M.Sc (Tech.) Geophysics

GS-101 GEOLOGY – I

UNIT I: Origin of Earth, Branches of Geology, Interior and Exterior of the Earth. Weathering phenomenon, Geological work of wind: various erosional and depositional features of wind like hannadas, yardangs, lag deposits, loess, sand dunes, types of sand dunes, structure of stationary and migrating dunes, pedestal rocks and oasis.


Books:
1. Physical Geology, G.Gorshkov, A.Yakushova
2. Physical geology, A.K.Datta
4. The principles of petrology, G.W.Tyrell.
5. Rutleys mineralogy, H.M.Read
6. Physical Geology, Arthur Holmes
7. Physical and Engineering Geology: S.K. Garg
8. A textbook of Geology: G.B. Mahapatra
9. Engineering and general geology: Parbin Singh

Unit II: Computer Operating systems: Different types of operating systems: Single user operating System- MSDOS; Basic structure of DOS, DOS commands, Control-Function keys. DOS editing keys. Formatting etc.; Multi-tasking operating system- MS WINDOWS, Basic concepts of windows. Advantages of WINDOWS over MSDOS; Multi-user and multi-tasking operating systems- UNIX, File system in UNIX, File management, UNIX commands and Shell programming.

Unit III: Structure of FORTRAN-77, programming preliminaries, Constant and Variables, expressions- Statements Library functions, Control statements - GOTO, Logical expressions, DO statement & Nesting, STOP, END and PAUSE statements; subscripted variables. Arrays and DIMENSION statement; Special statements - COMMON, DATA statements. Input and Output statements; Subprograms –SAVE & EQUIVALANCE, Function and Subroutines Double Precision.

Unit IV: C programming language: Basic concepts of C; Symbolic and arithmetic constants and variables; Data types in C Decision control. Loop control and Case control structures in C; Functions; Pointers and Arrays; Input and Output; Interaction with Hardware through C and Operations on Bits; Some selected Geophysical problems and their C programs.

Unit V: Programming Examples both in Fortran and C-Languages to handle,
Geophysical Problems like - Calculation of normal Gravity, Gravity Anomalies of Spheres and Horizontal Cylinders, Magnetic Anomalies of Point Dipole, Dykes, Faults and Sheets Refraction hodograph-2 Layer Earth- Practicing these programmes using control statements, SUB ROUTINES, I/O Statements and Nesting.

Books:

1. Fortran programming. A.K. Jain & M.N.Kesava Rao
2. Fortran 77 programming, V.Rajararnan ,
3. Let us C, Yashavant Kanetkar
4. UNIX shell programming , Yashavant Kanetkar
GS 103: PHYSICS OF THE EARTH

Unit I: Origin of the earth- the Universe and our galaxy, chemical evolution of galaxy formation of the earth and planets, primary differentiation of the earth. Composition of the various zones, abundance of elements in the earth, the rotation of the earth, the moon, salient concepts of plate tectonics.

Unit II: The earth's gravity field, the force of gravity on the surface of the earth, the figure of the earth, Clairaut's theorem, the geometric and gravitational flatten! International gravity formula, geoid and spheroid, the gravity potent establishment of gravity bases, drift correction, reduction of gravity data, free and Bouguer anomalies, Isostasy - Pratt - Hayford, Airy - Heiskanen system anomalies.

Unit III: Geochronology, Radioactive decay. Dating of rocks - potassium-argon – rubidium strontium-uranium-lead-carbon 14 methods, age of the earth. The earth's thermal properties, the basic thermal data, the measurement of terrestrial flow, calculation and analysis of heat flow rate, heat flow over the ocean floor, flow over continents, sources of heat in the earth, temperature distribution in earth. The equality of continental and oceanic heat flows, regions of anomalous flow, hot spots, relation ship of heat flow to the radioactivity of the earth.

Unit IV: Formation of surface water resources, streams, rivers, lakes, swamps, caves, seas and oceans. Definition of river, river basin and water divide. formation of river values, sediment discharge, sediment transportation, sediment yield of watersheds, suspended load and bed load measurements, Runoff, Disposition of total precipitation to total runoff, runoff phenomena, factors affecting runoff, and estimation of runoff. Types of current meters, velocity measurements by current meters, floats, and velocity rod. Methods of discharge estimation.

Unit V: Hydrographs: Discharge of hydrograph, features of a hydrograph, factor affecting shape of hydrograph, components of hydrograph, base flow separation methods. Unit-hydrograph Principle of unit, application of unit hydrograph, S-hydrograph, Dimensionless unit hydrographs. Floods, design flood, maximum probable flood, flood control methods, flood frequency methods, flood routing methods, flood forecasting techniques.

Books:
1. Introduction of Geophysics, Howell
2. Physics and Geology, Jacobs and Russel
3. Physics of the earth, Stacy
4. The interior of the earth, M.H.P. Bott
5. Topics in Geophysics, P.J. Smith
8. General Climatology, HJ. Critchfield
9. Earth, Press & Siever
10. A text book of Hydrology, Dr.P.Jayarami Reddy
11. Hand Book of Applied Hydrology, Ven Te Chow (ed.)
13. Engineering Hydrology, R.S. Varshney
16. A Textbook of Geology, P.K.Mukherjee
17. Applied Hydrology, K.N. Muthrejea
19. Facets of Hydrology , John C Rodda
20. A textbook of Hydrology , Dr. P. Jayaramireddy


Books:

1. Fundamentals of Geophysics, William Lowrie
2. Modern Global Seismology, Thorne Lay
3. Earthquakes, Bolt, B.A.,
4. Introduction to Seismology, Perry Byrle
5. The Earth, Jeffreys.S.H.
7. Earthquake Mechanics, Kasahara. K.
9. An introduction to the theory of seismology, Bullen. K.E.

UNIT II: Outlines of important Indian groups and systems: Archean-Dharwar-Cuddapah-Vindhyan-Gondwana Group-Deccan traps-Siwaliks. Quaternary formations.


Books:

1. Physical and engineering geology: S.K. Garg
3. Engineering and general geology: Parbin Singh
4. Sub marine geology, P.H.Kunen
5. Submarine geology, F.P.Sheppard.
6. Stratigraphy of India, M.S.Krishnan
7. Structural Geology, M.P.Billings
8. Economic mineral deposits, A-M.Bateman and M.N.Jenson
GS -202: GEOMAGNETISM

Unit I: The main magnetic field, magnetic observatories, Instruments - proton precision magnetometer, magnetic elements, magnetic charts, the magnetic dipole, the magnetic field of an electric current, separation of magnetic fields of external and internal origin, the magnetic field of the external origin, ionosphere, magnetosphere, diurnal variations of magnetic field, Sq and L variations, magnetic storms and Aurora.

Unit II: The magnetic field of the internal origin, IGRF, the dipole field, the non – dipole field, secular variation and westward drift, magnetic fields of the Sun, Moon and planets, theories on the origin of earth's magnetic field, the permanent magnet hypothesis, Blackett's theory, the earth as a dynamo, the disc dynamo, dynamo of Lowes and Wilkinson.

Unit III: Magnetic properties of rocks, dia, para and ferromagnetism, the ternary oxide system of magnetic minerals, the titanomagnetite series, the titanohematite series, other ferromagnetic minerals. Magnetic susceptibility of rocks, NRM in rocks, measuring instruments. Spinner magnetometer, Cryogenic magnetometers.

Unit IV: Palaeomagnetism, remanant magnetism in rocks, TRM, DRM, CRM, VRM, hysteresis curve. Isolation of remanence, cleaning methods. AF demagnetization, thermal demagnetization, laboratory procedure, tests for stability.

Unit V: Reversals of the magnetic field, polarity of the geomagnetic field, geomagnetic scale, projective method of presenting palaeomagnetic data, magnetic latitude and co - latitude, calculation of mean direction of virtual geomagnetic poles, palaeomagnetic poles, reconstruction of palaeomagnetic poles, continental drift, northward drift of India, results from different continents.

Books

1. Debate about the Earth, H. takenchi, S. Uyeda and H. Kanamori
2. Fundamentals of Geophysics, William Lowrie
3. Geomagnetism, Sydney Chapman
4. Application of Palaeomagnetism, E. Erwing
5. Palaeomagnetism and Continents, J D A Piper
6. Palaeomagnetism and Plate tectonics, M W McElhinny
UNIT I  Continental drift: Super continents, Gondwana land and its break up, Geophysical Evidences for continental drift and drift of India, Indian Ocean floor its evolution and active lithospheric processes.

UNIT II  Plate Tectonics: The lithosphere, Distribution of Plates, Major and Minor plates, Kinds of Plate Margins- Constructive, destructive and conservative plates, Characteristics and processes at accreting and consuming plate boundaries, Stability and stress distribution with in plates, active and passive continental margins, marginal basins, transform faults.

UNIT III Differences between plate tectonics and continental Drift, magnetostratigraphy, paleomagnetism, Plate tectonics and mountain building, relative motion of the plates, Methods of measuring plate motions, Causes of plate motions, Eulers pole of rotation, Forces acting on the lithospheric plates, the Wilson cycle, Continental collisions, seismicity and Intraplate earthquakes.

UNIT IV Eustatic movements, Evidences of sealevel changes, Global sea level changes, sea level changes during the Quaternary period, Pre-quaternary sea level changes, Mechanism of sea level change, Impact of sea level changes. Brief description of structure and composition of the oceanic and continental crusts, upper and lower mantle and core (inner and outer), Rheological effects of lithosphere, Brittle and ductile deformation, creep mechanism in the earth, Rigidity of Lithosphere, flexure of plates and compensation models in lithospheric studies. Stresses in the Lithosphere and their sources.

UNIT V Convection: Mantle viscosity, Concepts of mantle convection Models, Coupling between plates and mantle convection, Hot spots and Mantle plumes, Plume generation Mechanism, Evidence for mantle plumes from seismology and Geoid, Deep Continental structure of India-Sources of data, Suggested crustal column, seismic velocity structure, Heat flow and seismicity structure, evaluation of tectonic stress, Plate tectonics and evolution of Himalayas, models based on gravity, DSS data and seismicity (Brief description only).

Books:
3. The earths Dynamic Surface, K Siddhartha, Kisalaya Pub Pvt. Ltd. 1999
5. Geodynamics by Turcotte
6. Interior of Earth by M.H.P. Bott
7. The Encyclopedias of Solid Earth Geophysics by David E. James
8. Plate Tectonics and Crustal Evolution by Kent C. Condie
11. Gravity field, seismicity and tectonics of Indian peninsula and the Himalayas by R.K. Verma
UNIT I
Earth’s main magnetic field, origin and temporal variations (outlines only), Geomagnetic elements, Vectorial representation, spatial variation, Basic concepts, Coulomb's law of magnetic force and fields, magnetic moments, intensity of magnetization and induction, magnetic potential and its relation to field, units of measurement, origin of magnetic anomalies, interrelationship between different component anomalies, Poisson’s relation, Magnetic susceptibility, factors controlling susceptibility, magnetic classification of minerals and rocks, Laboratory and in-situ methods of determining susceptibility, Natural remanent magnetism, Astatic and Spinner Magnetometers, demagnetization effects,

UNIT II
Principle of magnetic prospecting, Instruments - Nuclear, fluxgate, Squid’s and optical pumping magnetometers, gradient measurements, Plan of magnetic surveys in different mineral exploration programs, Magnetic data reduction, diurnal and normal corrections, IGRF, Airborne magnetometry, orientation mechanisms, survey techniques, data acquisition and reduction, Advantages and disadvantages, brief principles of ship-borne and satellite magnetometry

UNIT III
Interpretation of magnetic data, qualitative interpretation, nature of anomalies, identification of different structural features. – Dependence of magnetic anomalies on latitude and orientation. Isolation and enhancement of anomalies using graphical, trend surface analysis, digital filtering, reduction to pole filter, derivative and continuation filters (Brief descriptions), Ambiguity in magnetic interpretation, generalized approach of interpretation.

UNIT IV
Magnetic anomalies (vertical and total field) of single poles and sphere, anomaly equations, profiles, properties and interpretation procedures. Similarity of magnetic anomalies of two dimensional bodies in different components – generalized equations for the magnetic anomalies of line dipoles, dykes, sheets and faults, profile shapes and interpretation by thumb rules and characteristic curves, ambiguity in interpretation of magnetized dyke, Koloumzine method, Forward modelling of magnetic anomalies: Gultee’s rule, two dimensional and three-dimensional bodies of arbitrary shape, use of graticules, Computer models, familiarization of anomaly equations,

UNIT V
Principles of inversion, Inversion of magnetic anomalies of 2D polygonal bodies, magnetic anomalies of dykes and magnetic interfaces - Frequency domain interpretation: Use of Fourier transforms in magnetic interpretation with special reference to dykes and faults, end corrections, use of Hilbert transforms, Relation figures, brief interpretation procedures of MAGSAT anomalies- Application of magnetic method for regional geological mapping, oil exploration, mineral exploration, ground water and Engineering problems.

Books:
1. Gravity and magnetics in oil prospecting, L.L.Nettleton
2. Gravity and magnetic methods, Rao, B.S.R and Murthy, I.V.R
3. Gravity and magnetic Interpretation in Exploration Geophysics, I.V.Radakrishna Murthy
5. Introduction to Geophysical prospecting, M.B.Dobrin
6. Interpretation theory in Applied Geophysics, F.S.Grant and West
GS 301: GRAVITY METHOD

Unit I

Unit II

Unit III
Regional and residual separation – graphical, average, grid and curve fitting methods, reliability of different types of residuals, use of filters, vertical derivative calculations, upward and downward continuation of anomalies, classical methods using continuation integral, employing harmonic analysis and Fourier Transformation.

Unit IV
Ambiguity in gravity interpretation, classical method of interpretation, gravity anomalies of point and line masses, circular discs, vertical cylinders, sheets, faults and rectangular slabs, Characteristics of anomalies, properties, interpretation by simple thumb rules and characteristic curves. Forward modeling of gravity anomalies of two-dimensional and three-dimensional bodies of arbitrary shape, Graticules, computer models, anomalies of two-and-half-dimensional bodies.

Unit V

Books:
1. The Earth and its gravity field, A.A.Heiskanen and F.A Vening
2. Gravity and magnetics in oil prospecting, L.L.Nettleton
4. Gravity and Magnetic Interpretation in Exploration Geophysics, I.V.Radhakrishna Murthy
5. Marine Gravity, Peter Denelinagar
6. Applied Geophysics, W.W.Telford et. al
7. Introduction to Geophysical prospecting, M.B.Dobrin
8. Interpretation theory in Applied Geophysics, F.S.Grant and West.


Unit III Self Potentials: origin- classification – electrochemical and electro-kinetic potentials – behavior. Measurement of self potentials- equipment- field techniques. SP anomalies over different geometrical models – sphere, fault, dyke and sheet etc.. - Interpretation of SP anomalies

Unit IV Potential due to a point source- dipole and line sources in homogeneous earth. Effect of inhomogeneous ground. Concept of apparent resistivity – apparent resistivity for multi-layered earth. Principle of reciprocity. Reflection coefficient

Unit V Different types of electrode arrays: Wenner- Schlumberger - Dipole- Dipole- Half Schlumberger-, Central Gradient etc.. Geometric factors and theoretical derivations for apparent resistivity for different electrode configurations.

2. Electrical Methods in geophysical prospecting by George V.Keller
3. D.C Geo electric sounding by P.K.Bhattacharya and H.P.Patra
Unit – I

Unit – II
Elastic wave velocities of rocks: laboratory and field measurements, dynamic moduli, P and S-wave velocities, anisotropy, attenuation, factors affecting velocity, different types of velocities, geometry of ray paths, refraction and reflection, horizontal layers and dipping layers, NMO and dip move out, discrete and continuous velocity changes, velocity inversion, low velocity layer, blind zone, hidden layer.

Unit – III
Electromagnetic geophone and its performance, damping coefficient, hydrophones, detector arrays, array response, uniform arrays, amplitude weighted arrays, distance tapered arrays, streamer, analog data acquisition, amplifiers, filters, gain control and recording types. Seismic energy sources for land and marine surveys. Dynamite thumper, dinoseis, vibrosies, land air gun, pinger, boomer, sparker, airgun, water gun, vaporchoc etc. Controlled explosions, shot control, source arrays, energy content, frequency, pulse length and resolution, penetration, signatures of energy sources.

Unit – IV
Digital data acquisition, digital field system, signal flow and recording. Constituent units and modules. Telemetry systems, wireline and radio telemetry, telemetry system configuration and specifications, dynamic range of signals noise: shot generation, ambient and electrical noises, their nature and attenuation requirements. Noise survey, noise analysis, fold back experiment, optimization of parameters.

Unit – V
Single channel and multi channel surveys, field layouts and shooting procedures for land and marine 2D surveys, split spread and end-on spreads, CDP procedures for land and marine surveys, stacking chart. 3D surveys, 3D layouts, swath, brick, odds & evens, zig zag, button patch, full range 3D, loop survey. Marine 3D shooting: two streamer system, alternate shooting, two boat operation, circles shooting, 3D bottom cable survey, quad quad 3D, multiple streamers, static binning and dynamite binning. Refraction surveys: Field procedures, fan shooting, broad side shooting, inline profiling, long refraction profiles, reversed and unreversed profiles, marine refraction surveys, sonobuoy surveys. (VSP, shear wave data acquisition and other special surveys procedures are included in paper II along with processing and interpretation of seismic data)

Books:
1. Introduction to geophysical prospecting, M.B.Dobrin.
3. Exploration seismology, Sheriff. R.E.
5. A hand book for seismic data acquisition, Brain J Evans
6. Designing seismic surveys in two and three dimensions, Dale G Stone
Unit 1: Basic concepts and objectives of well logging. Reservoir rocks and its petro physical properties. Porosity & Permeability: classification of porosity and Permeability; factors governing magnitude of Porosity & Permeability; permeability-porosity relationship. Formation resistivity factor (FR); correlations between FR and tortuosity; correlations between FR and cementation; correlations between FR and water saturation; correlations between FR and permeability. Need of drilling fluids, and its properties. Bore hole environment, invasion effect and invasion profile. Classification of well logging tools, well logging unit and logging setup. Reservoir geometry, temperature and pressure. Log header, depth scale. depth of investigation and vertical resolution.

Unit II: Electrical logging:

SP Log-Origin and occurrence of Self Potential. Factors affecting shape amplitude of SP curve, PSP & SSP, Determination of salinity of formation water from Sp log. Concept of resistivity in well logging; factors affecting the resistivity of electrolyte bearing rocks. Unfocussed Resistivity Devices: single-electrode systems and its limitations; normal and lateral resistivity tools and their limitations; factors affecting normal and lateral resistivity measurements; microresistivity measurements- tools, applications and limitations.

Focused Resistivity Devices: principle of measurement, tools and factors influencing resistivity measurements.


Unit III: Radioactive & Miscellaneous logs.

Sources of natural radioactivity and gamma radiation; geochemical behavior of potassium, thorium and uranium; radioactivity of shales and clays; simple and spectral gamma ray tool including radiation detectors; calibration of simple and spectral gamma ray tool; factors affecting gamma ray log response; depth of investigation and unwanted borehole effects in gamma log; qualitative and quantitative uses of simple and spectral gamma ray log, How SP log is different from gamma ray log.

Miscellaneous tools: Dipmeter, caliper, side wall coring tools, Casing Collar Locator.

UNIT IV: Porosity Logs

Acoustic Log: Principles; factors affecting acoustic wave velocity; acoustic logging tools- single and double receiver type tools; borehole compensated systems; cycle skipping in acoustic log; bed thickness effect on acoustic log; depth of investigation; porosity evaluation of consolidated and uncompacted sandstones (clean as well as shaly) and carbonates rocks; overpressure identification; seismic applications.
**Density Log:** Interaction of gamma rays with matter; principle of density log; energy requirements of gamma ray sources for density log; measurement tools—single and double detector type; log characteristics—depth of investigation and bed resolution; porosity measurements and other formation evaluations; factors affecting porosity measurements; litho-density log—principles and formation evaluation.

**Neutron Log:** Interaction of neutrons with matter, neutron sources and neutron detectors, neutron moderation and principle of neutron log, neutron logging tools—single spacing type, sidewall-neutron porosity probes, borehole compensated systems; corrections in porosity measurements due to the presence of shale, rock type, borehole, and cased hole; depth of investigation and source-detector spacing; calibration of logging systems.


Hydrocarbon zones, Mineral Zones, water Zones and Coals.

**Books:**

1. Formation Evaluation, E J Lynch
2. Induction Logging, Plusynin.
3. Log Interpretation Principles and Charts, Schlumberger
4. Schlumberger Documents,
5. Development and Exploitation of Oils and Gas Fields, Murovyer and Andiaseventnal
GS 401: SIGNAL PROCESSING AND INVERSION THEORY

Unit I  Introduction, Definition of signal and noise, various signal classes such as continuous, piece wise continuous, absolute integrable, singularity, unit impulse, unit step, etc. Fourier series and Fourier Transforms: Time and frequency domain, relations between various operations in both the domain, Fourier Transform and its properties, Fourier Transforms of some important functions: Rectangular, exponential functions, singularity functions and periodic functions.

Unit II  Time-series analysis: Discrete time signals, Correlation and convolution functions, impulse response and Transfer function spectrum of observational data: Discrete Fourier Transform (DFT), FFT, Z-Transforms, Delay properties of wavelets.

Unit III  Band limited signals: Properties, Sampling Theorem, Nyquist frequency, Aliasing, Sampling of band and time limited signals; Effect of sampling on spectrum and vice-versa; reproduction of continuous function from sampled data. Importance and effects of Windowing, Gibbs phenomenon, spectral leakage, various types of windows; power spectrum; Estimation of power spectrum, Wiener Khinchin theorem, use of various windows in power spectrum computation, spectrum computation via Auto-correlation and Periodogram.


Books:

1. Spectral analysis in Geophysics, Markus Bath
2. Theory and application of digital signal processing, Rabiner,L.R and Gold, B.
3. Digital signal processing and time series analysis, Enders A.Robinson
4. Statistical theory of communication, Y.W.Lee
5. Analysis of Geophysical Potential Fields, P.S.Naidu & M.P.Mathew
6. Seismic Filtering, Nathan Rothenburg, SEG publication
7. Time sequence analysis in Geophysics, E.R.Kanasewich
8. Signal Analysis, B.P.Lathy
UNIT I  
**Basics:** Electromagnetic Induction, Primary-Secondary field relations, Vector Diagram- Real and Imaginary components resolving; Inductive and resistive limits, Response function, Elliptic polarization, Maxwell’s equations, Boundary conditions, Wave equation, Quasi static condition, Solution of wave equation, Plane wave characteristics, propagation of plane waves in conducting media, Wave number, Impedance, Skin depth versus effective depth, factors controlling depth penetration.

Unit II  
**Classification of E.M. methods:** Sources used, continuous wave and pulse excitation principles, Measured components. Brief principles of solving electrodynamic problems including scale modeling. Field of large loop, magnetic dipole and electric dipole in air – frequency and Time domain approaches

Unit III  
Field of magnetic dipole and electric dipole (both in transient and frequency domains) in homogeneous, isotropic space. Response of stratified medium to the above sources. Frequency and transient response of local conductors in homogeneous field – Sphere and Cylinder. Effect of frequency and magnetic permeability on the secondary fields – Sphere as an example, Generalized induction parameter. Effect of overburden and Host rock on E.M. response.

Unit IV  

Unit V  

**Books:**

1. Interpretation theory in Applied Geophysics by Grant and West  
2. Applied Geophysics by Telford, et. al., revised edition  
3. Mining Geophysics, Vols. 1 & 2 – SEG publications  
4. Electrical methods of Geophysical Prospecting by Keller and Frischknecht  
5. Geosounding Principles Vol. II by Patra and Mallick  
6. Mining Geophysics by Parasnis  
7. Introduction to Geophysical Exploration, by Kearey and Brooks  
GS-403: SEISMIC METHODS – II

Unit –I Reduction of refraction data, interpretation of refraction data, analysis of refraction records, interpretation of reversed and unreversed profiles, delay time methods, forward modeling, masked layers and hidden layers, reduction and interpretation of sonobuoy data, crustal seismology, engineering surveys, exploration for ground water, application in mining industry.

Unit- II Reflection data processing, static and dynamic corrections, velocity determination. Preparation of seismic sections migration, analysis of analog records, automatic processing of digital seismic data, demultiplexing, TAR, velocity analysis, velocity spectra and velocity scan, automatic statics, picking, stacking, spiking deconvolution, dereverberation, whitening, time variant frequency filtering, apparent velocity filtering. AVO analysis, different methods of migration, automatic migration, wavelet processing.

Unit-III Seismic section plotting, display types, picking of events, marking-isochron & isopach maps, geological interpretation, application of reflection method exploration for oil and gas, groundwater, coal, mineral deposits, gas hydrates, etc., engineering applications, crustal studies, structural and stratigraphic traps, identification of geological structures like anticlines, faults, salt domes etc; fit falls in interpretation.

Unit-IV hydrocarbon indicators, bright spot, seismic attributes, AVO analysis, vertical seismic profiling, equipment, configurations like deviated well, walk away, offset VSP etc., applications, 3D data processing and interpretation, visualization in an animated interactive environment.

Unit – V Seismic stratigraphy, geological sea level change model, depositional patterns, seismic sequence, seismic facies, reflection character, synthetic seismogram, modeling concepts, high resolution seismic surveys, shallow engineering surveys and suitable energy sources, 4C, 4D recording, seismic tomography, reservoir applications of petrophysics concepts, generation and recording of shear waves, energy sources, geophones, recording, processing, section plotting, interpretation Vp/Vs as lightology indicator, hydrocarbons, engineering applications.

Books:
1. Introduction to geophysical prospecting, M.B.Dobrin.
3. Exploration seismology, Sheriff. R.E.
4. An introduction to seismic interpretation, R. Mcquillin et.al.
6. Shear wave exploration, SH Danbom and SN Domenico
7. Multicomponent seismology in petroleum exploration, RH Tathamz and MD McCormack
8. Fundamentals of seismic tomography, Lo and Inderweisen
9. Reservoir studies, SEG publication.
Unit-I: Reservoir Thickness, effective, Pay and Net thicknesses, Flow in Vertical Pipes, Flow Types, Reynolds Number, Perforations, Water Holdup, Water Cut, Slippage Velocity, Cased hole Production Log Units & different Tools Logging While Drilling (LWD).

Unit-II: Production Logs: Temperature Log, Flow meters, different types of Flow meters, Gradiomanometer, Radioactive tracer logs. Well problems- their diagnosis with different Production Logs, Injection Wells, Interpretation of Flow meter & Temperature logs in Injection/Production wells.

Unit-III: NMR technique for permeability, bound and Free water estimations-wire line sampling – Fluid sampling & Pressure measurements. Formation tester-Repeat Formation Tester, Formation Micro Imager.


Books:

1. Formation Evaluation- E J Lynch
2. Induction Logging- Plusynin.
3. Log Interpretation Principles and Charts - Schlumberger
4. Schlumberger Documents,
UNIT-1 Fundamentals of Remote Sensing: Introduction: basic principles of remote sensing; electromagnetic spectrum; Planck’s law and wien's displacement law; concept of incoming short wave and outgoing long wave radiation: passive and active remote sensing, interaction of electromagnetic radiation with matter; interaction of electromagnetic radiation with atmosphere; selective and non-selective scattering; impact of scattering on remotely sensed data; atmospheric windows and absorption bands.


UNIT-3 Aerial photography: various types of aerial cameras and black and white films; scale, brightness, contrast of photograph; resolution of photograph - resolving power of film and camera lens; vertical and oblique aerial photographs; methods of aerial photographic surveys; parallax/relief displacement, stereophotography, mirror arid pocket stereoscopes, Photomosaic, low and high sun elevation angle photography. Color theory - primary and secondary colors; additive and subtractive color mixtures to generate colors, color code, working principle of normal and infrared color films and photographs; color composites - true, standard false color and false color composites; application of normal and infra red photographs.

UNIT-4 Satellite remote sensing: Various platforms used for remote sensing data acquisition; orbits of satellites; geo-synchronous and sun-synchronous orbits; OPTICAL REMOTE SENSING SATELLITES: environmental meteorological satellites (past and present) and their sensors - GOES, Meteosat, INSAT, GMS, NOAA etc.; earth resources observation satellites (past, present and future) and their sensors - NIMBUS COASTAL ZONE COLOR SCANNER, LANDSAT, SPOT, MOS, IRS-I, I, IC, p2, p3, p4, p5, p6 etc. Indian remote sensing activity; future remote sensing missions of ISRO for earth observation.

UNIT-5 Thermal infrared remote sensing: Thermal processes and properties, radiant flux, heat transfer, atmospheric transmission, thermal properties of materials, thermal infrared signatures of various rocks and minerals, influence of water and vegetation on thermal inertia; thermal infrared sensors like infrared radiometers, working principle of thermal infrared scanner; TIMS etc.; satellites and sensors acquired and acquiring data under thermal infrared region - HCMM, NOAA-AVHRR, EOS-TERRA, EOS-AQUA, Geostationery satellite sensors etc.; characteristics of thermal infrared images, relative comparison of night and daytime thermal infrared imagery; advantage of thermal infrared remote sensing.

UNIT-5 Geographical information systems (GIS): Introduction: functions of GIS, spatial data bases - position, attributes; data base structures; data base management; geographic data types - vector and raster; introduction to coordinate system and map projections; application of GIS in Hydrology and other earth sciences.

Books:
2. Introduction to the Physics and Techniques of Remote Sensing, Charles Elachi: Johnwiley & Sons p. 413
3. Information Booklets form various satellite agencies
GS 502 : MARINE GEOPHYSICS

(Common paper for all specializations)

Unit I: Physiography and divisions of the sea floor, continental shelves, slopes and aprons, submarine canyons and deep sea channels, sea mounts and abyssal plains, turbidity currents and submarine sedimentation, the mid oceanic ridge systems and its structure, aseismic ridges, various types of ridges in the Indian ocean region, the continental fracture system and island arcs, occurrence of offshore mineral deposits and hydrocarbons, hotspots, mineral resources of the sea: surficial deposits of the shelf and deep sea, heavy mineral placers, calcareous shells, pearl oysters, phosphorites, glauconite, barium sulfate carcretions, sand and gravel, extensions of ore deposits, hydrocarbon potential of the shelf and offshore sedimentary basins.

Unit II: Geophysical instrumentation and surveys: Adaptation of geophysical instruments for marine surveys, Measurements at the sea surface and under water, geophysical equipment currently in use and board research vessels, complement of equipment on board the survey ship and layout of equipment, towing logistics, survey procedures and planning of survey lines, marine magnetometers, marine gravimeters, surface and under water gravimeters, Graf Askanian, Lacoste Romberg and vibrating string gravimeters, calculation of gravity anomalies.

Unit III: Map projections: Different kinds of map projections, Position fixing at sea: long range and short range systems, integrated satellite navigation, Global Positioning System (GPS), Bathymetry: echosounding, bathymetric charts, bathymetry as an adjunct to geophysical surveys, submersibles, seabed mapping by side scan sonar, multibeam, lider and other surveys, seabed sampling, dredging and coring, marine geophysical surveys for sealed resources, site selection for production platforms, tunneling, waste disposal etc.

Unit IV: Oceanic magnetic anomalies, sea floor spreading, Vine-Mathews hypothesis, geomagnetic time scale and dating the ocean floor, linear magnetic anomalies. Heat flow: Earth's internal sources of heat, transfer of heat within the earth, measurements at the ocean bottom, heat flow probes and measurements, factors affecting the Heat flow measurements in sea, oceanic heat flow, ocean ridges and ocean basins, marginal basins, rift valleys.

Unit V: Objectives of marine geophysical surveys, marine geophysical surveys for sea bed resources, engineering investigations, deep sea geological mapping, delineation of continent-oceanic boundary, geological mapping in the coastal zone. Results of some rare studies. Geophysical anomalies of trenches, active and passive margins, ridges, island arcs, Large scale and small-scale structural features of the oceanic crust from seismic surveys (velocity structure)

Books:
1. Marine geophysics, EJW Jones
2. Physics and geology, Jacobs, Russel and Wilson
3. Introduction to geophysical prospecting, MB Dobrin
5. Geodynamic, Turcutoe
6. The interior of the Earth, MHP Bott.
Unit I

Unit II

Unit III

Unit IV
Seismic data processing – outlines, preparation of seismic section, Reflection character- structure, pitfalls – migration 2D & 3D significance – velocity pull up, structure identification.

Unit V

Books:
1. Ravi Bastia: Geologic settings and petroleum system of India-East coast off shore basins- Concepts and application.
2. A.I.Levorson: Geology of Petroleum
3. R.C.Selly & David C.Morri:-Basic concepts of petroleum Geology
4. Jutshi P.L and Pawar M.S:Geology of Petroleum basins of India
5. Weimer P & R.M.Slatt: Introduction to petroleum Geology of deep water settings, AAPG studies in Geology series
Unit I

Crustal layers—upper and lower, Different elements in the crust, Precious and other useful substances in the upper crustal layers, Metallogenic provinces and periods. Classification of mineral deposits – Metallic and non metallic, Classification of metallic deposits—Ferrous and non ferrous, Base and noble metals, Sulphides, Oxides, Silicates and Carbonates, Processes of formation of mineral deposits – Igneous activity, Sedimentation, Metamorphism, Weathering and Erosion, Hydrothermal processes.

Unit II

Mineral deposits of India—Base metals and Ferrous metals, Geological mapping-Geophysical methods, Sulphide ores—Massive and disseminated ores—Prospecting strategies—examples, Iron ores—Strong and weak magnetic iron ores, genesis-prospecting.

Unit III


Unit IV


Unit V


Books:

1. Mining Geophysics, SEG, Volume-I
2. Ground water Hydrology, D.K.Todd
3. Geophysical practice in mineral exploration and Mapping, T.S. Rama Krishna
GS-505: NATURAL HAZARDS, COASTAL ZONE MANAGEMENT AND OCEAN LOGISTICS

(Special paper for M Sc (Tech) Geophysics with Marine Geophysics Specialization)

Unit-I: Cyclones, storm surges and Tsunami, Concept of Tsunami; Relation between sub-sea earthquakes and onset of Tsunami; Impact of Coastal morphology on Tsunami surge. Tsunami Surge Models.

Unit-II: Land-Ocean Tectonics, Coastal seismicity, neotectonics, geophysical methods on Land-Ocean Tectonics, some case studies, Seismo-tectonics of Indian sub-continent, High resolution seismsics to delineate Geohazards like Sediment lumps, Buried channels, Palaeo-reefs etc.

Unit-III: Threat to Coastal Zone due to industrialization, CRZ, its concept, Integrated Coastal Zone Development. Environmental Impact assessment for sustainable Coastal Zone Development. Public awareness on sustainable Coastal Zone Development.

Unit-IV: Geophysical studies in EIA, Seabed studies for recommendation of marine outfalls-Case-Studies.

Unit-V: Law of Seas, Legal Continental Shelf (LCS), Geophysical studies for identifying LCS. Other International Conventions for exploration of deep-sea-resources.

Books:
4. Indian Ocean Tsunami by Tad Murthy et al
6. Tropical Cyclone: The Storm Surge: www.britannica.com
9. Aylesburn, 2nd Ed 32 Page
11. CRZ in India www.envfor.nic.in/legsi.htm
12. M.S. Swaminathan Report on CRZ (website)
15. The legal continental shelf www.springer.com
Unit-1

Unit-II

Unit-III
Pumping tests: Conducting pumping tests, Theis, Jacob, Chow and Papadopulous methods of determining aquifer parameters, recovery test: Determination of transmissivity, storage coefficient, specific yield and specific capacity, recovery test. Types of water wells, methods of drilling wells, well design, well completion and development, pumping equipment.

Unit-IV
Physical and chemical properties of water, chemical dissolved constituents – major and minor and traces, water sampling techniques and analysis for chemical constituents. Interpretation of chemical data, representation of data : Gibb’s diagram, Piper, Wilcox, SAR and Durov plots.

Unit-V
Groundwater pollution, point source and non point source, environmental impact of municipal solid waste dumps, hospital wastes, excess pumping in coastal areas, mining areas, mineral and hydrocarbons Aquaculture, subterranean water of oil field, oil field brines. Identification of groundwater contamination, environmental isotopes, tracers, and their application. Control measures of contaminant into groundwater

Books:
2. Groundwater Hydrology, D.K.Todd
3. Facets of Hydrology, John C Rodda
4. Groundwater ,H.M.Raghunath
6. Hydrogeology , Davis & De weist
7. Geohydrology , De weist
8. Applied Hydrology, K.N.Mutreja
9. A textbook of Hydrology, prof. PJayaramireddy
10. Applied Hydrology , R.K.Linsley, M.A.Kohler & Paulhus
11. Study and Interpretation of the chemical properties of Natural waters – an USGS publication – JD Hem
12. The properties of groundwater – George Mathess
17. Groundwater Hydrology – H. Bower

Unit-II: Multiple well system, partially penetrating wells, well losses. Well flow near aquifer boundaries: Image well theory, recharge boundary and barrier boundary and other boundaries.

Unit-III: Different Types of Hydrological models: Introduction to Physical models, Continuous and Discrete models

**Physical models:** Sand models, Tank model to simulate network of reservoirs; Laboratory tank models used in Electrical resistivity modelling, Horizontal and Vertical HELESHAW (Viscous fluid) model.

**Continuous systems:** Conductive liquid and solid analogue models


Unit V: Watershed concept, concepts of integrated study of watershed management. Rain water structures, design and economic aspects.


Books:

1. Hand Book of Applied Hydrology, Ven Te Chow (ed.)
2. Groundwater, D.K.Todd
3. Groundwater resource evaluation, W.C.Walton
4. Applied Hydrology, K.N.Mutreja
5. Physical principles of water percolation and seepage, J. Bear et al
6. Advances in Hydro-sciences, Ven Te Chow
8. Computer simulation Techniques in Hydrology, George Fleming
10. Watershed Management, J.V.S.Murthy
11. Facets of Hydrology, John C Rodda
12. Watershed Development, V.V.J.Sarma, C. Subba Rao and N.V.B.S.S.Prasad
13. Watersheds Comprehensive Development, K.V.Seshagiri Rao