

MANONMANIAM SUNDARANAR UNIVERSITY
Abishekapatti – 627 012

Ph. D. Program in Geotechnology / Geology
(For all affiliated colleges / Research centers and University Department)

Course Structure and Syllabus as per the Choice Based Credit System (CBCS)
(Curriculum Effective From 2018-2019 Onwards)

Course Structure for Ph. D. Program in Geotechnology / Geology –2018-2019 onwards

Course	Name of the Course	credits	Hours /week
Core-I	Analytical Techniques in Geology	4	4
Core-II	Coastal Environments	4	4
Core-III	Groundwater Chemistry	4	4
Core-IV	Engineering Geology	4	4
Core-V	Geohazards	4	4
Core-VI	Research Methodology	4	4
Core-VII	Geomagnetism	4	4
Core-VIII	Geophysical prospecting methods	4	4
Core-IX	Remote Sensing & GIS	4	4
Core-X	Mini Project	4	4

1. ANALYTICAL TECHNIQUES IN GEOLOGY

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Unit-I: Introduction to advanced laboratory techniques: Working principles and concepts of Differential Thermal Analysis (DTA), X-ray Diffractions (XRD), Scanning Electron Microscope (SEM), ICP MS, X-ray fluorescence (XRF), Energy-dispersive X-ray spectroscopy (EDS, EDX, or XEDS), Mass spectrometer, CT-scan tomography, Fission Track Dating, etc.

Unit-II: Sample Preparations: Techniques of sample preparation, applications and limitations of Differential Thermal Analysis (DTA), X-ray Diffractions (XRD), Scanning Electron Microscope (SEM), ICP MS, X-ray fluorescence (XRF), Energy-dispersive X-ray spectroscopy (EDS, EDX, or XEDS), Mass spectrometer, CT-scan tomography, Fission Track Dating, etc. in the field of geosciences.

Unit-III: Optical Studies: Understanding of petrological and stereozoom microscopes. Identification of common rock forming minerals. Sample preparation techniques for petrological sections studies, geochemical and palaeontological studies. Review of literatures on the applications of advance laboratory techniques in geology.

Unit-IV: Pollution And Quality Analysis Of Ground Water: Municipal /industrial /agricultural /miscellaneous sources & causes of pollution, attenuation/ underground distribution / potential evaluation of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples, graphical representations of ground water quality.

Unit-V : Surface, Sub-Surface Investigation Of Ground Water: Geological, geophysical exploration, remote sensing ,electric resistivity ,seismic refraction based methods for surface investigation of ground water. Test drilling & ground water level measurement, sub-surface ground water investigation through geophysical / resistivity /spontaneous potential /radiation / temperature / caliper / fluid conductivity / fluid velocity /miscellaneous logging.

References:

1. Recent developments in geochemical microanalysis: Chemical Geology by Reed, S. J. B., 1990, Volume. 83, PP. 1-9.
2. Elements of X-ray Diffraction by Cullity B.D., 1978, Addison-Wesley Publishing Company.
3. Principles of isotope geology by Faure, G., 1986, John Wiley and Sons, Inc., New York.
4. Introduction to Analytical Electron Microscopy by Goldstein, J., 1979, Plenum Press, New York and London.
5. Introduction to X-ray Powder Diffractometry by Jenkins, Ron and Snyder, Robert L., 1996, Vol. 138, Wiley & Sons, New York.
6. Electron Microprobe and Scanning Electron Microscopy in Geology by Reed, S. J. B., 1996, Cambridge University Press, Cambridge.
7. Handbook of Instrumental Techniques for Analytical Chemistry by Frank A. Settle, 1997, Prentice Hall, Upper Saddle River, NJ.
8. Stable isotope geochemistry by Hoefs J., 1987, Springer-Verlag, Berlin, Germany.
9. Microprobe Techniques in Earth Sciences by Potts, P. J., Bowles, J. F. W., Reed, S. J. B., and Cave, M. R., 1995, Chapman and Hall, London.
10. Electron Microprobe Analysis by Reed, S. J. B., 1993, Cambridge University Press, Cambridge.
11. Quantitative Electron-probe microanalysis by Scott, V., and Love, G., 1983. : West Sussex, Ellis Horwood.

12. Atomic absorption spectroscopy: Chemical Analysis by Slavin, Morris, 1978, John Wiley and Sons, New York.
13. D.K. Todd and L. F. Mays, "Groundwater Hydrology", John Wiley and sons.
14. K. R. Karanth, "Hydrogeology", Tata McGraw Hill Publishing Company.

2. COASTAL ENVIRONMENTS

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UNIT-I: Introduction – nature of the shore line – coastal erosion, sediment deposition and transport – Cliff erosion, sediment deposition and transport – cliff erosion – storms and coastal erosion – strategies for limiting cliff erosion – emergent and submerging coastlines – causes of changes in shore and elevation – wave cut platforms – drowned valleys.

UNIT-II: Present and future sea level trends – difficult coastal environments – barrier islands – cost of construction in high energy environments – land reclamation from estuaries – recognition of coastal hazards.

UNIT-III: Definition, meaning and scope of coastal regulations – sustainable coastal zone management – river input to the ocean system – Man's influence on river input to the ocean system and comparison of pathways in the coastal zone – land water interface.

UNIT-IV: International initiatives for coastal zone protection – defense of the coastal areas and coastal zone management- principles – bases for decisions on coastal zone development – Essential national and international linkages.

UNIT-V: Planning and management of coastal zone – coastal zone regulations in the world and in India – Success and failures of coastal zone management

References:

1. Coastal and estuarine sediment dynamics by Dyer.K.R, John Wiley and sons.
2. The waters of the sea by Groen, P., Van Nostrand.
3. Sedimentology – process and product by Leeder, M.R.,Pethick, Edward Arnold.
4. Tides, Surges and Mean Sea Level by pugh, D.T.,wiley.
5. The waters of the sea by P.Groen., Van Nostrand.
6. Satellite Oceanography by Robinson, I.S., Ellis Horwood

3. GROUNDWATER CHEMISTRY

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Unit-I: Hydrogeology: Hydrologic cycle and its components, Origin and age of groundwater, Occurrence of groundwater, Global distribution of fresh water. Vertical distribution of groundwater. Aquifers: Types of aquifers. Springs: Types of springs. Hydrologic properties of rocks: Porosity, Permeability, Specific yield, Specific retention, Hydraulic conductivity, Transmissivity and Storage coefficient. Groundwater movements: Sub surface movement, Base flow, Effluent flow and influent flow. Darcy's law, Reynold's number, Laminar flow and turbulence flow. Water level fluctuation: Water table and Piezometric surface and its fluctuations. Pumping test: objectives, layout of the test and measurements.

Unit – II: Water well technology: Well types, drilling methods, construction of well, design of well, development and maintenance of wells. Artificial recharge of groundwater: Concept and methods. Saline water intrusion in aquifers: Saline water intrusion, Ghyben–Herzberg relation between fresh and saline water, Prevention and control of salt water intrusion in the coastal aquifers.

Unit – III: Ground water quality: Sources of salinity, estimation of major elements, reporting of chemical analysis; Groundwater pollution: Problems of arsenic and fluoride, groundwater quality map of India, quality criteria for groundwater use, salt water intrusion in coastal aquifers and remedial measures.

Unit-IV: Hydrochemistry: Analysis surface water and subsurface water; classification of groundwater for use in drinking, irrigation and industrial purposes; presentation of chemical analysis; data and plotting; chemical classification diagram.

Unit-V: Groundwater exploration techniques: Surface investigation of groundwater- Geologic method, electrical resistivity method, seismic method, gravity and magnetic method. Subsurface investigation of groundwater: test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration. Groundwater provinces of India.

References:

1. Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
2. Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley& sons, Inc, New York, 463p.
3. Fetter, C.W., (1990), Applied Hydrogeology-Mc Graw Hill, Publisher, New Delhi.
4. Freeze, R.A. and John, A., (1979), Groundwater, Cherry, Prentice Hall, Inc, 604p.
5. Hem J.D., (1970), Study and interpretation of the chemical characteristics of Natural water, USGS Edition.
6. Hiscock, K., (2005), Hydrogeology, Principles and Practice, Blackwell Publishing, 389p.
7. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p.
8. Manning, J.C., (2007), Applied Principles of Hydrology, CBS Publishers and Distributers, New Delhi.
9. Raghunath, H.M., (2007), Groundwater 3rd edition, New Age International Publishers,520p.
10. Reddy and Rami, J.P., (2008), A Textbook of Hydrology, University Science Press, Bangalore.
11. Schwartz, F.W and Zhang, H., (2003), Fundamentals of groundwater, John Wiley& sons, Inc, New York, 583p.
12. Shaw, E.M., (1994), Hydrology in Practice,3rd edition, Chapman and Hall,London,569p.

13. Subramaniam, V., (2000), Water-Kingston Publ. London.
14. Todd, D.K., (1980), Groundwater Hydrology-John Wiley & sons publishers, New York, 535p.

4. ENGINEERING GEOLOGY

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UNIT-I: Surface and Subsurface Geological Investigations

Field investigations, electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering, Description of discontinuities, bed rock attitudes, thickness, calculation of True thickness and vertical thickness of bed rock. Geological information for slope stabilization.

UNIT-II: Engineering Properties Of Rocks And Soils

Rock description and engineering classification of rocks – weathering and its significance in engineering site- Engineering properties of rocks and soils, RMR, RQD methods, determination of engineering properties in field and laboratory.

UNIT-III: Geological Investigations For Dams & Tunnels

Dams-geological investigations- suitability of site, geological profile from catchment area to Dam site, lithology, structures, topography, slope, drainage system, water budget studies, Reservoir site investigations, siltation analysis, Geological investigations for soft rock and hard rock tunnels construction.

UNIT-IV: Geological Investigations For Coastal Development

Coastal erosion and accretion process and its impact. Geological investigations for harbor construction, Coastal protection structures-Sea walls, bulk heads, groins, jetties.

UNIT-V: Geotechnical Studies Of Landslides And Subsidence

Landslide - Classification, causative factors, control measures. Land subsidence, factors, causes and remedial measures. Geological considerations for monitoring of landslides. geotechnical problems related to foundation for bridge and building site investigations.

References:

1. Krynine and Judd. Principles of Engineering Geology and Geotechnology, McGraw Hill, New York, 1962.
2. Chandler. R.J. Slope Stability and Engineering Developments, 1992.
3. Waltham, T. Foundations of Engineering Geology, SPON Press, London 2002, ISBN 0-415- 25449-3.
4. Bell F G Engineering Geology, Second Edition by, 2007. Butterworth-Heinemann, Oxford
5. Sathya Narayanaswami. Engineering Geology. Dhanpat Rai and Co. 1710, Nai Sarak, Delhi- 110006, 2000.
6. Waltham, A.C. Foundations of Engineering Geology, Blackie Academic Professional Pub., I Ed.,UK,1994.

5. GEOHAZARDS

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Unit-I: Internal structure of the Earth. Endogenic and exogenic earth processes. Earth as a dynamic and continuously evolving system as a result of interactions between lithosphere, hydrosphere, atmosphere and biosphere.

Unit-II: Definition, types and genesis of natural geohazards - Earthquake, Volcanism, Landslide, Tsunami, Flood, Drought, Cyclone, Forest Fire, Meteorite impact, land subsidence, Quick sand, Heat wave, coastal erosion and inundation. Primary, secondary and tertiary impacts of geohazards.

Unit-III: Causes and consequences of geohazards. Anthropogenic intervention with natural processes and exacerbation of hazard vulnerability. Man made hazards.

Unit-IV: Hazard zonation, hazard mitigation. Tools and methods. Relief and rescue operations.

Unit-V: Hazard vulnerability classification of Indian sub-continent. Indian scenario of hazard preparedness. Command structure and operations of National Disaster Management Agency.

References:

1. Bandibas, J.C., Wakita, K. and Kato, H., 2003 Interactive presentation of geological hazard maps using Geohazardview. Jour.Nat.Dis.Sci. v.25. pp.75-83.
2. Government of India, 2004 Disaster management in India – A status report.88p.
3. Government of India, 2007 National disaster management guidelines. 72p.
4. Hamilton, R., 1997 Report on early warning capabilities for geological hazards. IDNDR. 35p.
5. Kato, H., Wakita, K. and Bandibas, J.C., 2003 Eastern Asia geological hazards map: Paper and digital versions. Jour.Nat.Dis.Sci.v.25. pp.65-74.
6. Ramkumar, M. and Neelakantan, R., 2007 GIS technology based geohazard zonation and advance warning system for geohazard mitigation and information dissemination towards relief and rescue operations. Jour.Earth.Sci. v.1. pp.65-70.
7. Ramkumar, Mu., 2008 Geohazards: Causes, consequences and methods of mitigation. New India Publishers, New Delhi.

6. RESEARCH METHODOLOGY

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Unit-I: Types of research- Process of Research-Formulation of objectives. Hypothesis to theory – geological example: Continental drift hypothesis to plate tectonics theory. Research plan and its components.

Unit-II: Methods of research (Survey, observation, case studies, experimental, historical and comparative methods) Methods of Literature collection, Experimental design, planning and execution of investigation.

Unit-III: Analysis of numerical data – Central tendencies, dispersion, testing significance of variations, analyzing correlation of variables. Regression analysis, Principal Component Analysis and Factor Analysis, and Cluster Analysis and its use in geological research. Application of GIS in Spatial analyses of geological datasets.

Unit-IV: Writing of Research proposal, Report and Research paper, Meaning and types – stages in preparation-characteristics-structure-documentation, foot notes and bibliography-Editing the final draft - Evaluating the final draft-checklist for a good proposal/reporter/research paper.

Unit-V: Research ethics – ethical issues, ethical committees; Scholarly publishing – IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

References :

1. John C. Davis (2002), Statistics and Data Analysis in Geology
2. Kothari C R (2009), Research Methodology, 2nd edition, New Age Institute, New Delhi
3. Kenneth, J.P., Marine Geology, Prentice Hall Inc., 1982
4. Petti John, (2000) Sedimentary Rocks, CBS publications, New Delhi
5. Philips E M & Pugh D.S., (1998), How to get a Ph D, UBS publishers & Distributors, New Delhi
6. Rajit Kumar, (2005), Research Methodology, Pearson edition, New Delhi
7. Venugopal K , (2008), Research Methodology, university of Calicut
8. Rajendra Naragundkar : Marketing Research, Text and Cases, Mc Graw Hill, 2008.

7. GEOMAGNETISM

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Unit-I: Origin and sources of geomagnetic field, geomagnetic field elements, different periodicities and their implications, field variation of external origin, solar quiet variations, disturbed time variations, geographic and geomagnetic coordinates, concept of universal time, local time and magnetic local time, geomagnetic activity indices, importance of geomagnetic observatories.

Unit-II: Understanding the Earth's inner and outer atmosphere, Reversals of Earth's magnetic field, Magnetic observatory instrumentation, Micro pulsations, Analysis of Geomagnetic variations, Application of Geomagnetic data to explore the Earth and its atmosphere, Spherical Harmonic Analysis of Geomagnetic data, Introduction to Geomagnetic Hazards and Space weather.

Unit-III: Palaeomagnetism and history of the Earth's magnetic field, Palaeomagnetism, archeomagnetism and magnetic observatory records, Palaeolatitudes, pole position and apparent polar wander path, Geomagnetism from palaeomagnetism- basis of palaeomagnetic dating, Study areas and major findings.

Unit-IV: Environmental mineral magnetism: A multi-disciplinary approach, Environmental mineral magnetism and palaeomagnetism, Environmental magnetism: objectives and evolution, Characteristic curves for interpreting mineral magnetic data.

Unit-V: Measurements of magnetic susceptibility and remanence, Sediment and rock dating techniques, some complex issues associated with magnetic studies, Environmental magnetism- its application to Indian depositional settings, Magnetic susceptibility and depositional environments, Magneto-minerological s-ratio and palaeoclimate in sediments, Future studies.

References:

1. George Backus, Robert Parker, Catherine Constable, 1996, Foundations of Geomagnetism, Cambridge University Press.
2. Ronald T. Merrill, 2010, Our Magnetic Earth: The Science of Geomagnetism, University of Chicago Press.
3. Ronald T. Merrill, Michael W. McElhinny, Phillip L McFadden, 1998, The Magnetic field of the Earth: Paleomagnetism, the Core, and the Deep Mantle, Academic Press.
4. Nathani Basavaiah, 2011, Geomagnetism: Solid Earth and Upper Atmosphere Perspectives, Capital Publishing Company.
5. Gubbins-Herrero-Bervera, Encyclopedia of Geomagnetism and Paleomagnetism, Springer.
6. Tsuneji Rikitake, Yoshimori Honkura, 2011, Solid Earth Geomagnetism, Springer
7. Jack A. Jacobs, 1963, The Earth's Core and Geomagnetism, Elsevier Science and Technology.
8. William Lowrie, 1997, Fundamentals of Geophysics, Cambridge University Press.
9. Michael W. McElhinny, Phillip L. McFadden, 1999, Paleomagnetism: Continents and Oceans, Elsevier.

8. GEOPHYSICAL PROSPECTING METHODS

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Unit-I: Internal structure of the earth, Structure, composition and evolution of the earth and distribution of elements, Density distribution, shape and mass of the earth. Density vs depth profile, Various Geophysical Exploration Methods, Sea-floor spreading and magnetic polarity reversals, Magneto-stratigraphy.

Unit-II: Basic concepts, Earth's magnetism and gravity, Geomagnetic and gravity fields, Crustal magnetic and gravity anomalies & their sources, Surveying instruments for magnetic and gravity measurements, Magnetic and gravity surveys- ground, airborne, marine and satellite, Magnetic and gravity data processing & interpretation, Case studies.

Unit-III: Classification of electrical methods, Electrical properties of rocks and minerals, Elementary theory, Electrode layouts and field procedure, Processing & interpretation of resistivity data. Electromagnetic theory, Telluric and magnetotelluric methods, Geomagnetic depth sounding, Field survey and instrumentation, Interpretation techniques, Case studies.

Unit-IV: Seismic wave theory; Seismometry; Seismogram interpretation; Earthquake locations and Seismic sources; Determination of Earth structure; Earthquake kinematics and dynamics; Seismotectonics.

Unit-V: Elements of Geodesy, GPS Technology, Contributory Error and accuracy, GPS Observables, measurements and strategies, Terrestrial Reference frame, Applications of GPS, GPS measurements and active crustal motions: Case studies, Other spaceborne Geodetic techniques.

References:

1. Keller, G.V. Electrical Methods in Geophysical Prospecting, Frischnett, Pergamon
2. Patra, H.P. and Mallick, K. Principles of Geoelectric Soundings
3. Telford, W. K and Geldart, L.P., Sheriff, R. F and Keys D.A Applied Geophysics Cambridge
4. Keller and Frischkeicht , 1966, electrical methods in Geophysical prospecting Pergaon
5. Patra and Bhattacharya 1969 , Direct Current, Geoelectrical Sounding, Elsevier
6. Yilmaz, O, 1987, Seismic Data Processing, SEG Publication.
7. Dobrin M.B. Savit C.H. 1988 Introduction to Geophysical Prospecting. Mc. Graw Hill Book
8. Sheriff. R.E. and Geldart. L.P. 1987 Exploration Seismology, Vol. 1. Cambridge Univ. Press.

9. REMOTE SENSING & GIS

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Unit-I: Electromagnetic energy resources, electromagnetic radiation (EMR) spectrum, EMR energy – frequency – wavelength relationship, Boltzman law, Wien Law.

Unit-II: Characteristics of aerial photographs and satellite imagery – false colour composites, photo-elemental characters, reflectance and emittance- Geosynchronous and sunsynchronous orbits, location of a satellite in space, world referencing system.

Unit-III: Remote sensing plate forms - Characteristics of different remote sensing satellites and sensors, resolution, parallex, vertical exaggeration, relief displacement, mosaic, analysis and interpretations of aerial photographs and satellites imagery. Satellite remote sensing digital data products, data format and storage, preprocessing – atmospheric, geometric and radiometric correction, image rectification and registration.

Unit-IV: Digital image processing – contrast enhancement, image arithmetic, filtering, image transformation, classification of satellite image – supervised and unsupervised classification techniques, visible, thermal infra-red, microwave and hyper-spectral remote sensing principles and techniques. Advantages and disadvantages of Remote Sensing –Various application of remote sensing.

Unit-V: Definition of GIS – components of GIS – Geographical concepts – Input data for GIS – Types of output products – GIS Data types – Data representation – Data sources – Data acquisition – Geo referencing of GIS data – Spatial data errors – Spatial data structures. database management – hierarchical, network, relational, object oriented databases, data stream – data encoding and editing, data analysis - Application of GIS.

References:

1. P.K. Guha, Remote sensing for Beginner – EWP, New Delhi, 2003.
2. Sabino. F.F. Remote sensing principles and interpretation, Freeman, San Francisco, 1978.
3. Arnold. R.H. Interpretation of air-photo and Remotely sensed imagery, Printice-Hall, New Jersey, 1997.
4. Drury. S.A. Image Interpretation in Geology – Chapman Hall, London, 1993.
5. Lillesand. T.M. and Kiefu. R.W. Remote sensing and Image Interpretation, Willey, New York.
6. Miller.V.C, Photogeology, McGraw Hill – London, 1961.

10. MINI PROJECT

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