

511. GEOPHYSICS

UNIT-I

Mathematics:

TENSORS: Introduction, Definition, Contraction, Direct product, Quotient rule, Pseudo tensors, Dual Tensors, Studies of some Geophysical examples.

ANALYTIC FUNCTIONS: Functions of a complex variable. Mappings Limits. Theorems on Limits, Continuity Derivatives. Differentiation Formulas. The Cauchy Riemann Equations, Sufficient conditions. The Cauchy–Riemann Equations in polar Form. Analytic Functions Harmonic Functions. Principles of Fourier Series and Fourier Integral transform and their applications

Numerical analysis and inversion: Numerical differentiation and integration, finite element, and finite difference techniques; Simpson's rules; Gauss' quadrature formula; initial value problems; pattern recognition in Geophysics. Well posed and ill-posed problems; method of least squares; direct search and gradient methods; generalized inversion techniques; singular value decomposition; global optimization.

Signal Processing: Continuous and discrete signals; Fourier series; linear time invariant systems with deterministic and random inputs; band limited signal and sampling theorem; discrete and Fast Fourier transform; Z-transform; convolution; Filters: discrete and continuous, recursive, non-recursive, optimal and inverse filters; Principles of digital filtering, Concepts of low pass, high pass, and band pass; deconvolution, relation between Z and Fourier transforms, Hilbert transform, analytic signal, Amplitude, phase, instantaneous frequency and envelope of time series. Radon, Walsh and Mellin transforms, their discrete transforms and properties.

UNIT-II

Geology:

Fundamentals of Mineralogy: Basic concepts of Mineralogy, Physical and optical properties of minerals. Isomorphism and polymorphism, Solid Solution, Silicate Structure, and classification of minerals; A brief study of the physical properties and Chemical Classification, and Mode of occurrence of the following rock forming minerals.

Olivine, Augite, Hypersthene, Hornblende, Actinolite, Orthoclase, Microcline, Albite, Quartz, Biotite, Muscovite, Garnet, Chlorite, Calcite, Talc, Tourmaline, Beryl, Corundum, Kyanite and Magnetite.

Petrology: Definition & classification of rocks, Igneous rock-forms of igneous bodies.

classification and association of igneous rocks. Sedimentary rock classification, texture and structure. Metamorphic rock classifications and texture and structures.

Structural Geology: Concept of stratum, Contour, Outcrop patterns, maps and cross sections. Strike, dip and apparent dip. Classification of folds, faults, joints, foliation and lineation.

Economic Geology: Ore minerals, gangue, ore and ore deposits. Syngenetic and epigenetic mineral deposits, concepts of magmatic, hydrothermal, sedimentary deposits, residual and Mechanical concentration and respective types of ore mineral occurrence. A brief study of distribution, lithology and economic importance of following geological groups of India: Cuddapah, Kurnool, Gondwana and Deccan Traps.

Stratigraphy: Principle of stratigraphy, Standard geological time scale, Principles of correlation: Physiographical sub-divisions of India.

Plate Tectonics: Plate tectonics hypothesis; plate boundaries.

Remote Sensing and GIS: Principle of Remote sensing, EM spectrum, Remote sensing observation platforms, characteristics of remote sensing sensors. Satellites, types of satellites, data reception, characteristics of IRS satellites. Elements of photogrammetry, elements of photo-interpretation, geological interpretations of air photos and imageries. Global positioning systems. GIS- data structure, attribute data, thematic layers.

Hydrogeology: Groundwater, Darcy's law, hydrological characteristics of aquifers, hydrological cycle. Hydrological classification of water-bearing formations. Fresh and salt-water relationships in coastal and inland areas. Groundwater exploration and water pollution. Groundwater regimes in India.

UNIT-III

Introduction to Geophysics: Geophysics and its importance among earth Sciences.

Paleomagnetism: Natural Remanent Magnetisation, Measurement of direction and intensity of NRM. Continental drift and polar wander curves.

Petrophysics: Different physical and Engineering properties of rocks, Laboratory measurements of the physical properties of rocks namely Density, Seismic wave velocities, magnetic susceptibility, Electrical resistivity, thermal conductivity, porosity and permeability.

Seismology: Natural and Artificial seismology and its relation to other Earth System sciences. Classification of Earth quakes, Causes and propagation of Different seismic wave and fundamental laws. Various methods for determination of focal depth and epicentral location. Interior of the Earth and Earth quake prediction. Concepts of Geodynamics.

Gravity and Magnetic Methods: Normal gravity field; Clairaut's theorem; Shape of the earth; deflection of the vertical, geoid, International gravity formula. Gravimeters and magnetometers; data acquisition from land, air and ship; corrections and reduction of anomalies; Concept of anomaly & Definition of micro gravity anomaly. Density of rocks and minerals and their variations. Free-air, Bouguer and isostatic anomalies, isostatic models for local and regional compensation, ambiguity; regional and residual separation; continuation and derivative calculations; interpretation of anomalies of simple geometric bodies, single pole, sphere, horizontal cylinder, sheet, dyke and fault. Forward modelling and inversion of arbitrary shaped bodies and 2-D, 3-D interfaces. Interpretations in frequency domain.

UNIT-IV

Seismic Methods: Generalized Snell's Law; Ray theory; reflection, refraction, diffraction; Zoeppritz's equation; seismic energy sources; detectors; seismic noises and noise profile analysis; seismic data recording and telemetry devices; reduction to a datum and weathering corrections; Interpretation of a refraction seismic data by graphical and analytical techniques; CDP/CMP; seismic reflection data processing, velocity analysis, F-K filtering, stacking, deconvolution, migration before and after stack; bright spot analysis; wavelet processing; attenuation studies, shear waves, AVO; VSP; introduction to 3D seismic; seismic stratigraphy.

Electrical and Electromagnetic Methods: Electrical profiling and sounding, typical sounding curves, pseudo-sections; resistivity transform and direct interpretation; induced polarization methods. Electromagnetic field techniques; elliptic polarization, in-phase and out of phase components, horizontal and vertical loop methods; interpretation; VLF (very low frequency); AFMAG (Audio frequency magnetic) methods; and central frequency sounding; transient electromagnetic methods; magneto-telluric method; geomagnetic depth sounding.

Well logging and other methods: Open hole, cased hole and production logging; Electrical logs; lateral, latero, induction, S.P; porosity logs; sonic, density, neutron; natural gamma; determination of formation factor, porosity, permeability, density, water saturation, lithology; logging while drilling. Radioactive and geothermal methods.

LIST OF RECOMMENDED BOOKS:

- 1) Murray R-SPIGEL, May 1981, Advanced Calculus, Mc Graw Hill, International Book Company, Singapore.
- 2) R.V. Churchill, 1963 Fourier series and boundary value problem, Mc Graw Hill Koga Kusha Ltd., Tokyo.
- 3) Murray R-SPIGEL, 1965, Laplace transforms, Schaum's out line series Mc. Graw Hill, International Book Company, New York.
- 4) L.A. Pipes, 1970, Applied Mathematics for Engineers & Physicists, Mc. Graw Hill, Koga Kusha Ltd., Tokyo.
- 5) B.S. Grewal, 1999, Higher Engineering Mathematics, Khanna Publishers Delhi.
- 6) M.K.Jain, Numerical solution of differential equations. Wiley Eastern Ltd., New Delhi.
- 7) Rutleys, 1991, Elementary of Mineralogy – Revised by Gribble, C.D. CBS, Publishers and Distributors.
- 8) Tyrrell, G.W. 1975, The Principles of Petrology B.I. Publications.
- 9) Billings, M.P.1974, Structural Geology, Printice Hall.
- 10) Krishnan, M.S. 1982 Geology of India and Burma CBS Publishers.
- 11) Jenson, M.L. and Bateman, A.M. 1981, Economic Mineral Deposits – John Wiley & Sons.
- 12) Krishnaswamy S., 1972, India's Mineral Resources – Oxford & IBII Publishing Co.,
- 13) P.V. Sarma, 1976, Geophysical Methods in Geology, Elsevier.
- 14) Howell, 1959, Introduction to Geophysics, Mc Graw Hill Book Co. New York.
- 15) R.E. Sheriff, 1989, Geophysical Methods. Prentice Hall Engle Wood Cliffs. New Jersey.
- 16) I.K. Kaul, S. Senugupta and A.K. Bhattacharya, 1990, General and Applied Geophysics, (An introduction), Associate of, Geophysics.
- 17) F.D. Stacey, 1977, Physics of the Earth, John Wiley and Sons, New York.
- 18) Rezhevsky and Novik, 1971, Physical properties of Rocks, Mir Publications.
- 19) Richter, C.F. 1969, Elementary Seismology, Eurasia Publishing house, Pvt. Ltd. New Delhi.
- 20) Dobrin M.B. Savit C.H. 1988 Introduction to Geophysical Prospecting. Mc. Graw Hill Book Company, Singapore.
- 21) Telford, W.M., Geldart, L.P. Sheriff, R.E. and Keys, D.A. 1981, Applied Geophysics, Cambridge University Press, Cambridge.
- 22) Sheriff, R.E. and Geldart, L.P. 1987 Exploration Seismology, Vol. I, Cambridge Univ. Press, Cambridge.
- 23) Sheriff, R.E. and Geldart, L.P. 1987 Exploration Seismology, Vol. II, Cambridge Univ. Press, Cambridge.
- 24) Sheriff R.E. 1989, Geophysical Methods, prentice Hall, Englewood cliffs,
- 25) Robinson, E.A., 1988, Migration of Seismic data SEG Publication.
- 26) B.S.R. Rao and IVR Murthy, 1978, Gravity and Magnetic Methods of Prospecting Arnold – Henniman Publishing Company, Delhi. 390 P.
- 27) D.S. Parasnis 1973, Mining Geophysics, Amsterdam, Elsevier Publishers,
- 28) The Netherlands, 354 P.
- 29) Grant F.S. and West G.F., 1964, Interpretation Theory in Applied Geophysics Mc Graw Hill Publication, New York.
- 30) L.L. Nettleton, 1967,. Gravity and Magnetics in oil Propoecting McGraw Hill Publication, New York. 464P.
- 31) E.I. Parkhomenko – 1967 Electrical Properties of Rocks – Plenum Press, New York.
- 32) Keller and Frischkeicht, 1966, Electrical methods in Geophysical Prospecting Pergaon.
- 33) Patra and Bhattacharya 1969, Direct Current Goelectrical Sounding, Elsevier.
- 34) Marcus Bath, 1974, Spectral Analysis in Geophysics, Elsevier.
- 35) A Populis, 1962, The Fourier integral and its applications, MC Graw Hill Publishers.
- 36) J.F. Clarbout, 1976, Fundamentals of geophysical data processing. Mc. Graw Hill Publishers.
- 37) E.A. Robinson and S. Treitel, 1983, Digital Seismic inverse methods, D. Reidel Publishing Co.
- 38) Serra ,1986, fundamentals of well log interpretation-2.The acquisition of
- 39) Logging data.,Elsevier Science Publishers ,B.V
- 40) Itenberg,S.S. 1971, Study of oil and gas series from Well logs, Mir. Pub. Moscow
- 41) Schlumberger, 1972 , Essential of log interpretation Practice . Schlumberger France
- 42) Bhimasankaram, V.L.S., Savenko, E.I. and Venkat Rao, N., Centre of Exploration Geophysics,1973. Laboratory and Field Methods of Radiometry and Nuclear Geophysics.
- 43) Bhimasankaram, V.L.S., Venkat Rao, N. Sri Rama Murthy, K, and Savenko, E.I., 1985. Principles and Methods of Nuclear Geophysics, AEG.
- 44) Ward, Ed.S.H., 1990. Geotechnical and Environmental Geophysics, Vol. I, SEG. (pp. 219-286).
- 45) Stanislav Mares, D., 1984, Introduction to Applied Geophysics.(Chap-III), Reidel, Publishers.