

## **B. Tech. in Geoinformatics Engineering**

### **Syllabus of Paper – 1**

#### **CARTOGRAPHY**

Map – A Special Graphic Communicator: Maps, their functions and use – Definition of Cartography – Types of Maps – other cartographic products – map making steps – surveying and mapping – Role of IT and computers, RS, GIS and GPS – Concepts of sphere, ellipsoid and geoid - latitudes, longitudes and graticules - Map Scales and Contents – accuracy and errors- History of Cartography – Mapping organizations in India. Abstraction of Earth And Map Projection: Map projections – shape, distance, area and direction properties - role of aspect, development surface, secant and light source / view points – perspective and mathematical projections – Indian maps and projections – Map co-ordinate systems – UTM and UPS references – common projections and selections– projections for hemispheres and the world maps. Map Compilation And Design: Base map concepts – scanning and digitization – planimetric, topographic and thematic information – sample and census surveys – attribute data tables – Elements of a map - Map Layout principles – Map Design fundamentals – symbols and conventional signs - graded and ungraded symbols - color theory - colours and patterns in symbolization – map lettering. Map Making: Definition of chropleth, daysimetric and isopleth maps – class interval selection and shading – isopleth maps and interpolation strategies – located symbol maps – flow maps – cadastral and engineering maps – demographic and statistical mapping –sequential maps – map production – map printing– colours and visualization – map reproduction – printing soft copies and standards. Map Transformations: Map generalization – attribute conversions and transforms – reduction and enlargement - fusions - geometric transformations – bilinear and affine transformations - hardware and software in map making – conversion to multimedia, internet and web objects - mobile maps–cartometry.

#### **SURVEYING**

Fundamentals And Chain Surveying: Definition- Classifications - Basic principles – Mistakes, errors and accuracy. Equipment and accessories for ranging and chaining – Methods of ranging - well conditioned triangles – Errors in linear measurement and their corrections - Obstacles - Traversing – Plotting - applications. Compass Surveying And Plane Table Surveying: Compass – Basic principles - Types - Bearing - Systems and conversions- Sources of errors - Local attraction - Magnetic declination-Dip-Traversing - Plotting - Adjustment of closing error – applications - Plane table and its accessories - Merits and demerits - Radiation - Intersection - Resection – Traversing- sources of errors – applications. Theodolite Surveying: Theodolite - Types - Description - Horizontal and vertical angles - Temporary and permanent adjustments – Heights and distances– Tangential and Stadia Tacheometry – Subtense method - Stadia constants - Anallactic lens. Route Surveying: Reconnaissance - Route surveys for highways, railways and waterways - Simple curves – Compound and reverse curves - Setting out Methods – Transition curves - Functions and requirements - Setting out by offsets and angles - Vertical curves - Sight distances. Hydrographic And Mine Surveying: Tides - MSL - Sounding methods - Three-point problem - Strength of fix - Sextants and station pointer - River Surveys - Measurement of current and discharge – Mine Surveying Equipment - Weisbach triangle - Tunnel alignment and setting out - Transfer of azimuth - Gyro Theodolite - Shafts and Adits.

## **PRINCIPLES OF REMOTE SENSING**

Electromagnetic Radiation: Electromagnetic Spectrum - radiation quantities - spectral quantities - relationship between luminous and radiant quantities - hemispherical reflectance, transmittance and atmosphere measurement of electromagnetic radiation - responsivity - normalization, radiating structures- thermal emission - fluorescent emission - Radiation principles - Planck's law, Stephens Boltzmann law, Kirchoff's law. Interaction of EMR with Atmosphere And Earth's Surface: EMR - atmospheric scattering, Raleigh scattering, Mie scattering, non-selective scattering - atmospheric absorption - atmospheric windows, refraction - interaction of EMR earth's surface - reflection - transmission - spectral signature - Reflectance characteristics of Earth's cover type: Vegetation, water, soil - Interaction of microwave with atmosphere and Earth's surface - Radar operating principle - radar equation - Definitions: Incidence angle, look angle, depression angle, Azimuth angle - Spatial resolution in radar - Synthetic aperture - radar. Optics for Remote Sensing: Lenses, mirrors, prisms - Defects of lens - chromatic aberration - longitudinal chromatic aberration - achromatism of lenses - achromatism for two lenses in contact - separated by a distance - spherical aberration - minimization of Spherical aberration - coma astigmatism - Radiative Transfer Functions, Lamella Pack, Volume scattering - Principles of photography: black and white photography - sensitivity - speed - characteristic curve - developing and printing - basic colour photography - construction of colour films - film type - types of filter - and its uses. Gravitation And Satellites: Newton's law of gravitation - gravitational field and potential - determination of gravity, variation of acceleration due to gravity of the earth with depth and with altitude - Variation of acceleration due to gravity due to rotation of the earth - Refraction. Diffraction - fresnel theory, Circular diffraction diffraction gravity, Polarisation double diffraction - Escape velocity - Kepler's law of planetary motion - dopplar effect - Satellites - types of satellites - Earth observation satellites, communications satellites, Navigation satellites, weather satellites, military satellites and scientific satellites. Velectro-Optic Non-Imaging and Imaging Sensors: Photomultipliers, photo resistors, photodiodes, nonselective detectors - Optical receivers, PIN and APD, optical preamplifiers, Detectors: Basic detector mechanisms, noise in detectors. Thermal and photo emissive detectors, Photoconductive and photovoltaic detectors, performance limits, Photographic, - Sensitivity, time and frequency response - hybrid photo detectors - Imaging detectors - eye and vision, photographic film. Camera tubes, solid-state arrays, video, Detector electronics, detector interfacing - Different CCD cameras. Orbital Mechanics, Concept of orbits-propulsion, aero dynamics, navigation guidance and control.

## **PHOTOGRAMMETRY**

Principles of Photography & Co-Ordinate Measurement: History of Photogrammetry - Definition, Applications - Types of Photographs, Classification - Photographic overlaps - contact printing - projection printing. Analog and Digital Aerial cameras, Linear array scanner - Construction - Camera accessories - Camera calibration -Terrestrial Metric cameras. Coordinate measurement using comparators - - refinement of photo coordinates- Photo Interpretation. Stereoscopic Concepts & Vertical And Tilted Photographs: Stereoscopic depth perception - Different types of stereoscopes vertical exaggeration - base lining and orientation - principle of floating mark - methods of parallax measurement -vertical photographs - geometry, scale, parallax equations, - Tilted photograph - Geometry, Coordinate system, Scale - Scheimpflug Condition , Rectification Geometry, Graphical and Analytical methods. Project Planning: Flight Planning - Crab & Drift - Computation of flight plan - Specification for Aerial photography - Basic horizontal and vertical control - Pre pointing and Post pointing -Planning for Ground Control survey. Stereo Plotters And Techniques Of Orientation: Inner orientation- Relative orientation- Absolute orientation - Model deformation - Projection - Viewing - Measuring - Tracing system - Optical projection

equipments - Mechanical projection equipments - Zeiss parallelogram - Map compilation. Analytical Stereo Plotters & Orthophotography: Analytical plotters- Orientations - Two dimension coordinate transformation - Classification of Orthophoto systems- Online and Offline instruments - Automatic Contouring - Instruments for Orthophoto productions - Digital Orthophotos.

## **GEOLOGY FOR GEOINFORMATICS**

Introduction: Geology for natural resources inventory – Branches of geology – Scope. Interior of the Earth, Stratigraphic sequence, weathering, Introduction to geological structures, Plate Tectonics – Earth quake and volcanic belts in India. Geomorphology: Landforms and geomorphic processes – Classification and description of Structural, Denudational, Fluvial, Glacial, Aeolian, and Coastal landforms. Drainage pattern and morphometry. Petrology: Classification and description of rocks – Forms and mode of occurrence of rocks – Physical properties of important rocks and ore forming minerals –distribution of economic minerals in India. Geophysical Methods And Geo- Exploration: Geophysical methods – Seismic, Electrical, Gravity, Magnetic and aeromagnetic methods – their bearing on Natural Resources Inventory - Remote Sensing techniques for Groundwater Mineral Hydrocarbon and Geothermal energy exploration. Natural Hazards: Classification – Causes for natural hazards – Earthquakes – Landslides – Volcanism – Tsunami – Cyclones and Floods – Mitigation – Remote Sensing Applications in Natural Hazards.

## **GEODETIC SURVEYING**

Levelling: Level line - Horizontal line - Datum - Bench marks -Levels and staves - temporary and permanent adjustments – Methods of leveling - Fly levelling - Check levelling - Procedure in levelling - Booking -Reduction - Curvature and refraction - Reciprocal levelling - Precise levelling - Types of instruments - Adjustments - Field procedure- sources of errors. Contouring, Area And Volume Computation: Longitudinal and Cross-section-Plotting - Contouring - Methods - Characteristics and uses of contours – Plotting – Methods of interpolating contours The Planimeter - Areas enclosed by straight lines - Irregular figures - Volumes - Earthwork calculations - Capacity of reservoirs - Mass haul diagrams. Control Surveying: Horizontal and vertical control- Methods- specifications - Triangulation- Base line - Instruments and accessories – Corrections - Satellite station - Reduction to centre – Trigonometric levelling- Single and reciprocal observations - Traversing - Gale's table. Astronomical Surveying: Celestial sphere - Astronomical terms and definitions - Motion of sun - horizon, hour angle, right ascension and ecliptic Celestial coordinate systems – Sidereal, universal, zone and atomic time systems - Nautical Almanac. Practical Astronomy: Apparent altitude and corrections - Field observations and determination of time, longitude, Latitude and azimuth by altitude and hour angle method.

## **ADVANCED PHOTOGRAMMETRY**

Aerial Triangulation Principles And Adjustments: Basic concepts of strips and blocks photographic aerial triangulation - Analog triangulation-Independent Model Triangulation - Strip formation, graphical strip adjustment-polynomial strip adjustment - Analytical aerial triangulation, adjustment of blocks of aerial photographs- Three-dimensional coordinate transformation. Non Topographic Photogrammetry: Applications - terrestrial cameras - stereometric cameras - horizontal and vertical angles from terrestrial photographs - Camera azimuth - analytical determination of horizontal position of a point from Photographic measurement - graphical method– use of plotting equipments - control consideration for terrestrial Photogrammetry - X-ray Photogrammetry. Digital Cameras, Scanners & Workstations: Representation of Images- Cameras – Technology of CCD- types of scanners- typical

photogrammetric Scanner – image Geometry & Radiometry – stereo viewing – stereo W/S requirements – Photogrammetric functionalities- quality checks. Digital Image Handling: Image Generation – epipolar geometry - data Compressions – formats – Image pyramids- sub-band coding – scaline functions image matching Techniques – template, correlation – statistical - Geometry, texture based – decision theoretic methods – string matching – trees image measurements – single library. Photogrammetric Products And Applications: DEM, DTM, DSM- Representation of DEM generation from visible images – point matching – quality factors and checking – DEM correction – DSM generation – DTM characteristic features-relief characteristics- orthophoto generation – feature extraction – satellite stereo missions and products.

## **OPTICAL AND THERMAL REMOTE SENSING**

Remote Sensing And Electromagnetic Radiation (EMR): Definition - components – History- EMR Specification- wave theory, particle theory- radiation sources and quantities – Atmospheric region and characteristics- Atmospheric windows – scattering (Rayleigh, Mie, non-selective scattering) Radiative transfer & volume Scattering-Lamella pack – absorption & transmittance – EM Interaction with various earth elements – spectral signature – interpretation elements. Platforms And Sensors And Data Products: Ground Space based platform – SUN and Geosynchronous orbits – sensors for EM Spectra - Orbital & Sensor characteristics – Calibration- International Satellite Mission - high resolution satellite sensors- „Step & Stare“ and Time Delay Integration mode - Hardcopy and digital data Products - stereo satellite data products – Indian Remote Sensing Program. Thermal Remote Sensing: Thermal radiation principles – Thermal interaction sensors and characters – thermal image characters – image degradation sources & correction – interpretation of thermal images – Applications. Hyperspectral Remote Sensing: Diffraction principles - field spectrum – BDRF and spectral reflectance & imaging spectrometry - sensors - virtual dimensionality – Data reduction, Calibration and normalization – Hough's phenomenon - Data Characteristics Binary encoding- thresholding - library matching. LIDAR: LIDAR – Principles and Properties- different LIDAR System- Space Borne and airborne LIDAR missions – Typical parameters of LIDAR system. Data Processing – geometric correction- data quality enhancement – filtering LIDAR mapping applications – hydrology, Disaster mitigation and management.

## Syllabus of Paper – 2

### ENVIRONMENTAL SCIENCE AND ENGINEERING

Environment, Ecosystems And Biodiversity: Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers- Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds. Environmental Pollution: Causes, effects and control measures of: (a) Air pollution (Atmospheric chemistry-Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry;- Mitigation procedures- Control of particulate and gaseous emission, Control of SO<sub>2</sub>, NO<sub>x</sub>, CO and HC) (b) Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. (c) Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards–role of an individual in prevention of pollution – pollution case studies . Natural Resources: Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins – Biochemical degradation of pollutants, Bioconversion of pollutants. Social Issues And The Environment: From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization-environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act –The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labeling of environmentally friendly products (Ecomark). Enforcement machinery involved in environmental legislation- central and state pollution control boards-disaster management: floods, earthquake, cyclone and landslides. Public

awareness. Human Population And The Environment: Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.

## **GEO DATABASE SYSTEM**

Introduction: Data – Information - File system vs DBMS – Database Management Systems – Database Architectures, users and administrators – Classification of Database Management Systems - Spatial Data- Points, Lines, Polygons- definition of SDBMS -user classes of SDBMS - Multi layer architecture of SDBMS - GIS and SDBMS. Spatial Concepts And Datamodels: Field based model – object based model – spatial data types – operations on spatial objects-Entity Relationship Model (ER Model) – Relational Model – Constraints and Normal forms of Relational Model - mapping ER model to Relational model – ER model with spatial concepts – Object-oriented data modeling with Unified Modeling Language (UML). Query Language: SQL – Data Definition – Data Manipulation - Basic structure of SQL – Set operations – Aggregate Functions –Simple queries –spatial vs non spatial- Nested sub queries – Complex queries – Views – Trigger - OGIS standard for extending SQL - example spatial SQL queries – Object relational SQL. Spatial Storage And Indexing: Disk geometry – Buffer manager –Field-Record – File – File Structure – Clustering -Basic concepts of file organizations, indexing – Spatial Indexing – Grid files – R Tree – Concurrency support – Spatial Join index - Database recovery techniques – Database Security. Spatial Database Systems And Application Design And Developments: Exploring Spatial Geometry, Organizing spatial data, spatial data relationships and functionalities of any one commercial and one FOSS DBMS each – Application program and user Interfaces.

## **GEODESY**

Fundamentals of Geodesy: Definitions- Classifications, Problem of Geodesy and purpose of Geodesy Historical development and Organization of Geodesy. Reference Surfaces and their relationship. Applications - Engineering, Lunar and Planetary Geodesy - Interferometric Synthetic aperture radar Geodesy – Local and International Spheroid. Geometric Geodesy: Geometry of ellipsoid, fundamental mathematical relationship of ellipsoid, Geodetic, Geocentric and Reduced latitudes and their relationship. Ellipsoidal Co-ordinates in terms of Reduced, Geodetic and geocentric latitude. Radius of curvature in the meridian & prime vertical and their relationship. Mean Radius of curvature in any azimuth, Length of the meridian arcs and arcs of parallel and Area of trapezium on the ellipsoid. Curves on the ellipsoid, properties of Geodesic. Co-Ordinate Systems: Natural or Astronomical Co-ordinate System, Geodetic or Geographical co-ordinate System, Rectangular or Cartesian Co-ordinate System and relationship between them. Curvilinear Co-ordinate System. Deflection of Vertical, Spherical excess. Astro-Geodetic method of determining the reference Spheroid. Physical Geodesy: Basics - INGN -the significance of gravity measurements, Gravity field of earth, Concept of equipotential, Geo potential and Sphero potential Surface - Normal gravity and its computations, Methods of measuring Absolute and Relative gravity- Gravimeters-Reduction of gravity measurements, terrain and Isostasy corrections. Gravity networks. Gravity anomaly and Gravity disturbance-Fundamental equation of Physical Geodesy. Gravimetric determination of Geoid and Deflection of Vertical. Geodetic Astronomy: Celestial coordinates systems and its relationship with Cartesian Co-ordinates and Transformation between them -Special star positions, Major constellations- time systems (sidereal, Universal , atomic and standard ) rising and setting of Stars with respect to Declination, hour angle and Azimuth, Culmination, Prime Vertical Crossing and Elongation.

## **DIGITAL IMAGE PROCESSING FOR GEOINFORMATICS ENGINEERS**

Fundamentals of Image Processing: Information Systems - Encoding and decoding - acquisition, storage and retrieval –data products-Digital Image Processing Systems - Hardware and software design consideration Scanner, digitizer - photo write systems. Sensor Models And Pre Processing: Image Fundamentals – Sensor models – spectral response – Spatial response – IFOV, GIFOV & GSI – Simplified Sensor Models – Sampling & quantization concepts – Image Representation & geometry and Radiometry – Colour concepts – Sources of Image degradation and Correction procedures- Atmospheric Radiometric, Geometric Corrections- Image Geometry Restoration- Interpolation methods and resampling techniques. Image Enhancement: Image Characteristics - Histograms - Scatter grams – Univariate and multi variate statistics-enhancement in spatial domain – global, local & colour Transformations – PC analysis, edge detections, merging- filters-convolution – LPF, HPF , HBF, directional box, cascade – Morphological and adaptive filters – Zero crossing filters – scale space transforms – power spectrum – texture analysis - Fourier Transformations- inverse transformations wavelet & curvelet transformations. Image Classification: Spectral discrimination - pattern recognition concepts - Baye"s approach - Signature and training sets – Separability test – parametric and non parametric classifiers – Segmentation (Spatial, Spectral)- Fuzzy set classification , member ship function and de-fuzzifications – sub-pixel classifier- hybrid classifiers - accuracy assessment – error matrix – Kappa statistics – ERGAS, RMS etc., Object Recognition: Morphological operators - descriptors - representation schemes – Compressions- Image matching, template, correlation, texture based operators, Geometry operators- Artificial Neural nets - Expert system, types and examples - Knowledge systems- representation knowledge handling – decision making paradigms.

## **GEOGRAPHIC INFORMATION SYSTEM**

Fundamentals of GIS: Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data-types of attributes – scales/ levels of measurements. Spatial Data Models: Database Structures – Relational, Object Oriented – Entities – ER diagram - data models-conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models. Data Input And Topology: Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input –Digitiser – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration. Data Quality And Standards: Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards – Interoperability - OGC - Spatial Data Infrastructure. Data Management And Output: Import / Export – Data Management functions - Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS-distributed GIS.

## **MICROWAVE REMOTE SENSING**

Fundamentals and Active System: Introduction-Plane waves-Interference, Radar remote sensing - Radar basics- Antenna Systems - Real aperture radar - Radar frequency bands - SLAR Imaging Geometry, Resolution Concepts - Geometric Distortions, SAR – Concepts - Doppler principle & Processing. RADAR Interaction with earth surface- RADAR equation. Measurement And Discrimination: Measurement and discrimination – sensors and target parameters- Surface

Scattering – Dependence on Roughness - dependence on dielectric constant, Simple physical scattering models, Volume Scattering- Penetration depth - Volume scattering behavior of earth features, Speckle reduction. Special Topics: SAR Interferometry-Basics- Differential SAR Interferometry-applications polarimetry- Introduction - Polarization Ellipse - Polarization types – Synthesis and signatures – Polarimetric parameters-Information extraction – Polarimetric Image Interpretation and applications. Altimetry - Principle – Frequency bands – Location Systems-missions, Scatterometry- Scatterometer types and calibration. Sar Sensors & Applications of Radar: Airborne, Space borne – different platforms and sensors- History- ENVISAT, ASAR, ALOS / PALSAR- RADARSAT missions.- SAR Data products and selection procedure - Applications in Agriculture- Forestry - Geology –Hydrology - Ice Studies - Landuse- landcover mapping – Ocean related studies. Passive System : Radiometry- Passive microwave sensing components - Blackbody radiation and Greybody radiation – Emissivity, Radiometers – Components - Brightness temperature - Antenna temperature - Power-temperature correspondence, passive microwave interaction with atmospheric constituents - Emission characteristics of various earth features – Data products and Applications - Passive missions- DMSP, TRMM, Aqua missions, AMSR-E.

## **TOTAL STATION AND GPS SURVEYING**

Fundamentals Of Total Station And GPS: Methods of Measuring Distance, Basic Principles of Total Station, Historical Development, Classifications, applications and comparison with conventional surveying. Basic concepts of GPS-Historical perspective and development - applications - Geoid and Ellipsoid- satellite orbital motion - Keplerian motion – Kepler's Law - Perturbing forces - Geodetic satellite - Doppler effect - Positioning concept – GNSS. Electromagnetic Waves: Classification - applications of Electromagnetic waves, Propagation properties, wave propagation at lower and higher frequencies- Refractive index (RI) - factors affecting RI-Computation of group for light and near infrared waves at standard and ambient conditions-Computation of RI for microwaves at ambient condition - Reference refractive index- Real time application of first velocity correction. Measurement of atmospheric parameters- Mean refractive index- Second velocity correction -Total atmospheric correction- Use of temperature - pressure transducers. Electro Optical And Micro Wave System: Electro-optical system: Measuring principle, Working principle, Sources of Error, Infrared and Laser Total Station instruments. Microwave system: Measuring principle, working principle, Sources of Error, Microwave Total Station instruments. Comparison between Electro- optical and Microwave system. Care and maintenance of Total Station instruments. Modern positioning systems – Traversing and Trilateration. Satellite System: GPS - Different segments - space, control and user segments - satellite configuration - GPS signal structure - Orbit determination and representation - Anti Spoofing and Selective Availability - Task of control segment - GPS receivers. GPS Data Processing: GPS observables - code and carrier phase observation - linear combination and derived observables - concept of parameter estimation – downloading the data -data processing – software modules -solutions of cycle slips, ambiguities, RINEX format. Concepts of rapid, static methods with GPS - semi Kinematic and pure Kinematic methods -basic constellation of satellite geometry & accuracy measures - applications- long baseline processing- use of different softwares available in the market.

## **OPEN SOURCE GIS**

Basics For Open Source Implementation: Open Source Software and Freeware W3C, WWW and Protocols – Software standards and open source GIS -OGC , GDAL and OSGeo, FOSS4G - Open source software for Desktop GIS and WEB mapping - Proprietary vs Open source - OGC



Standards. Open Source Development Environment: Linux and Windows – Post gresSQL and Oracle Engines - C,C++, OOP and Java streams - GNU, SUN Solaris, Mosix – WAP and Android stack –Scripts and Macros. Desktop GIS With Open Source GIS: View Graphics – Data exchanges- portability and interoperability – Raster handling and Image analysis – vector data management –Rater and vector analysis - 2D/3D vectors with topology, 3D Voxel, 2D Raster. Data Base Management And User Interface: Files vs Database - Distributed operations and Architecture – ODBC - Open source Database management tools- Database: Spatial and Attribute queries Spatial functions and Analysis – Map Server, Application Server and Data Base server concepts. Open Software And Web Mapping: Open Source Software : GRASS, QGIS, OSSIM, Postgres SQL and (R) Environment – WEB Mapping Architecture and components – WEB mapping servers- Thin clients in WEB mapping - WMS,WFS, WCS,WPS and other web services- Open Server standards.

## **SPATIAL AND NETWORK ANALYSIS**

Raster Analysis: Raster Data Exploration: Query Analysis - Local operations: Reclassification, Logical and Arithmetic Overlay operations- Map Algebra –Neighbourhood operations: Aggregation, Filtering – Extended Neighbourhood operations- Zonal Operations - Statistical Analysis – Cost-Distance Analysis-Least Cost Path. Vector Analysis: Non-topological analysis: Attribute database query, Structured Query Language, Co-ordinate transformation, Summary Statistics, Calculation of Area, Perimeter and distance– Topological Analysis: Reclassification, Aggregation, Overlay analysis: Point-in-polygon, Line-in-Polygon, Polygon-on-Polygon: Clip, Erase, Identity, Union, Intersection – Proximity Analysis: Buffering. Network Analysis: Network – Introduction - Network Data Model – Elements of Network - Building a Network database - Geocoding – Address Matching - Shortest Path in a Network – Time and Distance Based shortest path analysis – Driving Directions – Closest Facility Analysis – Catchment / Service Area Analysis-Location-Allocation Analysis. Surface And Geostatistical Analysis: Surface Data – Sources of X,Y, Z data – DEM, TIN – Terrain Analysis – Slope, Aspect, Viewshed, Watershed Analysis: Watershed boundary, Flow Direction, Flow Accumulation, Drainage Network, Spatial Interpolation: IDW, Spline, Kriging, Variogram. Customisation, Web GIS, Mobile Mapping: Customisation of GIS: Need, Uses, Scripting Languages –Embedded scripts – Use of C++, Java and Python in GIS - Web GIS: Web GIS Architecture, Advantages of Web GIS, Web applications-Mobile Mapping - Location Based Services and Applications.

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