

**MANONMANIAM SUNDARANAR UNIVERSITY**

**CENTRE FOR GEOTECHNOLOGY**

**Syllabus for M.Sc Applied Geophysics (CBCS)**

**2016 – 2017 onwards (Fulltime)**

**Regulations**

- Duration** : Two academic years (Four semester course)
- No. of seats** : 20 Seats
- Eligibility** : Degree in any Branch of Engineering or B.Sc in Physics/  
Chemistry/Mathematics/ComputerScience/Geology/Geophysics/  
Statistics/Electronics and communication/Electronics/Applied  
Electronics/IT and other equivalent courses
- Examination** : There will be internal assessments comprising of tests, seminars and assignments and one end-semester examination during each semester. A minimum of 50% marks in a course is prescribed for a pass. The candidate who has not secured a minimum of 50% marks in a course will be deemed to have failed in that course.
- Eligibility for Teaching :  
Appointment** As per UGC Norms with the specialization on Geophysics / Applied Geophysics / Exploration Geophysics / Mineral Exploration / Marine Geology / Marine Geophysics / Applied Geology with strong mathematics background / Earthquake Engineering / GeoTechnology.

## SCHEME OF EXAMINATIONS

### M.Sc., APPLIED GEOPHYSICS (CBCS)

Paper	Subject	Credit	Int.	Ext.	Total	Teaching Hours
<b>Semester I</b>						
Paper I	Principles of Geophysics and Electronic Instrumentation	4	25	75	100	4
Paper II	Electrical and Electromagnetic prospecting	4	25	75	100	4
Paper III	Remote sensing and GIS	4	25	75	100	4
Paper IV	Computer programming and software application in geosciences	4	25	75	100	4
Paper V	Geology or Mineral exploration (Elective Major)	3	25	75	100	3
Paper VI	Practical – Geology or Mineral exploration / Electrical and Electromagnetic prospecting / Remote sensing and GIS	2	25	75	100	4
<b>Semester II</b>						
Paper VII	Geophysical Signal Processing and inversion	4	25	75	100	4
Paper VIII	Ground water Geophysics	4	25	75	100	4
Paper IX	Seismic Prospecting	4	25	75	100	4
Paper X	Gravity and Magnetic Prospecting	4	25	75	100	4
Paper XI	Tectonics and Seismology or Disaster management - (Elective Major)	3	25	75	100	3
Paper XII	Elective- (Non major)	3	25	75	100	3
Paper XIII	Practical - Gravity and Magnetic prospecting / Seismic Prospecting/ Geophysical Signal Processing and inversion	2	25	75	100	4
<b>Semester III</b>						
Paper XIV	Well logging	4	25	75	100	4
Paper XV	Marine Geophysics	4	25	75	100	4
Paper XVI	Environmental GeoTechnology	4	25	75	100	4
Paper XVII	Energy Resources	4	25	75	100	4
Paper XVIII	Elective- (Non major)	3	25	75	100	3
Paper XIX	Practical – Marine Geophysics / Well logging	2	25	75	100	4
<b>Semester IV</b>						
Paper XX	*Industrial training & Dissertation and Viva Voce**	24	25	75	100	48

*\*Industrial training – 5 Internal marks      \*\* Dissertation and Viva Voce – 20 Internal marks*

**\*Training at Oil/Mineral Exploration units/Research**

**Institutes in Geophysics for a period of 20 days**

Total Credits : 90 Credits

Total Marks : 2000 marks

**Note: Courses to be offered to other departments as non-major electives**

**Electives to be offered to other departments:**

- 1) Introduction to Remote sensing
- 2) GPS Technology

**Other Recommendations of the Core committee**

**1. Internal assessment:**

**25 Marks**

Components	Marks
The average of the best two tests from three compulsory Tests.	20
Assignment / Seminar	05
<b>Total</b>	<b>25</b>

Note : Each test is of one hour duration.

**2. Project Work: External**

**75 Marks**

Components	Marks
Project Report	50
Viva – voce	20
Industrial training	5
<b>Total</b>	<b>75</b>

Note: Project report evaluation and Viva – voce will be conducted by both the External examiner and the guide

**3. Practicals:**

**100 Marks**

Components	Marks
Internal	25
External	75
<b>Total</b>	<b>100</b>

Laboratory Work and Observation	=	5
Record	=	10
Internal Test	=	10
<b>Total</b>	=	<b>25</b>

**4. The Performance of the Students is indicated by the seven point scale grading system**

**as per the UGC norms given below:**

Grade	GradePoint	Percentage of Marks	Performance
S	10	91-100	Excellent
A	9	81-90	Very good
B	8	71-80	Good
C	7	61-70	Very Fair
D	6	55-60	Fair
E	5	50-54	Average
F	0	Upto 49	Fail

**5. The overall performance level of the candidates will be assessed by the following formulae :**

$$\text{Cumulative weighted Average of Marks} = \frac{\Sigma(\text{Marks} \times \text{Credits})}{\Sigma \text{Credits}}$$

$$\text{Cumulative Weighted Average Grade points} = \frac{\Sigma (\text{Grade point} \times \text{Credits})}{\Sigma \text{Credits}}$$

**6. There is separate passing minimum for the external and the overall components.**

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**Code No.**

**Sub Code**

**M.Sc. DEGREE EXAMINATION**

**Applied Geophysics (CBCS)**

**Semester**

(For those who joined in July 2016 – 2017 onwards)

**(SUBJECT)**

**Time : Three Hours**

**Max. 75 Marks**

**Section – A**

**Answer all questions**

**All questions carry equal marks (10 X 1= 10 Marks)**

**TEN QUESTIONS (1 - 10)**

**Section – B**

**Answer all questions**

**All questions carry equal marks (5 X 5= 25 Marks)**

**FIVE QUESTIONS (11 - 15)**

**(a OR b)**

**Section – C**

**Answer all questions**

**All questions carry equal marks (5 X 8= 40 Marks)**

**FIVE QUESTIONS (16- 20)**

**(a OR b)**

## Paper I PRINCIPLES OF GEOPHYSICS AND ELECTRONIC INSTRUMENTATION

Credits 4

**Unit I:** Concepts of fields; scalar, vector, raster; conservation laws; mass, momentum, energy and charge; constitutive relations; and dynamical equations; elastic, viscous, electro-magnetic and thermal. Laws of thermodynamics and entropy – partial differential equation of physics-wave diffusion, potential and schrodinger

**Unit II:** Linear stability theory and onset convection, critical points limit cycles and bifurcation of nonlinear systems. Electric and magnetic potentials and fields, static charge distributions, Newtonian potential; Laplace and Poisson's equations; Green's Theorem; Gauss' law; Continuation integral; equivalent stratum; Maxwell's equations and electromagnetic theory; Displacement potential, Helmholtz's theorem and seismic wave propagation.

**Unit III:** Op-Amp: Characteristic – Common Mode Rejection Ratio (CMRR) – Slew rate - block diagram representation of a typical Op-Amp – adder subtractor, integrator, and differentiator Op-Amp - Differential amplifier, DC and AC analysis of differential amplifiers, constant current bias, current mirror, cascaded differential amplifier stages.

**Unit IV:** Amplifiers built with Op-Amp: Inverting, non-inverting – offset null - Input impedance, output impedance, closed-loop gain and bandwidth calculation for the amplifiers built with Op-Amps. Other applications of Op-Amps: Instrumentation amplifier, voltage to current and current to voltage converts, active filters, oscillators, comparators .

**Unit V:** Digital Electronics: Basic logic gates and truth-tables, Karnaugh map, implementing arbitrary truth-tables, sequential logic – flip flops, registers, multiplexers and de-multiplexers, Transducers and its types.

### Reference Books:

1. Achenbach, J.D (1975) Wave propagation in Elastic Solids, North Holland
2. Auld, B.A (1990) Acoustic Fields and Waves in solids, Krieger Publ. Co.,
3. P.V. Sarma. (1976). Geophysical Methods in Geology, Elsevier.
4. Howell. (1959). Introduction to Geophysics, McGraw Hill Book Company, New York.
5. Fowler, C.M.R (1990) The Solid Earth, An introduction to Global Geophysics, Cambridge Press
6. R.E. Sheriff. (1989). Geophysical Methods, Prentice Hall Engle Wood Cliffs, New Jersey.
7. I.K. Kaul, S. Sengupta and A.K. Bhattacharya.(1990). General and Applied Geophysics (An Introduction), Associate of Geophysics.
8. F.D. Stacey. (1977). Physics of the Earth, John Wiley and Sons, New York.
9. Ramakant A. Gayakwad: Op-Amps and Linear Integrated circuits – Third Edition.
10. Paul Horowitz, Winfield Hill: The art of electronics
11. C.S. Rengan, G. R. Sharma & V.S.V. Mani: Instrumentation: Devices and systems.
12. Aditya, P. Mathur – Introduction to Microprocessor

## Paper II ELECTRICAL AND ELECTROMAGNETIC PROSPECTING

Credits 4

**Unit – I:** Basic principles of electrical methods of prospecting, classification of methods. Electrical properties of rocks, minerals, influence of mineral composition, moisture and salinity, Temperature on resistivity- Current flow in a homogeneous media - Current flow across layers of differing resistivities.

**Unit- II:** Basics of resistivity methods of prospecting: concepts of true and apparent resistivities. Field methods - Vertical Electrical Sounding (VES), Resistivity Profiling. Resistivity imaging: some fundamental concepts. Methods in resistivity imaging, field surveys and uses. Resistivity data analysis and Interpretation - Applications

**Unit – III:** Principles of electromagnetic method - Vertical loop (VLEM) - Horizontal loop - (HLEM) –Very Low Frequency (VLF) - Audio Frequency Magnetics (AFMAG) - TimeDomain systems - Terrain Conductivity. Magneto Telluric (MT) and Transient Electromagnetic (TEM) methods of geophysical exploration.

**Unit IV :** Electrochemical methods : origin and nature of electro chemical processes (spontaneous polarization) in the earth. Exploration of sulphide ore bodies. Typical responses of SP over sphere and rod like bodies. Induced polarization (IP) method: Introduction, Source of IP, membrane, and electrode polarizations, Time domain and frequency domain measurement of IP, Application of IP methods.

**Unit – V:** Electromagnetic Principles of GPR - GPR Systems and Design, Data Processing, Modeling and Analysis in Environmental Applications, GPR application in Water Resources Research, Mineralogical, Stratigraphy and Archeological Science.

### Reference Books:

1. Parasnis, D.S., 1973. Mining Geophysics, Elsevier.
2. Keller, G.V. Electrical Methods in Geophysical Prospecting, Frischnecht, Pergamon
3. Patra, H.P. and Mallick, K. Principles of Geoelectric Soundings
4. Telford, W. K and Geldart, L.P., Sheriff, R. F and Keys D.A Applied Geophysics Cambridge University Press
5. Harry M. Jol., 2008. Ground Penetrating Radar: Theory and Applications
6. E.I Parkhomenko – 1967 Electrical properties of Rocks – Plenum Press, New York.
7. Keller and Frischkeicht , 1966, electrical methods in Geophysical prospecting Pergaon
8. Stansilav Mares et al.. 1984, Introduction to Applied Geophysics , D. Reidel
9. D.S Parasnis, 1977, Introduction to Applied Geophysics, Published by Chapman &Hall , London.
10. Patra and Bhattacharya 1969 , Direct Current Geoelectrical Sounding , Elseivier

**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.

#### Reference Books:

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.

**Paper IV    COMPUTER PROGRAMMING AND SOFTWARE  
APPLICATION IN GEOSCIENCES**

Credits 4

**Unit-I:** Fundamentals of Operating systems and Introduction to Language: Operating system (DOS, Windows, LAN, WAN, Linux) – Languages. Computer and Programming concepts: Algorithms and Flow charts – Programming fundamentals – (Constants variables, Operators and Expressions) – Programming statements – (Branching and Looping, Arrays, Functions and Procedures) – File Handling. Problems solving with computers using C/C++.

**Unit-II:** Introduction to efficient use of Matlab as a tool for research in Engineering and Earth Sciences- 2D and 3D visualization features-Numerical capabilities - Matlab toolboxes addressing problems in widely applicable areas.

**Unit-III:** Basic Statistics: Frequency distributions, Cumulative Frequency distribution and Frequency curves, measures of central tendencies – (Mean, Median and Mode) – Measures of dispersion – (Range, Mean deviation, Quintile deviation variance and Standard Deviation) moments.

**Unit-IV:** Regression Analysis – Linear correlation coefficient – Linear Regression – Partial and Multiple correlation coefficient – Factor analysis – Principal component analysis – Discriminant function analysis – Canonical correlation – Empirical Orthogonal functional analysis.

**Unit-V:** Test of Significance: Large and small tests for Mean, Proportion and Variance and correlation coefficient – Concept of modeling: Fundamentals of Modelling – Types of Modelling – (Parametric – Stochastic – predictive types and illustrations)

**Reference Books:**

1. Urray R. Spiegel, 1972: Theory and Problems of Statistics, Schaum's Outline series – McGraw Hill Book Company.
2. Sizeh, B, 1987: Use and Abuse of Statistical Methods in the Earth Science, Oxford University Press, Oxford.
3. Davis, A. C., (1973), Statistics and data analysis in Geology, Wiley & Sons.
4. Isaake, E. & Srivastava, R., An introduction to Applied Geostatistics, Oxford University Press, NewYork, 1989.
5. 8)William, Palm Introduction to Matlab for Engineers
6. 9)Amos Gilat, MATLAB; An introduction with applications
7. 10)Balagurusamy.E., Objected Oriented Programmings
8. E. Balagurusamy, 2007, Programming in ANSI C, Fifth edition,.
9. Mike Meyers & Scott Jernigan,2004, Operating SystemsTataMcgraw-Hill edition,
10. Andrew.S. Tanenbaum., 2010, Modern Operating system, PHT learning Private Limited, New Delhi.
11. Marc E. Herniter, 2003, Programming in MATLAB, Thomson Asia pre Ltd, Singapore,.
12. Brian R.Hunt, Ronald L Lipsman, Jonathan M. Rosenberg, 2008, A Guide to MATLAB For Beginners and Exerience User, Cambridge University Press, Cambridge.



**Unit I:** Crystal systems, Chemistry of minerals, atomic bonding. Structural classification of Silicate minerals and their compositional variations, rock-forming and economic minerals- Major silicate mineral groups (quartz, feldspar, pyroxene, amphibole, mica, olivine and garnet) and their diagnostic properties- Basic optical mineralogy.

**Unit II:** Introduction – Types of Rocks – Igneous Rocks: forms of Intrusive and extrusive igneous bodies – structures and textures – its classification- Properties of magma. Bowen's reaction series- Magmatism in relation to tectonic settings, radioactivity & dating of rocks.

**UNIT III:** Metamorphism, agents of metamorphism, types of metamorphism, metamorphic reactions, metamorphic textures and structures. Classification of metamorphic rocks based on chemical composition and mineralogy. Grades and zones of metamorphism. Metamorphic facies

**Unit IV:** Formation of sediments & sedimentary rocks: their compositions, textures & structures; origin & classification of conglomerate, sandstone, shale & limestone; sedimentary environments & facies; characteristics of non-marine, transitional & marine environments.

**Unit V:** Principles of stratigraphy: law of order of superposition. law of uniformitarianism and law of faunal succession. Standard stratigraphic scale and Indian Geologic Time scale. Imperfections in Geological record. Geological divisions. Precambrian Stratigraphy: Mineral Wealth of Cuddapahs, Vindhya, Kurnool group. Paleozoic Stratigraphy: Paleozoic rocks of Peninsular India, Mesozoic Stratigraphy: economic importance of Gondwana formations of India, Coastal Gondwana of India, Gondwana formations of Tamilnadu- Cretaceous of Tiruchirapalli - Deccan traps. Cenozoic Stratigraphy:

**Reference Books:**

1. Mukerjee, P.K. A Textbook of Geology, World Press, 1997.
2. Rutley, F. Elements of Mineralogy, CBS, 1991.
3. Tyrrel, G. W. The Principle of petrology – Chapman and Hall Ltd, London, 1998.
4. Winter. J. D. Igneous and metamorphic petrology, 2001.
5. Pettijohn, F.J. Sedimentary rocks, III Ed., Harper & Row, 1975.
6. Sengupta, S.M. Introduction to Sedimentology, Oxford & IBH, 1994.
7. Krishnan, M.S. Geology of India and Burma, CBS Publ. & Distr., 1982.
8. Ravindra Kumar Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern. 1985.

**Unit I:** A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies Principles of mineral prospecting and exploration - conceptualization, methodology and stages; sampling, subsurface sampling including pitting, trenching and drilling, core and non-core drilling, sampling and assaying. Gravity, electrical, magnetic, airborne and seismic methods of exploration, planning of bore holes and location of bore holes on ground..

**Unit II:** Guides for locating ore deposits: structural, lithological, stratigraphic and physiographic guides. Surface and Sub-surface exploration: use of diamond drilling in exploration; Resource, reserve definitions; mineral resource in industries - historical perspective and present. methods of ore reserve estimations; recoverable reserves and anticipated life of the deposits.

**Unit III:** Application of Geophysical techniques, Geomorphological and remote sensing techniques and Geobotanical and geochemical methods. Application of geostatistical techniques in Mineral Exploration.

**Unit IV:** Mining methods; surface and underground mining methods; factors in selection of open cast and underground mining methods. coal mining methods: room and pillar method, long wall method. Environmental aspects of Mining activities. Petroleum exploration; geological, reservoir rocks, geochemical and geophysical methods of exploration.

**Unit V:** Principles of mineral economics: Strategic, critical and essential minerals. Mineral production in India. Changing pattern of mineral consumption. National mineral policy. Mineral concession, rules, marine mineral resources and Law of Sea.

## Reference

1. Sharma, P.V., 1986: Geophysical Methods in Geology. Elsevier
2. Sharma. P.V., 1997: Environmental and engineering Geophysics, Cambridge University Press
3. Stanislave, M., 1984: Introduction to Applied Geophysics, Reidel Publ
4. Turaga, S.P., 2006. Drilling Fluids, their composition, function and properties, Centre for Rural Development and Environmental Studies (Pub.), Secunderabad.
5. Govett, G.J.S.(Ed) 1983: Handbook of Exploration Geochemistry Elsevier.
6. Mckinstry, H. E., 1962: Mining Geology. II Ed. Asia Publishing House
7. Hunt, J.M., Petroleum Geochemistry and Geology, 1996, 2<sup>nd</sup> Edn. W. H. Freeman, San Francisco.

**Paper VI**

**PRACTICAL – GEOLOGY OR MINERAL EXPLORATION /  
ELECTRICAL AND ELECTRO MAGNETIC PROSPECTING / REMOTE  
SENSING & GIS**

Credits 2

- 1) Megascopic and microscopic identification of common silicate and ore minerals
- 2) Megascopic identification of common rocks
- 3) Computation of Resistivity profiling curve with a Two Electrode spread over a vertical contact
- 4) Computation of Resistivity profiling curve with a three Electrode spread over a vertical contact.
- 5) Computation of Resistivity profiling curve with a four electrode spread over a vertical contact.
- 6) Analytical and Graphical construction of VES curves.
- 7) Application of curve matching techniques in interpretation of VES curves
- 8) Computer interpretation of VES data
- 9) Computation and interpretation of S.P. anomaly over a sphere.

## II Semester

### Paper VII GEOPHYSICAL SIGNAL PROCESSING AND INVERSION

Credits 4

**Unit I:** Continuous and discrete signals, operation on signals, linear and time invariant systems, digitization, sampling interval and aliasing, Dirac delta function and impulse response of a linear system, impulse response function, Z-transform, properties of Z-transform, wavelets, minimum delay, maximum delay and mixed delay wavelets.

**Unit II:** Fourier series, Orthogonal function and Dirichlet conditions, Fourier transform, properties and applications of FT, Fourier transform of a symmetrical rectangular pulse, reciprocity, Interpretation of geophysical data using Fourier transform,

**Unit III:** Convolution, methods for convolution, properties of convolution, autocorrelation, crosscorrelation, and their applications, time domain and frequency domain concepts. Deconvolution.

**Unit IV:** Analog filters – Butterworth, chebyshev and elliptic, Low-pass, high-pass and band-pass digital filter designs, Gibb's phenomenon, Recursive filters. Wiener inverse filtering and its mathematical details, homomorphic applications of deconvolution filtering. Windowing - Triangular, Hanning and Hamming window, Bartlett window, Parzen window, Daniell window, practical applications of windows

**Unit V:** Inversion Theory: Introduction, Fundamentals of Inversion, Linear Inversion, Non Linear Inversion, Incorporating prior information, Parametric Inversion, Assessing the uncertainty in inverted models.

#### Reference Books:

1. Silvia & Robinson : Deconvolution of Geophysical Time Series in the Exploration for Oil and Natural Gas
2. Robinson & Trietel : Geophysical Signal Analysis
3. Kanasevich : Time Sequence Analysis in Geophysics
4. Bath : Spectral Analysis in Geophysics
5. Oppenheim & Schafer : Digital Signal Processing
6. Papoulis: The Fourier Integral and its Applications
7. Bracewell, R. The Fourier Transform and its applications McGraw Hill
8. W. Menke, Geophysical data analysis: Discrete inverse theory, Academic Press,
9. International Geophysical series, Vol. 45, 1989.
10. J. A. Scales, M. L. Smith and S. Trietel, Introductory Geophysical Inverse Theory,
11. Samizdat Press, Golden Colorado, USA, 2001
12. D. Gubbins, Time series analysis and Inverse theory for Geophysicists, Cambridge
13. Univ. Press, 2004.
14. A. Tarantola, Inverse Problem Theory, Elsevier Publishers, New York, 1987.

**Unit I:** Water on earth; Types of water — meteoric, juvenile, magmatic and sea water; Hydrological Cycle and its components; Water balance; Water-bearing properties of rocks — porosity, permeability, specific yield and specific retention; Vertical distribution of water; Zone of aeration and zone of saturation; Classification of rocks according to their water-bearing properties; Aquifers; Classification of aquifers and aquifer parameters

**Unit II:** Theory of groundwater flow; Darcy's law and its applications; Determination of permeability in laboratory and in field; Flow through aquifers; steady, unsteady and radial flow conditions; Evaluation of aquifer parameters of confined, semi-confined and unconfined Aquifers.

**Unit III:** Groundwater levels: Fluctuation of water table and piezometric surface, water table contour map. Groundwater Quality; properties of water , quality criteria for different uses, graphical representation of groundwater quality data, groundwater quality in different provinces in India, groundwater contaminants: natural and anthropogenic contaminants.

**Unit IV:** Groundwater modeling; geochemical, mathematical and analog models. Saline water intrusion. Over exploitation of groundwater and groundwater mining, groundwater problems in urban areas, climate change impact on groundwater resources. Groundwater management and groundwater legislation.

**Unit V:** Geological and hydrogeological methods of groundwater exploration; Geophysical exploration methods - geo-electrical, seismic, gravity and magnetic methods. Role of remote sensing in groundwater exploration.

### Reference Books:

1. Groundwater by Raghunath H.M
2. Groundwater hydrology by Todd D.k
3. Groundwater hydrology by M. Karamouz
4. Remote sensing and Geospatial information system by A.M. Chandra & S.K Ghosh
5. Outlines of Geophysical Prospecting – A Manual for Geologists by M.B. Ramachandra Rao
6. Applied Geophysics, Cambridge University Press, Cambridge Telford, W.M. Geldart, L.P. Sheriff, and Keys, D.A. 1981.

**Unit – I :** Seismic source theory – wave propagation, Historical Development and Background of Refraction and Reflection Methods, Difference between Refraction and Reflection Surveys, Propagation of Seismic waves in Linear and Nonlinear medium, N Layered case, continuous increase of velocity. Waveforms and their characteristics, Elastic wave velocities in rocks. Stress, Strain, elastic constants.

**Unit – II:** Basics of Seismic data Acquisition systems, Energy sources - explosive and non explosive sources, Zoepritz's equation Seismic operation on Land, Grouping of Geophones and shot points. Recording formats, Different types of Display of Digital and Magnetic Recordings, Wiggle Trace, Common Depth Point technique.

**Unit – III:** Sequence of Digital Seismic data Processing, Seismic data reduction, static and dynamic corrections Analysis of Multiples and Ghost Reflections, Processing of Seismic Data Imaging, Time and Depth Sections, Seismic Inversion, Migration Techniques – Wave Velocities.

**Unit – IV:** Synthetic Seismograms, Processing and interpretation of Refraction Seismic data – Methods based on first and later arrivals, Hidden layer. seismic stratigraphy, introduction to 3D seismic.

**Unit – V :** Introduction to SASW and MASW. Data acquisition and processing concepts of MASW. Application of Seismic methods in Hydrocarbon, Mining, Groundwater.

#### Reference Books:

1. Yilmaz, O, 1987, Seismic Data Processing, SEG Publication.
2. Dobrin M.B. Savit C.H. 1988 Introduction to Geophysical Prospecting. Mc. Graw Hill Book Company, Singapore.
3. Telford, W.M. Geldart, L.P. Sheriff, and Keys, D.A. 1981. Applied Geophysics, Cambridge University Press, Cambridge.
4. Sheriff. R.E. and Geldart. L.P. 1987 Exploration Seismology, Vol. 1. Cambridge Univ. Press, Cambridge.
5. Sheriff. R.E. and Geldart. L.P. 1987 Exploration Seismology, Vol. 1. Cambridge Univ. Press, Cambridge.
6. Anstey N.A., 1971, Seismic Prospecting Instruments Vol. II Gebrudev Borntraege Berlin, Stuttgart.
7. Evenden, B.S. and Stone, D.R., 1971, Seismic Prospecting Instruments, Gebrudev Borntraege, Berlin, Stuttgart.
8. Sheriff. R.E. 1989, Geophysical Methods, prentice Hall, Englewood cliffs. New Jersey.
9. Att. Balch and M.W. Lee, 1984, Vertical Seismic Profiling. Technique, Applications and casehistories, D. Reidal Publishing Company, Boston, USA.
10. Robinson, E.A., 1988, Migration of Seismic data SEG Publication
11. Verma, R.K. 1986, Offshore Seismic Exploration Gulf Publishing Co.,Gurvitch, II, Seismic Prospecting Mir Publications

**Unit – I:** Basic equations and Earth's gravity field – Measurement of gravity: Absolute gravity and Relative gravity - Basic equations and units of magnetic field - Susceptibilities and densities of various rocks and minerals - factors affecting density and susceptibilities - density and susceptibility determination. Normal gravity field Clairaut's theorem; Shape of the earth

**Unit – II:** Gravity prospecting instruments: Stable and unstable gravimeters, borehole and airborne gravimeters. Magnetic prospecting instruments: flux gate, proton precession and Rubidium vapour magnetometers

**Unit – III:** Reduction of gravity data, latitude effect, Free-air effect, Bouger correction, topographic correction and various types of gravity anomaly; regional and residual separation, concept of isostasy and isostatic anomaly, principle of equivalent stratum, Excess mass calculations. The gravity anomaly over simple geometric shapes

**Unit – IV:** Corrections applied to magnetic field - The magnetic field over simple geometric shapes - Relation between gravity and magnetic potentials, curve matching techniques. Transformation of gravity and magnetic anomalies in frequency domain, spectral representation of field data.

**Unit – V:** Quantitative interpretation of gravity and magnetic anomalies over simple geometric shapes. Applications of gravity and magnetic prospecting in oil/gas, mineral and groundwater exploration – Applications in geological / structural mapping. Forward modelling and inversion of arbitrary shaped bodies and 2-D, 3-D interfaces. Interpretations in frequency domain.

**Reference Books:**

1. Stanislav Mares et al., 1984. Introduction to Applied Geophysics, D. Reidel Publishing Company, Dordrecht/Boston.
2. Telford, W.M., Goldart, L.P., Sheriff, R.E. and Keys, D.A., 1981. Applied Geophysics, Cambridge University Press, Cambridge.
3. B.S.R. Rao and I.V.R. Murthy. 1978. Gravity and Magnetic Methods of Prospecting, Arnold-Henninman Publishing Company, Delhi.
4. S.H. Ward (Ed.). 1967. Mining Geophysics, Vol. I and Vol. II., SEG Publication, Tulsa, Oklahoma, USA.
5. Grant, F.S. and West, G.F. 1964. Interpretation Theory in Applied Geophysics, McGraw Hill Publication, New York.
6. D.S. Parasnis. 1973. Mining Geophysics, Amsterdam, Elsevier Publishers, The Netherlands.
7. L.L. Nettleton. 1976. Gravity and Magnetics in Oil Prospecting, McGraw Hill Publication, New York.
8. V.L.S. Bhimasankaram and V.K. Gaur. 1978. Lectures and Exploration Geophysics, AEG Publications, CEG, Osmania University, Hyderabad.
9. I.V. Radhakrishna Murthy and D.C. Mishra. 1989. Gravity and Magnetic Anomalies in space and frequency domain, AEG Publications.
10. Edwin S. Robinson and Cahit Coruh. 1988. Basic Exploration Geophysics. John Wiley and Sons, New York/Toronto/Brisbane/Singapore.

**Unit-I :** Concept of Tectonics-Continental drift and the origin of Plate Tectonic theory- Pangea, Gondwanaland and the supercontinent hypothesis-Tectonics on a Sphere-Palaeomagnetism and past plate motions with emphasis on the history of modern oceans. Components of the oceanic lithosphere – ridges, transform faults, trenches and oceanic islands.

**Unit-II:** Geosynclines, Isostasy, Island arcs, Deep sea trenches, Continental drift, Sea floor spreading and Plate tectonics. Plate subduction and convergent plate tectonics. Orogeny and orogenic cycles – Epeirogeny and evolution of plateaus. Structural and tectonic features of India–Quaternary tectonics.

**Unit – III:** Introduction to seismology. Fundamentals of wave motion. Seismic waves types. (Body waves. Surface Waves,). Seismic wave propagation. Huygen's principle and Fermat's principle. Free oscillations of the Earth, the internal Structure of the Earth. Introduction of earthquake focal mechanism. Types of Earthquakes- Tectonic, Volcanic, Collapse and explosion., Micro earthquakes. Reservoir induced earthquakes. Seismic zoning. Earthquake effects and hazards.

**Unit IV:** Seismometry: Introduction, Principle of Seismometer, Historical seismographs. Long period seismometers and Short period seismometers. Vertical motion seismometer and Horizontal motion seismometer. Broad Band seismometer, Analog recorders. Digital recorders. Selection of seismograph stations. Global seismic network .

**Unit V:** Seismogram Interpretation, Earthquake intensity Magnitude, Frequency, Energy released in an earthquake. Epicenter determination. Analysis of earthquake focal Mechanism. Earthquake location- Graphical method of locating local earthquakes and Location of earthquake by Geiger method. Earthquake prediction and precautions.

### **Reference**

1. Fundamentals of Geophysics, William Lowrie
2. Telford, W.M., Goldart, L.P., Sheriff, R.E. and Keys, D.A., 1981. Applied Geophysics, Cambridge University Press, Cambridge.
3. Introduction to Seismology, Perry Byrle
4. The Mechanics of Earthquakes-faulting, Scholtz.C.H.
5. An introduction to the theory of seismology, Bullen. K.E.
6. Quantitative seismology: theory & methods, Aki. K. and Richards. P.G
7. Haakon Fossen (2010), Structural Geology, Universiteteti Bergen, Norway,
8. David D. Pollard, Raymond C. Fletcher (2005), Fundamentals of Structural Geology,
9. David Gubbins (1990), Seismology and Plate Tectonics.



**Paper XI      DISASTER MANAGEMENT      (Elective major)      credits 3**

**Unit –I:** Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

**Unit -II:** Study of Environmental Impacts Induced By Human Activity; History of Disasters and Types of Hazards: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches. Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

**Unit -III:** Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics. Types of News Media, Structure and Trends, News Media during Crisis, Impact of Media on Policy.

**Unit IV :** Disaster Management Concepts : Meaning of disaster, elements and Scope of disaster management, Approaches to disaster management, Disaster Management Cycle, Disaster Law and Policy related to disaster prevention, emergency response, compensation & insurance, human rights, and community recovery, relief policy and procedure; exploring the legal issues, Disaster Law and Policy, features: legal analysis of issues emerging from disastrous events the causes of disasters and their relationship to laws, designed to protect health, safety, and the environment.

**Unit V :** Other related Acts and policies of India; Map policy of India, Remote Sensing Policy, RTI Act, Privacy Act, Groundwater Act, Mines & Mineral Act, Atomic Mineral Act, Oil & Natural Gas Act (including coal), Environmental Pollution and Prevention Act, Wildlife Act, Forest Act, Western Ghats Ecosystem act, National Biodiversity Act, National Marine Biodiversity act, Marine Environmental Act, Integrated Coastal Zone Regulation, Offshore Mining Regulation, Law of the Sea, Maritime Law; National Data sharing & accessibility policy.

**Reference**

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Central Water Commission, 1987, Flood Atlas of India, CWC, New Delhi.
4. Central Water Commission, 1989, Manual of Flood Forecasting, New Delhi.
5. Sharma, Kadambari C, Avina 2010 Disaster Management in India Jnanada Prakashan [P&D], New Delhi
6. Mishra A 2012 New Dimensions of Disaster Management in India: Perspectives Approaches and Strategies (Set of 2 Vol) Serials publications, New Delhi
7. Disaster Law and Policy, Wolters Kluwer Law & Business/Aspen Publishers, 2010
8. The Disaster Management Act (2005) National Act, Rules and Notifications) along with State DM Rules and Notification

**Paper XIII**

**PRACTICAL - GRAVITY AND MAGNETIC PROSPECTING/ SEISMIC PROSPECTING /GEOPHYSICAL SIGNAL PROCESSING AND INVERSION**

Credits 2

1. Reduction of field gravity data
2. Construction of gravity profiles on some simple geometrical models
3. Computations pertaining to basement depth estimation from gravity
4. Ore – lode estimation from gravity anomaly using gauss theorem
5. Construction of travel time of direct and refracted and reflected waves (Horizontal layer)
6. Construction of travel time curves of direct and refracted and reflected waves (Dipping layer)
7. Processing and interpretation of given refraction and reflection seismograms
8. Velocity analysis
9. Signal and noise statistics from seismic traces
10. Study of the seismic refraction/reflection unit
11. Processing and interpretation of acquired shallow depth seismic refraction data
12. Noise estimation using Auto and cross correlations
13. Hilbert transform
14. Amplitude and phase characteristic of digital filter

## Semester III

Paper XIV

### WELL LOGGING

Credits 4

**Unit I:** Porosity, permeability, fluid saturation, drilling fluids and its properties, invasion process and various profiles, classification of formation evaluation methods, objective of well logging methods, logging operational field system and its procedure.

**Unit II:** Electric Logging : Spontaneous Potential (SP) logging: Spontaneous potentials in boreholes and its sources, SSP and its measurements, SP curves and its interpretation, factors affecting the shape and amplitude of SP curve, Non-focussed, focussed and induction logging, principle of sonde, Interpretation of Electric Log Data : Determination of resistivity of interstitial water  $R_w$ , porosity and water saturation  $S_w$  of clean and shaly sandstones, determination of  $R_w$  of clean sandstone from SP curve, estimation of permeability.

**Unit III:** Gamma ray logging, details of the radiation logging, density or gamma-gamma logging, principle of the neutron-gamma logging, neutron-epithermal-neutron logging, neutron-thermal-neutron logging, interpretation and applications of radiation logging for evaluation of reservoir characteristics.

**Unit IV :** Acoustic velocity (Sonic) logging, Cement Bond Log (CBL), Litho-density Tool (LDT), thermal log, caliper or section gauge log, Casing Collar Locators (CCL), dip and direction logging, gravity logging, nuclear magnetic resonance logging.

**Unit V:** Resistivity-porosity cross plots, Porosity Cross plots: neutron – density, sonic density and sonic neutron density cross plots. Application of well logging to ground water, mineral and petroleum resource

#### Reference Books:

1. Lynch : Formation Evaluation
2. Wyllie : Fundamentals of Well Log Interpretation
3. Vaish : Geophysical Well Logging : Principles and Practices
4. Schlumberger : Schlumberger Log Interpretation Principles / Applications
5. Schlumberger : Schlumberger Log Interpretation Charts
6. Serra : Fundamentals of Well-log Interpretation
7. Pirson : Hand book of Well log Analysis for Oil and Gas formation Evaluation
8. Deveton : Log analysis of Subsurface Geology : Concepts and Computer Methods

**Unit-I :** Waves, tides, currents, turbidity currents, long shore currents, rip currents, circulation, wave reflection, refraction and diffraction – Seiche and tsunamis – Causes of marine regression and transgression – Description of important regressions and transgressions in the geological past – Eustacy — Abyssal plains and its various topographic features – ridges, seamounts, guyots, mud banks – Evolution and classification of sea coasts and shore lines.

**Unit-II :** Origin, morphology and distribution of ocean basins – mid-ocean ridge systems – Raised and sunken features – Palaeo-ocean basins. Littoral processes – Evolution of headlands and bays – Beaches, continental shelves, continental slopes, trenches and canyons - Marine Sedimentation – Sources and distribution of sediments – Transport of sea bottom sediment – Rate of deposition – Mineral resources of the oceans and the factors controlling their distribution. Stratigraphy and geochronometry of deep-sea deposits – phosphorite, glauconites, barium sulphate concentrations, polymetallic nodules – Beach placers.

**Unit-III :** Physio-chemical characteristic of sea water – distribution of temperature, salinity and density for sea water – diagenetic changes in oxic and anoxic environments – mobility of redox metals – sedimentary markers of palaeo environmental conditions – chemistry of oceanic rocks. Formation of subtropical gyres; western boundary currents; equatorial current systems; El Nino; monsoonal winds and currents over the North Indian Ocean; Somali current; southern ocean.

**Unit – IV:** Techniques of echo sounding, sound ranging side scan sonar, Finger, Boomer, sparker and pneumatic pulsar profiling. Gravity and magnetic survey over the oceans, Marine magnetic and gravity instruments, reduction of observations, identification of anomalies and interpretation of the data set. sea bed mapping, seabed sampling, dredging and coring, Navigation methods and Position location methods

**Unit V:** Seismic energy sources- Airgun, water guns, Seismic reflection receivers- geophones, hydrophones. Array configuration and advantages. Single channel and multi-channel seismic reflections, Sonobuoys, ocean bottom seismometers (OBH) – Data acquisition and quality control- Seismic data processing. Application of geophysical methods in offshore exploration for oil and natural gas and other minerals.

**Reference Books:**

1. Shephard, F. P., 1973. Submarine Geology, Harper and Row.
2. Kurekian, K.K., 1990. Ocean, Prentice Hall
3. Seabold, E. and Berger, W.H., 1982. The Sea floor, Springer Verlag.
4. King, C.A.M., 1975. Introduction to Marine Geology and Geomorphology. Edward Arnold, London.
5. Radhakrishnan, V., 1996. General Geology, V.V.P Publishers, Tuticorin.
6. Shepard, F.P., 1978 Geological Oceanography, Heinmann, London.
7. Jones, E.J.W.(1994). Marine Geophysics, John Wiley and sons.
8. Reynolds J.M.(1997) An Introduction to Applied and Environmental Geophysics

**Unit-I :** Aims of Environmental Geotechnology – Environment cycles and their interaction with Geotechnology - Man made Environment – Environmental Geotechnical problems

**Unit-II :** Shrinkage, Swelling and Cracking characteristics of soil - Hydraulic conductivity - Infiltration, Percolation and Retention – Thermal conductivity and Resistivity of soil – Fundamentals of Soil Electrochemistry

**Unit-III :** Radioactive Decay Process – Environmental Geotechnical Aspects of Radiation – Radioactive and toxic radon gas- Nuclear waste disposal – Utilization of nuclear energy for construction applications - Soil compaction – Dynamic consolidation – Stress-Strain- Strength characteristics of soil – Soil dynamics

**Unit-IV :** Soil structure vs Structure - Soil Interactions. Load , Factor of safety and allowable condition – Bearing capacity of Ground Soil – Underwater Foundation Problems

**Unit-V :** Beaches and Beach Erosion – Salt water intrusion, Estuaries – Marine sediments and sea floor problems – Dredging and dredging material – Water erosion – Wind erosion – Erosion controls in Construction areas

**Reference Books:**

1. Introduction to Environmental Geotechnology – Hasi – Yang Fang – CRC press, 1997
2. N. ChennaKesavulu (2009) Textbook of Engineering Geology
3. Parbin singh, (2008) Engineering and general Geology, Kataria & Sons. NewDelhi
4. Sathya Narayanaswami, B.S (2000) Engineering Geology, Dhanpat Rai & Co.Pvt.Ltd, New Delhi
5. Perry H. Rahn (1996) Engineering Geology: an environmental approach
6. Fred G. Bell (2004) Engineering Geology and Construction, CRC Press
7. Roberts, A., Geotechnology, Pergamon, 1961

**Unit-I:** Coal: Definition and origin of coal. Sedimentology of coal bearing strata – Rank, grade and type of coal – Indian and International classifications, Chemical characterization: Proximate and ultimate analyses – Macroscopic ingredients and microscopic constituents, concept of ‘maceral’ and microlithotypes.

**Unit-II:** Coal petrology, and its applications in solving industrial and geological problems – Preparation of coal for industrial purposes – coal carbonization (Coke manufacture), coal gasification and coal hydrogenation . Application of coal petrology in hydrocarbon exploration

**Unit-III:** Coal Bed Methane - new energy resource – maturation of coal and generation of methane in coal beds – coal as reservoir – fundamentals of coal bed methane exploration and production . Coal forming epochs in the geologic past geological and geographical distribution of coal deposits in India – Detailed geology for some important coal fields of India

**Unit IV:** Petroleum: - its composition and different fractions - Origin, nature and migration (primary and secondary) of oil and gas – Transformation of organic matter into kerogen, organic maturation, thermal cracking of kerogen - characteristics of Reservoir rocks and traps (structural, stratigraphic and combination)– Prospecting for oil and gas, drilling and logging procedures – Oil bearing basins of India and the world. Geology of the productive oilfields of India – Position of oil and natural gas in India

**Unit- V:** Atomic fuel: Mode of occurrence and association of atomic minerals in nature. Atomic minerals as a source of energy – Methods of prospecting and productive geological horizons in India – Nuclear power stations of the country and future prospects.

#### Reference Books:

- 1) Chandra D, Singh, R.M Singh , M.P., 2000 :Text book of coal(Indian context) Tara book agency, Varanasi
- 2) Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert, P., 1998: Organic Petrology. GebruderBorntraeger, Stuttgart.
- 3) Singh, M.P. (Ed.), 1998: Coal and Organic Petrology. Hindustan Publ. corp., NewDelhi.
- 4) Holson, G.D and Tiratso, E.N 1985 , Introduction to petroleum geology. Gulf publishing, Houston, Texas
- 5) Durrance, E.M., 1986: Radioactivity in Geology. Principles and Application. Ellis Hoorwool.

**Paper XIX PRACTICAL – MARINE GEOPHYSICS / WELL LOGGING**

Credits 2

1. Beach Profiling and Sediment Budgeting
2. Computation of wave patterns and current velocity
3. Sedimentological analysis – Grain size, Clay analysis ,
4. Micropaleontological analysis – Picking and mounting of microfauna
5. Compute the volumetric producible hydrocarbon reserves and estimate the formation pressure and geothermal gradient using well logging data.
6. Determination of formation water resistivity using SP log data.
7. Compute and locate the hydrocarbon saturation using Ratio method.
8. Compute a borehole logging data to estimate porosity from density measurements.
9. Computation of M-N\* crossplot using lithology mapping techniques.
10. Determination of water saturation, cementation factor and matrix parameters for porosity logs using Pickett crossplot method.
11. Determination of hydraulic conductivity on soil.

**Paper XX PROJECT AND VIVA VOCE**

Credits 24

## **ELECTIVES TO BE OFFERED TO OTHER DEPARTMENTS (NON-MAJOR)**

**Paper XII      GPS TECHNOLOGY      Elective (Non Major)      Credits 3**

**Unit I :** History of the Global positioning system – Development of Global surveying Techniques – Over view of GPS – Reference system.

**Unit II :** Satellite orbits : orbit description – orbit determination – orbit dissemination.

**Unit III :** Satellite signal : signal structure – signal processing.

**Unit IV :** Observative : Data acquisition – Data combinations – Atmospheric effects – Relative effects – multipath.

**Unit V :** GPS survey – planning – surveying procedure – Insitu data processing – Application of GPS – survey report.

### **Reference Books**

1. B.Hofmann – wellenhof, H.Lichfenegga and J.Collins; GPS theory and practice – Springer, 2007.
2. Ackroyd.N, Lorimer.R. Global Navigation – a GPS user's guide – Lloyds of London, 1990.
3. Kanla,W.M. Theory of satellite geodesy Blaisdell, Toronto, 1966.
4. Logsdon.T. The NAVSTAR Global Positioning system. Van Nostrand , Rein hold, NewYork, 1992.



**Paper XVIII      REMOTE SENSING - Elective (Non Major)**

Credits 3

**Unit I:** Fundamental Concepts of Remote Sensing – Sensor – aerial photography.

**Unit II:** Satellite remote sensing – Landsat – SPOT – IRS – ERS-1 – JERS1 – Radarsat – IKONOS – Quick Bird – Satellite data products – Guidelines for selection of data products.

**Unit III:** Interpretation of Remote Sensing – Digital Image Processing.

**Unit IV:** Remote sensing application : Agriculture – Forestry – water resource – Geology and Mineral Resources – Land use & Land cover – hazards.

**Unit V:** Concept of GIS – use of remote sensing data in GIS – Spatial elements – Data Encoding & storage – Data manipulation – Data output.

**Reference Books**

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 airphoto 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 Kieffner.R.W. Remote sensing and Image Interpretation, Willey, Newyork.
6. Miller.V.C Photogeology, McGraw Hill – London, 1961.