards.
Surface and groundwaterpollution.Geochemistryoftoxic elements innaturalwaters.
Environmentalproblems connectedwithexploitationofminerals and energyresources.Acidminedrainage.
Landuse and land degradationduetomining.
Studyofsurfacegeologicalprocesses,earthquakesandvolcanismwithreferencetotheirimpacton environment.
Soils,erosionand conservation.Introductionto MedicalGeology.
Geologicalsolutions to environmentalproblems.
Roleofgeologyin nuclearwastedisposal, Global warming,ClimatechangeandMitigation.Environmentalplanning,managementandeconomics (EMP and EIA).

UnitII:Introduction to Geostatistics

ClassicalStatistics:Universe,PopulationandSample;ConceptofRandomvariable;Probabilitydistributions, viz.Normal(Gaussian) andLognormaldistribution.

Concepts ofGeostatistics:Support,Autocorrelation,Random Function,Regionalizedvariable.ExploratoryDataAnalysis.

Semi-variogram**:**definition,properties,calculationofexperimentalsemi-variogramsin1-,2-,and 3-dimensions.

Mathematicalmodelsof semi-variogram;Techniquesof modelfitting,Practicaldifficultiesassociatedwithsemi-variography.

ExtensionandEstimationVariance:definition,formulation,andmethodsofcalculation,viz.method ofdiscretizationanduse ofauxiliaryfunctions.

Dispersionvariance– definition,formulationand itscalculation.

UnitIII:GeostatisticalAnalysis

Kriging:Introductionanddefinition;Linearkriging– OrdinarykrigingandSimplekriging;SolvingkrigingsystemofequationsforPointandBlockKrigedEstimatea ndKrigingVariance–casewithtwosamples,generalcasewithmanysamples.

Nuggeteffect.InfluenceofNuggeteffectonkrigingweights;Propertiesofkriging,viz.Screeneffect andShadow effect.

PracticeofKriging:Geostatisticalevaluationofmineraldeposit,extentofpollution,orebodymodelling,calcul ation ofmineralinventory,establishmentofgrade-tonnage relationships.

Roleofkriging varianceinoptimization ofexplorationdrillingandmisclassifiedtonnages.Abriefintroductionto GeostatisticalConditionalSimulation.

Unit IV: Practical

Fieldbasedpracticalforsample/datacollection andin-situ study.

Histogramplottingand estimation ofmean,median,mode, skewnessand kurtoisis;

FittingofProbabilitydistributionstosampledistribution,viz.NormalandLognormal;Chi-squaredgoodness offit;

Computation ofSemi-variogramsin 1-, and 2-dimensions;Semi-variogrammodeling;Computation ofestimationvariance;Exercises on kriging.

Use ofStatisticalSoftwares.

Suggested Readings:

WebsterRichard&Oliver MargaretA.GeostatisticsforEnvironmentalScientistsSecondEdition2007, John Wiley&SonsPP333.

Trosset,MichaelW.AnIntroductionto StatisticalInferenceand DataAnalysis

EssentialsofMedicalGeologyImpactsoftheNaturalEnvironmentonPublicHealth:EditorOlleSelinus, 2005,ElsevierAcademicPress.PP: 826

Clark, Isobel.,PracticalGeostatistics1979

ElsevierAppliedScienceSahu,B.K.SatisticalModels inEarthSciences, BS Publications

Sharma,D.D..Geostatistics withApplications inEarthSciences.Springer,2005

Clark, IsobelandHarper,Bill. PracticalGeostatistics2000/2010. Geostokos (Ecosse)Limited

GEOL-PG-S304:MineralExploration,Miningand Surveying Tech

UnitI:GeologicalProspectingand Exploration

Definitions and Principles.

Methods ofProspecting.Methods ofExploration.Radiometricsurvey.

Sampling:theory and methods;Geologicalplansand sectionsfororebody evaluation;Explorationdrilling,drillcore loggingand sampling.
Cut-off gradeconcepts andapplications;Resourcesand Reserves.Estimation ofreserves– methods and practice.

UnitII:GeochemicalExploration

Introduction,Geochemicalcycle,geochemicalmobilityandassociationofelements.Pathfinderandtargetelementsforgeochemicalexploration.Primaryandsecondarydispersionsofelements.Determinationofbackground,andgeochemicalanomalies.Geochemicalmethodsofmineralexploration:Proceduresforgeochemicalsampling;Interpretationofgeochemicalsurveys.Indiancasestudies.
CollectionofdataalongGeological(G),Feasibility(F)andEconomic(E)axesduringvariousstages ofexploration.

UnitIII:Introduction to mining

Elements ofmining,definitions andexplanation ofdifferent miningterms.Introductionto surfacemining.Deposits amenabletosurfacemining.
Classification ofsurfaceminingsystems.Rippling,drillingand blasting.Introductionto undergroundcoalmining.
Underground coalminingtermsand theirexplanations.
Classificationofundergroundcoalminingmethods.BordandPillarmethod– generaldescription.Panelsystemofminingandits advantagesanddisadvantages,Longwallmethod.Introduction to PSLWtechnologywithshearer.
Introductiontoundergroundmetalmining;Depositsamenabletoundergroundmetalmining;,modesofentryto undergroundmineraldeposits;Minedevelopment:drifting,raisingandwinzing;Classificationofundergroundmetalminingmethods:generaldescription,applicabilityand operations involved.
Introductionto MineralBeneficiation.

Unit IV: Practical

Introductionto Surveying principlesand methods
PreparationofbasemapsusingPrismaticCompass&Tape,Chain,PlainTable,TheodoliteandTotalStation.
Measurementofslopeheights,aspects and gradients.Use ofabneylevel
FieldSurveybyusing: CompassandTapeSurvey,PlainTableSurvey, and TotalStation

Suggested Readings:

Evans,A.M.1993.OreGeologyandIndustrialMinerals.BlackwellScLPubl.Guilbert,J.M.andParkJr.,C.F.1986.TheGeologyofOredeposits.Freeman&Co.Bateman,A.M.andJensen,
M.L. 1990. EconomicMineralDeposits.John Wiley
Gokhale,K.V.G.K.andRao,T.C.1978.OredepositsofIndiatheirdistributionandprocessing,Tata-McGraw Hill,NewDelhi.
Deb,S. 1980. Industrialminerals and rocks ofIndia.AlliedPublishers
Singh,R.D.PrinciplesandPractices ofModernCoalMining. 1997 New AgeInternationalHartmannH.L.,IntroductoryMiningEngineering,2Nd Ed Wiley
Punmia, B,Jain,A.K.&Jain,A.K.,Surveying(Volume- 1), 2005,LaxmiPublicationLtd.
BasakNN.,SurveyingandLevelling,2001(1stEdition)TataMcgrawHillEducationPrivateLimited
Bannister,A.,Raymond,S.&Baker, R. Surveying7thEdition, 2006, PearsonEducationSingaporePteLtd.

GEOL-PG-S305:Applied RiverScience

UnitI:Basicstreamhydrology

Physicalpropertiesofwater,sedimentandchannelflow,Riverdischarge,Riverhydrographs(UH,IUH,SUH, GIUH) and its application in hydrologicalanalysis,Floodfrequencyanalysis;

UnitII:RiverBasin Analysis

Riverbasin
Sedimentsourceandcatchmenterosionprocesses,Sedimentloadandsedimentyield,Sedimenttransportproces ssinrivers,Erosionandsedimentationprocessesinchannel.Drainagenetwork,Quantitativeanalysisofnetwor korganization–
Slopeanalysis,morphometry,RandomTopology(RT)modelandfractalanalysis,Roleofdrainagenetworkinf luxtransfer,Evolutionofdrainagenetwork in geologicaltimescale.

UnitIII:RiverDiversity

Riverdiversityin space
Patternsofalluvialrivers-
braided,meanderingandbranchingchannels,Dynamicsofalluvialrivers,Channelpatternsinstratigraphicseq uences,Differentclassificationapproachesinfluvialgeomorphologyand its applications.

Unit IV: Neotectonics andStreamFlow

Bedrockchannels,Bedrockincisionprocess,Riverresponsetoclimate,tectonicsandhumandisturbance,Bedr ockchannelprocessesandevolutionoffluviallandscapes;Fluvialhazards,Integratedapproachtostreammana gement,Introduction toriverecology;Techniquesof artificialstreammodificationforthecontrol ofwaterflow,mitigation offloods and erosion.

Suggested Readings:

Davie, T., 2008. Fundamentals ofhydrology.RoutledgePublications.
Knighton,D., 1998. Fluvialforms and processes: Anew perspective.ArnoldPubs.Richards.K.,
2004. Rivers:Forms and processes inalluvialchannels.BalckburnPress.BryirelyandFryirs,
2005. Geomorphologyand rivermanagement.Blackwell Pub.,Julien,P.Y., 2002.
RiverMechanics.CambridgeUniversityPress.
Robert, A.,
2003.RiverProcesses:Anintroductiontofluvialdynamics.ArnoldPublications.Vanoni,V.A.,2006.Sedimen tationEngineering.ASCEManual,PublishedbyAmericanSocietyofCivilEngineering.
Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American GeophyscialUnionMonogrpah,Washington,DC.

GEOL-PG-S306:IsotopeGeology

UnitI:Fundamentals ofIsotope Geology

Fundamentals
ofradioactivityStableand
radiogenicisotopes.
Nuclearstructure,atomicweights,nuclearstabilityand abundance.
Theoryandmechanismofdecay,particlesemitted,positron,negatronandalphadecay,effectofmineral/crystal structures,growth and retention ofdaughter isotopes inearthsystems.
Abundancesofunstablenuclidesinearth,core,mantle,crust,oceansanddifferentrocktypes;theirdecayschem es,radioactiveelementsasmajorelements,minorelementsandtraceelementsand
theirgeochemicalbehaviour.

UnitII:IsotopicAnalysis

Mass spectrometer
Instrumentation,chemicalseparation,isotopedilution and ratioanalysis.
Methodsofdating:Isochronmethod,model/mineralages,Fissiontrack,40Ar-39Ar,UandThdisequilibrium,choncordiamethod, 14C, BeandAl.
Interpretationand geologicalsignificance
ofages.Isotopesystematics ofK-Ar, Rb-Sr,Sm-Nd,U-Th-Pb.

UnitIII:StableIsotopes
Stableisotopes ofoxygenand hydrogen, carbon, nitrogen and sulphurFractionation
ofstableisotopes inlithosphere,hydrosphere
andatmosphere.Stableisotopegeothermometryand geobarometry.
Environmentaland sediemntologicalstudies usingStableisotopes.

Unit IV: Applied IsotopeGeology
Isotopes in mineralexploration
Petroleumexploration,paleo-climateevaluation,health andenvironmentalaspects.Casestudies
and dataanalysisand interpretation.

Suggested Readings
Faure,G. (1986). Principles of IsotopeGeology. John Wiley, 589p.
Dickin,A.P. (2005). RadiogenicIsotopeGeology,CambridgeUniversityPress,512pDoe, B.R. (1970) Leadisotopes.SpringerVerlag, 137p.
Faure,G. and Powell,J.L.(1972) StrontiumIsotopeGeology.SpringerVerlag, 188p.

Semester IV

GEOL-PG-S401:Geomechanics

UnitI:Fundamentals ofGeomechanics
Definition ofgeomechanicsand classification ofgeologicalmaterials
RelationshipbetweenStressand Strainand theirmeasurementin rockmass andMohrcircles.Rock Properties – density,hardness,abrasion,slakedurability,permeability.
Strength ofrocks – tensile,compressive andshearstrength,Determination ofelasticmoduli.Rock mass classificationsystems– RQD, Q system,RMR and SMRclassification.
Laboratorymeasurementsofrock strength,Uniaxialand triaxialtests, Stress-strain relationships.Determinationofprincipalstresses.
Rockburstsandbumps;Subsidence-causes,prediction,monitoringandprevention.Techniquesin Borelogging, Core loggingand driftlogging.

UnitII:GeomechanicalCharacteristics
Sizeanalysis
Atterberglimits (plasticandliquidlimits).
BISClassificationsystem,Consolidationparameters,Swelling/ShrinkingIndex,VoidRatio,Effectivestressconceptsinsoil–
Total,neutralandeffectivestressdistributioninsoil,Permeability,Darcy'sLaw,Permeabilitymeasurementinthelaboratory–quicksandcondition,Seepage,LaplaceEquation,Liquifaction and Condensation.
Measurementofshearstrength,directshear,Triaxialcompression,UCCandVanesheartests.Types ofsheartests,Drained and undrainedbehaviour ofclayand sand.
Stress path
forconventionaltriaxialtest,cyclicsheartest.Techniques in
slopestabilityanalysis

UnitIII:GeotechnicalInvestigations

Physicomechanicalproperties ofbuildingstones andaggregate,alkaliaggregatereaction

Geotechnicalinvestigationfordamsite,reservoirsite;geotechnicalstudyforroadalignment,geotechnicaleval uationoftunnelalignment,methodsoftunneling,classificationofgroundfortunnelingpurposes.
Types ofsupportsystem.
Geotechnicalinvestigations forbridgefoundationandbuildingfoundation.
Massmovements,slopestabilityproblems,theirpredictionsand optimumdesignof slope(naturalslope,benchesinmines,minedumps).
Earthquakesandseismicity,seismiczonesofIndia,soilliquefaction,earthquakeresistancedesignofbuilding.I nfluenceofgeologicalconditionoffoundationanddesignofbuildings.Shorelineengineeringgeology.

Unit IV: Practical
Fieldbasedpracticalforsample/datacollection andin-situ study.GrainSizeAnalysis
DensityDeterminationAtt erbergsLimitTestsCompa ctionTestConsolidationT est
Direct andTriaxialShearTestCompressiveStr engthTestAbrasion and slakedurabilitytestPermeabilityTest
Selectionofsitesusingtopographicmapsfordams,tunnels,bridges,highwaysandsimilarcivil structures.
Computationofreservoirarea,catchmentarea,reservoircapacityandreservoirlife,dischargesand sedimentationrates.
Use ofsoftwares forsolving various geotechnicalproblems.

Suggested Readings:
Rock Mechanics forUndergroundMiningbyBradyand Brown;ChapmanandHall, 1993.EngineeringRock Mass Classifications byBieniawski;Wiley, 1989.
Rock Mechanics byFairhurst
PunmiaP.C.,"SoilMechanicsandFoundations",LaximiPublicationsPvt.Ltd.,NewDelhi,1995.
GopalRanjanandRaoA.S.R.,"Basicandappliedsoilmechanics",NewAgeInternationalPublishers,New Delhi,2000.
Krynin,D.P.and JuddW.R.1957. PrinciplesofEngineeringGeologyand Geotechnique,McGraw Hill(CBSPubl).
Johnson,R.B.andDeGraf,J.V.1988.PrinciplesofEngineeringGeology,JohnWiley&Sons,N.Y.
Goodman,R.E.,1993.EngineeringGeology:RockinEngineeringconstructions.JonhWiley&Sons,N.Y.
Waltham, T., 2009.Foundations ofEngineeringGeology(3rdEdn.) Taylor&Francis.

GEOL-PG-S402:Geodynamics and TectonicGeomorphology

UnitI:Geodynamics
Internalstructure ofthe earth
Variation ofphysicalproperties in theearth.
Detailedstructuresof core,mantleand crust,includingtheirgeophysicalpropertiesandcomposition.

Mainfeatures ofocean basins and deepoceanfloorand continentalCrust.Characters ofoceanicridges.Stages in theevolutionofocean basins.
Differenttypes ofcontinentalmargins andtheircharacters.Historicalbackground ofplatetectonics.
Earlierhypothesesoforogenesis,continentaldrift,palaeomagneticstudy,sea-floorspreading,and Isostasy.
Distribution oftectonicallyactivezones.

UnitII: Plate Tectonic

Plategeometryand plateboundaries.Triplejunctions
Plates invelocityspace.Sphericalcoordinates and referenceframe.
Cartesiancoordinates.FindingEuler'spole.VelocityduetorotationaboutanEuler'spole.Angularvelocityvectors.
Mechanismsof platemotion:mantleplumemodel,convectionmodel, viscousdragandbuoyancymodel.
Tectonics ofdifferentplateboundaries.
Differenttypes oftectonicsettings:extensional,compressionaland transformal.Petro-tectonicassemblages at differentplateboundaries.
Activationmodelandcollisionmodel oforogeny.Pacificand Andeantypeorogeny.Configuration ofthe Indianplateandorigin ofthe Himalayas.
Mountainbuildingprocess.
Thrust and foldbelts; Activefaults:concepts andmethods.

UnitIII:Introduction toNeotectonics

Introductionto Neotectonicsand activetectonicsGeomorphicmarkers oftectonicdeformation.Activetectonics andalluvialrivers.
Tectonics anderosion.Tectonic-climateinteraction.
Landscaperesponse toactivetectonics.
GPSgeodesyand its applications to lithosphericdeformation.
Rate ofdeformationand seismicity;Introductiontopaleoseismology.Tectonicgeomorphologyofmountains.
Application ofisotopicandfission-trackdataforuplift-erosion-incisionrelationships.

Unit IV: Introduction toEarth SurfaceProcesses

Introductionto earthsurfaceprocesses&terrestrialrelief
Scalesingeomorphology,energyflowandrelativeenergyofsurfaceprocesses.Morphometricanalysis ofdrainagebasinand geomorphology-hydrologyrelationship.
Ratesand changes in surfaceprocesses.
Techniquesforprocessmeasurement-sedimentbudgeting,rockmagnetism,Isotopegeochemicaltracers,cosmogenicnuclides, OSL&C-14 dating.
Introductionto Anthropocene.
Geomorphicconceptsincause-effectrelationship–Spatial&temporalscales,geomorphicsystem,connectivity,buffering,magnitude-frequencyconcept,time-lag,sensitivity,equilibrium,threshold,non-linearity&complexities.
Mega-geomorphologyand processinterrelationship,Appliedaspectsofgeomorphology.Introductionto planetarygeomorphology.

Suggested Reading:

Geodynamics:2nd Ed,Turcotte,D.L. and Schubert,G., John Wiley&Sons,NY, 2002.
MantleConvectionin theEarth andPlanets,Schubert,G.,Turcotte,D.L.andP.Olson,CambridgeUniversityPress, 2001.

Burbank, W.B., and Anderson,R.S., 2001. TectonicGeomorphology, Blackwell Science.Bull, W.B., 1991. GeomorphicResponse to ClimateChange,OxfordUniversityPress.
Bull, W.B., 2007. TectonicGeomorphologyofMountains, BlackwellPublishing.
Keller,E.A.andPinterN.,2001.ActiveTectonics:Earthquakes,Uplift,andLandscape,PrenticeHall.
McCalpin,J., 1998. Paleoseismology,AcademicPress.
Schumm,S.A.andHolbrook,2000.ActiveTectonicandAlluvialRivers,CambridgeUniversityPress.
Allen,P.A., 1997.EarthSurfaceProcesses,Blackwellpublishing.
Bloom, A.L.,1998. Geomorphology:A SystematicAnalysisofLateCenozoicLandforms,PearsonEducation.
Bridge,J.S. and Demicco,R.V.,2008. EarthSurfaceProcesses,Landformsand SedimentDeposits,CambridgeUniversityPress.
Easterbrook,D.J., 1992. SurfaceProcessesand Landforms,MacMillanPubl.
Kale,V.S. and Gupta,A.,2001. Introduction to Geomorphology,OrientLongmanLtd.Wilcock,P.R.,Iverson, R.M. (2003) Predictionin geomorphology,AGU Publication

GEOL-PG-S403:Geophysics

UnitI:Introduction to Geophysics
Introductionto methods ofGeophysicalInvestigation
Gravitymethod:Basisforgravityexploration,conceptofgeoid,internationalgravityformula,unit ofgravity.
Gravimeters:Spring-masssystemasbasicgravimeters,principlesofworkingofunstablegravimeters,zerolengthspring,La-Coste-RombergandWordengravimeters.Drift.correction.Gravityeffect due to buriedsphere.Densities ofcommon rocksand minerals.

UnitII: Magnetic and Resistivity Methods
Magneticmethod
Magneticsusceptibilityofrocksandtheirranges,elementsofearthmagneticfield;Magnetometers:FluxgateandProtonPrecessionMagnetometersDiurnalCorrection;Magneticeffect due to isolatedpole.
ResistivityMethod:Resitivitiesofcommonrocksandminerals,Trueandapparentresistivity,Electrodeconfigurations-SchlumbergerandWenner,ElectricalprofilingVerticalElectricalSounding.InterpretationoftwolayeredVES curves.

UnitIII:Seismic Method
PrinciplesofGeometricalOptics,generationandpropagationofseismicwaves,seismicenergysources,geometry ofrefractionandreflection,interpretationoftraveltimecurvesfortwolayeredearth·horizontalanddippinginterface,fieldprocedure-profileandbroadsideshooting,fanshooting, end on and splitspreadarrangements.
SeismicStratigraphyand its applications.
PrinciplesofSeismometry.Seismogramsassignals.Earthquakesandsourcetheory:Green’sfunctionandthemomenttensor,Earthquakefaults,radiationpatternandbeachballs,Stressdrop,earthquakeb-value,Finiteslipmodel,theheatflowparadox.SeismologyandTectonics.Continentaltectonics andintraplateearthquakes.

Unit IV: GeophysicalWelllogging Introductionto geophysicalwellloggingIntroductionto techniquesofMudLogging.
Boreholeenvironment,surfaceloggingsetup.Archie's lawandDarcy's law.Principlesandinstrumentation.SPlog,NaturalGammaRaylog,FormationWaterresistivityLogs,Porosity

Log, Neutron Log, Lithology-Porosity Logs, resistivity Logs, Induction Logging,ElectromagneticPropogationLogsandWell bore SeismicLogging.

Suggested Readings:

The SolidEarth:AnIntroductionto GlobalGeophysics(2nded. 2005) byCMRFowler,CambridgeUniversityPress.
AppliedGeophysicsbyTelfordW.M.,GeldartL.P.andSheriffR.E.,CambridgeUniversityPress.
LowrieRichard.Geophysics. 2007 CambridgeUniversityPress
SchlumbergerLog:Interpretations,Principles/Applications 1989,
Schlumberger.Introductionto Seismology(2ndEd) byPeterShearer,CambridgeUniversityPress.ModernGlobalSeismologybyThorn Layand TerryWallace byAcademicPress.

GEOL-PG-S404:CryosphericScience

UnitI:Fundamentals ofCryosphericSciences

Quaternaryglaciations inIndia
ClimatechangeinQuaternary–
casestudiesfromHimalaya(Ladakh,Uttarakhand,westernUP,Sikkim),RajasthanandGangaPlains,correlationwithGuliyaandGreenlandicecore,glaciertypes,dryandwetbasedglaciersandfactorsresponsible,sedimenttransportanddepositionbyglaciers,techniquesemployedforthedatingofglaciogenicdepositsandtheirlimitations,physicsof glacierice andsnow.

UnitII:Glaciology

Movement ofglacier,surfaceand subsurfacefeatures of glacier
Meterologicalparametersvis-a-
visglacier,affectofdebris/aerosolsonglaciersurface,energybalance,massbalancestudyofglaciers,variousmethodsofmassbalancestudy,isotopestudyofglaciericeandsnowvis-à-
visclimatechange,chemistryofsnow/ice,sedimentdischargebymeltwaterandchemistryofmeltwater,snout monitoringtechniques,remotesensingandGISapplicationin thestudyofglaciers.

UnitIII:Mass Movements inPetrmafrostRegions

Characteristics ofpermafrostareas, rockand soilcharactersin cryosphereMass
movementin petrmafrost areas- causes andmitigation
Snowavalanches–
snowpackagesanddensity,avalanchetypes,characteristicsofavalanche,avalanchepronеareas andtheirmitigation.

Unit IV: CaseStudies

Briefhistoryof glaciologicalstudies on
IndianHimalayanglaciersCasestudyofHimalayan glaciers**.**
CasestudyofGlaciers inSikkim.Rathong,Talong,Chamgme-Khangpu and Zemuglaciers.

Suggested Readings

Maherand Thompson2000Quaternaryclimates,environmentsand magnetism.CambridgeUniv.Press
Williams,D. etal. 1998QuaternaryEnvironments.Wiley&Sons.
Raina,V.K.,Glaciers TheRivers of Ice 2005. GeologicalSociety of IndiaISBN 10: 8185867739Raina,V.K. and Srivastava,D.“GlacierAtlas ofIndia, 2008, GeologicalSocietyof India.

GEOL-PG-S405:Micropalaeontology

UnitI:Calcareous Microfossils

Foraminifera:PlankticForaminifera,theirmodernbiogeography,coiling,surfaceultrastructure,outlineofmorphology.Benthicforaminifera,theirbriefmorphology.LargerForaminifera,theiroutline ofmorphology,application in oceanography.

Calcareousnannofossils:Outlineofmorphology,modernbiogeography,applicationinOceanography;outlinemorphologyandwallstructureofostracoda,significanceofostracodainQuaternarypaleoceanographicandpaleoclimaticstudies.

UnitII:Siliceousand PhosphaticMicrofossils

Outlinemorphology,modernbiogeographyofradiolarian,diatomsandSilicoflagellates,theirapplicationin interpretingSST and palaeo-climates

PhosphaticMicrofossils-Outlinemorphology,paleo-ecologfyandenvironmentalsignificanceofconodonts.

UnitIII:Applied Micropalaeontology

OrganicWalledMicrofossils

Environmentalsignificance ofAcritarchsand Dianoflagellates.

Palynology:OutlineofmorphologyofPollensandSpores.PollensandSporesinmarinerealm.EnvironmentalapplicationofPollen and Spores.

Application ofMicropaleontologyand palynologyinPetroleumExploration

Unit IV: Practical

Techniques ofseparationofmicrofossils frommatrix

Types ofmicrofossils:Calcareous,Siliceous,Phosphatic and organicwalledmicrofossils

Study ofimportant plankticforaminiferausefulin surfacewaterpaleoceanographyandbiostratigraphy

Studyof largerbenthicforaminiferausefulin

Indianstratigraphywithspecialreferencetocenozoicpetroliferous basins of India

Studyofmodernsurfacewatermassassemblagesofplankticforaminiferafromindian,Atlanticand PacificOcean

Depthbiotopesandestimationof paleodepthofthe oceanusingbenthic foraminiferalassemblages

Identification ofbenthicforaminiferacharacteristicof various deep seaenvironmentIdentificationofplankticforaminiferacharacteristicofWarmMixedLayer,Thermoclineand deep surfacewaters ofthemodern oceans

Identification ofmodernandancientsurfacewatermass withthehelp ofplankticforaminifera

Suggested Readings:

Bignot,G.,1985. Elementsof micropalaeontology;Microfossils,their geologicalandpalaeobiologicalapplications, Graham &Trotman,London,UnitedKingdom.

Braiser,M.D., 1980. Microfossils,GeogrgeAllenandUnwinPublisher.

Hasllett,S.K.,2002.QuaternaryEnvironmentalMicropalaeontology,OxfordUniversityPress,New York.

Jones, R.W., 1996. Micropaleontologyin Petroleumexploration,ClarendonPress Oxford.KennettandSrinivasan,1983. NeogenePlanktonicForaminifera:A phylogeneticAtlas,HutchinsonRoss.

Sinha,D.K.,2007.Micropaleontology:ApplicationinStratigraphy andPaleoceanography,AlphaScienceInternational,Oxford&NarosaPublishingHousePvt.Ltd.Delhi.

GEOL-PG-S406:Oceanography

UnitI:PhysicalOceanography
Methodsofmeasuringpropertiesofseawater.Molecularstructureofwater.Temperatureandsalinity distributioninsurfaceoftheocean.Saltcompositionandresidencetime.Dissolvedgasesin seawater.Carbondioxide andcarbonatecycle.
Oceancirculation:TheOceanConveyorbeltanditsroleincontrollingworld'sclimate.Surfacecirculation;con ceptofmixedlayer,thermoclineandpycnocline,CoriolisForceandEkmanSpiral,Upwelling,Elnino.Processe saffectingbiologicalproductivityofoceanmarginwaters.DeepOceanCirculation,conceptofthermohalinecir culation,formationofbottomwaters;watermassesoftheworldoceans.Oxygenminimumlayerintheocean.Ma jorcurrentsoftheworld'socean.

UnitII:Deep-SeaSediments and Processes
Deep-
seasedimentsandtheirrelationtooceanicprocessessuchassolution,productivity,anddilution.Sedimentdistri butionsintimeandspaceasrelatedtotectonicmodels.DeepSeahiatuses and theircauses.Calcite and AragoniteCompensationdepthand significance.
OceanResources:MineralresourcesoftheoceanincludingpolymetalicnodulesMarineGasHydrates and theireconomicpotential.

UnitIII:MarinePollution
MarinePollutionemphasizinggeochemicalaspectsofthesources,transport,andfateofpollutantsinthecoastal marineenvironment.Interpretingmarinepollutionwiththehelpofmicrofossils duringQuaternary.
Paleoceanography:OceanFloorMorphology,OceanicCrustandOceanMargins.ApproachestoPaleoceanog raphicreconstructions.Paleoceanographicchangesinrelationtoearthsystemhistoryincludingimpactoftheoc eansonclimatechange.DeepSeaDrillingProject(DSDP);OceanDrillingProgram(ODP)andJointGlobalOc eanFluxStudies(JGOFS)andtheirmajoraccomplishments.IntegratedOceanDrillingProgram(IODP) and itsaimsandobjectives.

Unit IV: Evolution ofOceans in theCenozoic
OceanGatewaysoftheCenozoicandtheirroleincontrollingglobalclimates.SealevelchangesduringQuaterna rywithspecialreferencetoIndia.Applicationofstableisotopes(OxygenandCarbon)inPaleoceanographyand Paleoclimatology.Paleoclimaticreconstructionsfromicecores.MarineStratigraphy,correlationand chronology.

Suggested Readings:
Fischer,G.andWefer,G.,1999.UseofProxiesinPaleoceanography:ExamplesfromtheSouthAtlantic,Spring er.
Gross,M.G., 1977. Oceanography: Aview ofthe Earth,Prentice Hall.
Haq and Boersma,1978. Introductionto MarineMicropaleontology,Elsevier.Tolmazin,D., 1985.Elements ofDynamicOceanography,Allen and Unwin.

GEOL-PG-S407:Dissertation

The students areexpectedto submittheirdissertationbythe end ofthetenthsemester.
Thedissertationwillbeevaluatedbyanexternalexaminerandinternalexaminer(supervisor).Therewillbean openpresentationand viva-voce.