

# Indian Institute of Remote Sensing Dehradun

## Guidelines and Syllabus

### A. Guidelines for IIRS M.Tech. / M.Sc./ PG Diploma Entrance Examination

The Entrance Examination having objective type question papers of 100 marks for M.Tech., M.Sc. and PGD courses shall be conducted at different centers (Ahmedabad, Bangalore, Dehradun, Delhi, Hyderabad, Kolkata, Nagpur, Lucknow, Shillong, and Thiruvananthapuram). The entrance exam will be computer based exam (online) on the following topics:

#### i. M.Tech. /PG Diploma Entrance Examination

S. No.	Subjects of Examination	Number of Questions	Max. Marks	Time Duration	Examination Date and Time
1.	Basic Science	25	25	25 Min.	<b><u>Tentative</u></b> May 9, 2020 (forenoon)
2.	Basic Mathematics	25	25	40 Min.	
3	General knowledge, Aptitude Test and Reasoning	25	25	30 Min.	
4.	Optional Themes/Specialisation (any one of the eight, as per your choice):	25	25	25 Min.	Exam Time: 0930 - 1130 hrs.  Reporting Time : 0830 hrs
	a. Agriculture & Soils				
	b. Forest Resources & Ecosystem Analysis				
	c. Geosciences				
	d. Water Resources				
	e. Marine and Atmospheric Sciences				
	f. Urban & Regional Studies				
	g. Satellite Image Analysis & Photogrammetry				
	h. Geoinformatics				
	i. Natural Hazards & Disaster Risk Management				
	j. Spatial Data Science*				

The candidates have to select only one optional theme/specialisation paper for the examination, out of the 10 themes, given at serial No. 4 in above table. (\* only PG Diploma)

## ii. M.Sc. /PG Diploma-Geoinformatics Entrance Examination

S. No.	Subjects of Examination	Number of Questions	Max. Marks	Time Duration	Examination Schedule
1.	Basic Science	25	25	25 Min.	<b>Tentative</b> May 9, 2020 (forenoon) Exam Time: 1400 - 1600 hrs. Reporting Time : 1300 hrs
2.	Basic Mathematics	25	25	35 Min.	
3.	General knowledge, Aptitude Test and Reasoning	25	25	30 Min.	
4.	Geoinformatics	25	25	30 Min.	

### Please note that:

1. Candidates in the final semester/year of the qualifying degree can also apply under the "Result Awaited" category. For details, please read the 'Instructions for Appearing Candidates' in the 'Important Information' section given at the end of IIRS Academic Calendar available at following url:  
[https://iirs.gov.in/iirs/sites/default/files/pdf/AcademicCalendar\\_2020-21.pdf](https://iirs.gov.in/iirs/sites/default/files/pdf/AcademicCalendar_2020-21.pdf) .
2. TA/DA will not be paid by IIRS for appearing in the Entrance Examination.
3. Candidates have to make their own arrangements for accommodation.
4. IIRS reserves the rights to change the Centres of examination depending on its availability, no. of candidates or due to any other administrative reasons.
5. Any change, in the dates for entrance examination shall be notified on IIRS website.
6. The decision of Director, IIRS shall be final and binding regarding all issues related to admissions for various courses.
7. The addresses of the Entrance Examination Centres will be announced later.

## B. Syllabus for M.Tech. (RS & GIS), M.Sc. (Geoinformatics) and PG Diploma Entrance Examination

### 1. M.Tech. / PG Diploma Entrance Examination

#### 1.1 Basic Science (Common)

(25 Marks)

##### 1.1.1 Chemistry

Matter: solid, liquid and gas; change of state - melting (absorption of heat), freezing, evaporation (Cooling by evaporation), condensation, sublimation Elements, compounds and mixtures.

Atoms and molecules, Atomic and molecular masses, Valency. Chemical formulae of common compounds.

Electrons, protons and neutrons; isotopes and isobars.

Chemical Equation, types of chemical reactions, Acids, bases and salts, concept of pH scale Metals and non-metals formation and properties of ionic compounds, Carbon compounds, Covalent bonding in carbon compounds. Periodic classification of elements.

##### 1.1.2 Physics

Distance and displacement, velocity; uniform and non-uniform motion along a straight line; acceleration. Force and motion, Newton's laws of motion, inertia of a body, inertia and mass, momentum, force and acceleration. Elementary idea of conservation of momentum, action and reaction forces. Gravitation; universal law of gravitation, force of gravitation of the earth (gravity), acceleration due to gravity; mass and weight; free fall. Thrust and pressure. Archimedes' principle, buoyancy, elementary idea of relative density. Work, power, Sound, Basic principles of optics, Electromagnetic Theory Different forms of energy, conventional and non-conventional sources of energy: fossil fuels, solar energy; biogas; wind, water and tidal energy; nuclear energy. Renewable versus non-renewable sources.

#### 1.2 Basic Mathematics - Part I (Common)

(25 Marks)

##### 1.2.1 Number Systems

**Real Numbers:** Euclid's division Lemma, Fundamental Theorem of Arithmetic, proof of the results- irrationality of  $\sqrt{2}$ ,  $\sqrt{3}$ ,  $\sqrt{5}$  decimal expansions of rational numbers in terms of terminating/non-terminating recurring decimals.

##### 1.2.2 Algebra

**Polynomials:** Zeros of a polynomial. Relationship between zeros and coefficients of quadratic polynomials. Statement and simple problems on division algorithm for polynomials with real coefficients.

**Pair of linear equations in two variables:** Pair of linear equations in two variables and their graphical solution. Geometric representation of different possibilities of solutions/inconsistency. Algebraic conditions for number of solutions. Solution of pair of linear equations in two variables algebraically – by substitution, by elimination and by cross-multiplication. Simple problems on equations reducible to linear equations.

**Quadratic equations:** Standard form of a quadratic equation  $ax^2 + bx + c = 0$ , ( $a \neq 0$ ). Solution of the quadratic equations (only real roots) by factorization, by completing the square and by using quadratic formula. Relationship between discriminant and nature of roots.

**Arithmetic progressions:** General form of arithmetic progression (AP), finite and infinite AP, common difference, derivation of standard results of finding the  $n$ th term and summation of  $n$  terms of AP.

### 1.2.3 Trigonometry

**Introduction to trigonometry:** Trigonometry ratios of an acute angle of a right-angled triangle. Proof of their existence; Values of the trigonometric ratios of  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$  and  $90^\circ$ . Relationships between the ratios.

**Trigonometric identities:** Proof and applications of the trigonometric identities (e.g.  $(\sin A)^2 + (\cos A)^2 = 1$ ). Trigonometric ratios of complementary angles.

**Heights and distances:** Simple and believable problems on heights and distances.

### 1.2.4 Coordinate Geometry

**Lines ( 2-Dimensions):** Concepts of coordinate geometry including graphs of linear equations. Geometrical representation of quadratic polynomials. Distance between two points and section formula (internal). Area of triangle.

### 1.2.5 Geometry

**Triangles:** Definitions, examples, counter examples of similar triangles, properties of triangles (proof and application).

**Circles:** Definition of tangent to a circle, properties of the tangents drawn to a circle from a point (proof and application).

### 1.2.6 Mensuration

**Areas related to circles:** The area of a circle; area of sectors and segment of a circle. Problems based on areas and perimeter/circumference of the simple figures such as triangles, simple quadrilaterals and circles.

**Surface areas and volumes:** Problems on finding surface areas and volumes of combinations of the following: cubes, cuboids, spheres, hemispheres and right circular cylinders/cones. Frustum of the cone. Problems involving converting one type of metallic solid into another and other mixed problems.

### 1.2.7 Statistics and Probability

**Statistics:** Mean, median and mode of a ungrouped/grouped data, SD, Correlation, Regression Cumulative frequency graph.

**Probability:** Simple problems of single events on classical definition of probability.

### 1.3 General Knowledge, Aptitude test and Reasoning (Common) (25 marks)

No defined syllabus

### 1.4 Optional Themes –. (Choose any one of the options) (25 marks)

[M.Tech./PG Diploma students to choose one of the optional theme/specialisation; M.Sc./ PG Diploma-Geoinformatics students have to choose only Geoinformatics theme]

#### 1.4.1 Agriculture and Soils

**Agronomy & Crop Science:** Introduction and importance of agriculture in India, factors affecting crop production, classification and groups of crops, agronomic practices, crop planning, raising field crops in multiple cropping systems, crop combination and diversification, crop combination regions and agricultural development, methods of soil moisture estimation, water requirement and water management in different crops, crop water relations –physiological importance of water to plants, principles and practices of rainfed agriculture and watershed management, classification and distribution of dry land, regional pattern of crop productivity in India, agriculture land use pattern, land use policy and planning.

**Soil Science:** Pedological concepts, soil as a natural body, rocks and minerals, weathering, soil formation factors and processes, components of soils, geological structures and landforms, geomorphic processes, physiographic units, soil profile, soil fertility, factors affecting soil fertility, nutrient elements in plant nutrition – sources and classification, soil physical and chemical properties, soil textural classes, soil water retention, movement of soil water, infiltration, percolation, hydraulic conductivity, permeability, classification of manures and fertilizers and green manuring, soil survey and USDA Soil classification, Land Capability Classification, saline-alkali soils, acid soils, soils of India and their potential and problem, land reclamation, Soils of India.

**Agricultural Meteorology:** Weather and climate, weather elements, climatic factors, plant response to environment, measurement of weather parameters, concept of water balance-calculation of water balance and determination of climatic type, Earth's atmosphere, composition and structure of atmosphere, cyclones, anticyclones and general circulation system of earth, solar radiation – nature and properties, factors affecting solar radiation, solar constant and energy balance, types of precipitation, types of monsoon, agricultural seasons, index of aridity, drought and its classification, agro-

climatic zones of India, Global warming – indicator, agent and causes, Global warming and its impacts.

**Soil & Water Conservation:** Basics of soil hydrology, concept of watershed, geomorphology of watersheds - stream number, stream length, stream area, stream slope, drainage basin analysis, delineation of basins- subdivisions-stream ordering system, bifurcation ratio, drainage density, runoff - factors affecting, runoff measuring structures, introduction to watershed management and planning, soil erosion - causes, types and agents of soil erosion; soil loss estimation - universal soil loss equation, soil erosion control structures, agronomical soil conservation methods, water harvesting techniques, wind erosion, wind erosion control measures, water quality and pollution.

#### **1.4.2 Forest Resources & Ecosystem Analysis**

##### **Forest Mapping and Monitoring**

Forest types of India; Vegetation of the world; Species invasion; Forest disease.

##### **Forest Inventory and Informatics**

Forest inventory; Forest sampling; Estimation of volume, growth and yield; Statistical data analysis; Growing stock and biomass assessment; Protected areas, Corridors; Kyoto protocol, NATCOM, REDD, REDD+, Clean Development Mechanism (CDM); Forest, environment and biodiversity legislation; Biodiversity; Forest fire.

##### **Ecology/Ecosystem Analysis**

Forest ecosystems principles and concepts; Structural components; Functional analysis; Biogeochemical cycles; Carbon pools and fluxes assessment; Forest ecosystem and climate change; Climate change impacts on forests and biodiversity; Environmental impact assessment and monitoring; Environmental policy and strategy; Environmental monitoring; Agenda-21 and sustainable development planning; Millennium ecosystem assessment.

#### **1.4.3 Geosciences**

**Geomorphology and Photo geology/Remote Sensing:** Basic principles; Weathering and soils; Mass wasting; Geomorphology of fluvial tracts, arid zones, coastal regions, 'Karst' landscape and glaciated ranges; Geomorphic mapping, slope analysis, and drainage basin analysis; Applications of geomorphology in mineral prospecting; civil engineering and environmental studies; Topographical maps; Geomorphology of India; Fundamentals of geological interpretation of aerial photographs and satellite images.

**Structural Geology:** Principles of geological mapping and map reading, Structural analysis of folds, cleavages, lineations, joints and faults; Superposed deformation; Mechanism of folding and faulting; active tectonics; and Unconformities

**Geo-tectonics:** Earth and the solar system; Planetary evolution of the earth and its internal structure; Heterogeneity of the earth's crust; Major tectonic features of the

Oceanic and Continental crust; Sea floor spreading and plate tectonics; Isostasy, orogeny and epirogeny; Seismic belts of the earth; Seismicity and plate movements; Geodynamics of Indian plate

**Stratigraphy:** Geological time scale; Precambrian stratigraphy of India; Stratigraphy of Palaeozoic, Mesozoic and Ceinzoic formations of India; Gondwana system and Gondwanaland; Rise of the Himalaya and evolution of Siwalik basin; Deccan Volcanics; Quaternary Stratigraphy.

**Mineralogy:** Physical, chemical and crystallographic characteristics of common rock forming silicate mineral groups.

**Igneous and Metamorphic Petrology:** Forms, textures and structures of igneous rocks; Textures and structures of metamorphic rocks; Characteristics of different grades and facies of metamorphism.

**Sedimentology:** Sedimentary rocks, Sedimentary textures; Sedimentary environment and facies; Tectonics and sedimentation; Classification and definition of sedimentary basins; Sedimentary basins of India; Purpose and scope of basin analysis.

**Environmental Geology:** Concepts and principles; Natural hazards - preventive/precautionary measures - landslides, earthquakes, river and coastal erosion; Impact assessment of anthropogenic activities such as open cast mining and quarrying, river valley projects, disposal of industrial and radio-active waste, dumping of ores, mine waste and fly-ash.

**Economic Geology:** Occurrence and distribution in India of metalliferous deposits - base metals, iron, manganese, aluminum, chromium, nickel, gold, silver, Indian deposits of non-metals - mica, asbestos, barite, gypsum, granite, graphite, apatite, beryl; Gemstones, refractory minerals, limestone; Building stones; Phosphorite deposits; Placer deposits, rare earth minerals; India's status in mineral production.

**Engineering Geology:** Mechanical properties of rocks and soils; Geological investigations for river valley projects - Dams and reservoirs; tunnels - type, methods and problems; Landslides - classification, causes and prevention; Concrete aggregates - sources.

**Groundwater Geology :** Subsurface movement and vertical distribution of groundwater; Springs; Classification of aquifers; Concepts of drainage basin and groundwater basin; Hydrological properties of rocks - specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient; Water table fluctuations - causative factors; Classification of rocks with respect to their water bearing characteristics; Ground water quality; ground water recharge/artificial recharge.

## 1.4.4 Water Resources

### Basic Hydrology

Concept of Hydrology, Hydrological Cycle, Water Budget of India, Element of Hydrological cycle: Rainfall, interception, infiltration, Soil Moisture, Evapotranspiration etc. Measurement/estimation of elements of hydrological cycle.

### Rainfall-Runoff and Stream Flow

Types of precipitation, rainfall measurement and statistical analysis of rainfall data, interpolation of point rainfall data, Runoff generation process, methods/models to estimate runoff from a watershed, type of rainfall-runoff models and their limitations, different stream flow (velocity) measurement techniques, stage-discharge relationship in stream flow measurement, concept of hydrograph, components of hydrograph, unit hydrograph theory, derivation and conversion of unit hydrograph, application of hydrograph in watershed hydrology, Synthetic Unit Hydrograph, concepts of Instantaneous Unit Hydrograph, basics of open channel hydraulics

### Watershed Hydrology

Concept of watershed, watershed delineation, watershed characteristics, Morphology of watershed, effect of watershed characteristics on runoff response of watershed, rainfall-runoff-soil erosion process in watershed, concepts of soil erosion, agents of soil erosion, type of soil erosion, soil erosion and sediment yield modelling, concept of water conservation, measures for watershed conservation, rain water harvesting.

### Hydro-meteorological Disasters

Concepts of floods, flood analysis using stream flow data, data requirement for flood frequency analysis, flood frequency analysis, different methods of flood discharge estimation (rational, empirical, unit hydrograph etc.) Basics of flood routing, concept of flood attenuation, different techniques of flood routing, flood control works, Drought and its classification.

### Irrigation and Drainage

Types of irrigation system, different efficiencies in irrigation system, basics of soil mechanics (porosity, saturation, field capacity, type soil water, etc.), crop water requirement, Irrigation water requirement, infiltration, seepage, basic concepts of ground water, type of saturated formations, types of aquifer, aquifer properties, basics of governing equations of ground water flow for different aquifer conditions, groundwater pumping and recharge.



### 1.4.5 Marine and Atmospheric Sciences

**Atmosphere and Ocean Dynamics:** Atmospheric structure and composition, temperature and pressure variation with altitude, electromagnetic radiation, solar constant and solar radiation at top of the atmosphere. Energy balance (incoming and outgoing solar radiation), greenhouse use gases and their role to maintain the atmospheric temperature. Hydrostatic equation, difference between weather and climate, Ocean temperature variation with depth, radiation.

**Satellite Meteorology:** Basic radiometric quantities; interaction of electromagnetic radiation (EMR) with atmosphere: gaseous absorption and emission, scattering, reflection of solar radiation from the surface of earth.

**Coastal Processes and Marine Ecology:** Classification of coasts, primary coasts, secondary coasts, coasts formed by biological activity; beaches, beach scarp, berm, sand spit, sea cave, sea cliff, delta; landforms due to erosional and depositional activities.. Climate change and sea level rise. Coastal disasters like tsunami, cyclone, storm surge etc. Mangroves, corals and sea grasses

### 1.4.5 Natural Hazards & Disaster Risk Management

#### Basics of Natural Hazards and Disaster Risk Management

Definitions of Natural Disasters and Manmade disasters; Various types of Natural disasters and their basic understanding (Floods, Earthquakes, landslides, Tsunamis, Cyclones, droughts etc.); Disaster management framework of India and recent initiatives by Govt. of India such as National Disaster Management Act, and Disaster Management Institutions in India – NDMA, NIDM, International Initiatives in the field of Disaster Management – Sendai Framework.

#### Geological Hazards

Geomorphology of India – Indian Mountain ranges, deserts, coast line, rivers and river plains, plateaus and islands; Internal structure of earth; Seismic belts of the earth; Seismic hazard zones of India; Landslides – Causes and consequences; Earthquakes – causes, consequences and precautionary measures; Volcanoes – Types and consequences.

#### Hydrological-meteorological and coastal Hazards

Concepts of hydrology, hydrological Cycle, watershed & its characteristics, flood hydrology, flood hazards, Basic concepts related to droughts, Types of droughts and their impacts, soil erosion, coastal morphology and processes, tropical cyclones, tsunami, climate change.

#### Environment and Ecology

Intergovernmental Panel on Climate Change (IPCC), Climate change impacts on forests and biodiversity, Biogeochemical cycles (Carbon, Nitrogen and Phosphorus), Environmental impact assessment and monitoring, Sustainable development planning,

Millennium ecosystem assessment, protected areas, Wildlife and ecological corridors, disease and epidemic, Forest fires.

## **Drought and Atmospheric Science**

Composition and structure of atmosphere, temperature and pressure variation with altitude, interaction of EMR with atmosphere, basic laws of solar radiation, scattering, absorption, Beer Lambert's law. General circulation system of earth (Atmospheric circulation), air pollution, Global warming: indicators, greenhouse gases, atmospheric greenhouse effect.

### **1.4.6 Spatial Data Science**

#### **1.4.6.1 Computation Skills and Programming**

Computer-based statistical & Numerical methods (Errors, Algebraic and Transcendental Equations, Interpolation, numerical Integration and Differentiation, numerical Solution of Ordinary Differential Equation and statistical Computation), Programming and Problem Solving through C/C++/Python/Fortran etc. (Character Set, Constants, Variables, Instructions, Sequences, Basic Structure, Loop Control, Arrays and String, Pointers, Structure and Unions, and Storage Classes), Data Structures (Arrays, Strings, Stacks, Queues, List and Tree, Asymptotic analysis, Basic math operations- addition, subtraction, multiplication, division, exponentiation, Basic Recursion, Basic Dynamic Programming, Naive string searching, Sorting and Binary Searching), Object Oriented Programming, Computer System Architecture, Database Management System (DBMS/RDBMS), SQL, Data Warehouse, Data Communication and Network Technologies, Wireless and Mobile Communications.

#### **1.4.6.2 Physics (Part II)**

Units of measurement, Dimensions of physical quantities, Scalar and vector quantities, Laws of Motion, Elastic behaviour, Stress-strain relationship, Thermal equilibrium, Laws of thermodynamics, Kinetic theory of gases, Periodic motion, Resonance, Doppler effect, Electric Charges, Coulomb's law, Electric field, Electric potential, Electric current, Ohm's law, Electrical resistance, Carbon resistors, color code for carbon resistors, series and parallel combinations of resistors; Concept of magnetic field, Ampere's law, Magnetic dipole and its magnetic dipole moment, Torque, Electromagnetic waves and their characteristics, Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X rays, gamma rays) including elementary facts about their uses, Reflection of light, Refraction of light, Total internal reflection, lenses, Magnification, Power of a lens, Dispersion, Scattering of light, Wave optics, Resolving power, Dual nature of radiation, de Broglie relation, Radioactivity, Mass-energy relation, Nuclear fission and fusion, Semiconductors, Logic gates (OR, AND, NOT, NAND and NOR )

#### **1.4.6.3 Maths (Part II)**

##### **Sets and Functions**

**Sets:** Sets and their representations, empty set, finite & infinite sets, subsets, subsets of the set of real numbers especially intervals (with notations). Power set, universal set, Venn diagrams, union and intersection of sets, difference of sets, complement of a set

**Relations & Functions:** Ordered pairs, Cartesian product of sets, number of elements in the Cartesian product of two finite sets. Cartesian product of the reals with itself (unto  $\mathbb{R} \times \mathbb{R} \times \mathbb{R}$ ), definition of relation, pictorial diagrams, domain, co-domain and range of a relation, function as a special kind of relation from one set to another, pictorial representation of a function, domain, co- domain & range of a function, real valued function of the real variable, domain and range of these functions, constant identity, polynomial, rational, modulus, signum and greatest integer functions with their graphs, Sum, difference, product and quotients of functions. Types of relations: reflexive, symmetric, transitive and equivalence relations. One to one and onto functions, composite functions, inverse of a function. Binary operations.

**Trigonometric Functions:** Positive and negative angles, measuring angles in radians & in degrees and conversion from one measure to another. Definition of trigonometric functions with the help of unit circle. Signs of trigonometric functions and sketch of their graphs. Expressing  $\sin(x+y)$  and  $\cos(x+y)$  in terms of  $\sin x$ ,  $\sin y$ ,  $\cos x$  &  $\cos y$ . Identities related to  $\sin 2x$ ,  $\cos 2x$ ,  $\tan 2x$ ,  $\sin 3x$ ,  $\cos 3x$  and  $\tan 3x$ . General solution of trigonometric equations of the type  $\sin \theta = \sin \alpha$ ,  $\cos \theta = \cos \alpha$  and  $\tan \theta = \tan \alpha$ .

**Inverse Trigonometric Functions:** Definition, range, domain, principal value branches. Graphs of inverse trigonometric functions. Elementary properties of inverse trigonometric functions.

## Algebra

**Principles of Mathematical Induction:** Processes of the proof by induction, motivating the application of the method by looking at natural numbers as the least inductive subset of real numbers. The principle of mathematical induction and simple applications.

**Complex Numbers and Quadratic Equations:** Need for complex numbers, especially  $i$ , to be motivated by inability to solve every quadratic equation, Brief description of algebraic properties of complex numbers, Argand plane and polar representation of complex numbers. Statement of fundamental theorem of algebra, solution of quadratic equations in the complex number system.

**Linear Inequalities:** Linear inequalities. Algebraic solutions of linear inequalities in one variable and their representation on the number line. Graphical solution of linear inequalities in two variables. Solution of system of linear inequalities in two variables-graphically.

**Permutations & Combinations:** Fundamental principle of counting. Factorial  $n$  ( $n!$ ). Permutations and combinations, derivation of formulae and their connections, simple applications.

**Binomial Theorem:** History, statement and proof of the binomial theorem for positive integral indices. Pascal's triangle, General and middle term in binomial expansion, simple applications.

**Sequence and Series:** Sequence and Series. Arithmetic progression (A.P.), arithmetic mean (A.M.), Geometric progression (G.P.), general term of a G.P., sum of  $n$  terms of a G.P., geometric mean (G.M.), relation between A.M. and G.M. Sum to  $n$  terms of the special series.

**Matrices:** Concept, notation, order, equality, types of matrices, zero matrix, transpose of a matrix, symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, simple properties of addition, multiplication and scalar multiplication. Non-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists; (Here all matrices will have real entries).

**Determinants:** Determinant of a square matrix (up to  $3 \times 3$  matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

## **Coordinate Geometry**

**Straight Lines:** Slope of a line and angle between two lines. Various forms of equations of a line: parallel to axes, point-slope form, slope-intercept form, two point form, intercept form and normal form. General equation of a line. Distance of a point from a line.

**Conic Sections:** Sections of a cone: circle, ellipse, parabola, hyperbola, a point, a straight line and pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse and hyperbola. Standard equation of a circle.

**Three-dimensional Geometry:** Coordinate axes and coordinate planes in three dimensions. Coordinates of a point. Distance between two points and section formula. Direction cosines and direction ratios of a line, equation of a line in space, angle between (i) two lines, (ii) two planes. (iii) a line and a plane, shortest distance between two lines, Co-planarity of two lines, distance of a point from a plane.

**Vectors:** Vectors and scalars, magnitude and direction of a vector, direction cosines/ratios of vectors. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, additions and subtractions of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio, scalar and vector products of vectors, projection of a vector on a line, scalar triple product of vectors.

## Calculus

**Introduction to Limits and Derivatives:** Derivative introduced as rate of change both as that of distance function and geometrically, intuitive idea of limit. Definition of derivative, relate it to slope of tangent of the curve, derivative of sum, difference, product and quotient of functions. Derivatives of polynomial and trigonometric functions.

**Continuity and Differentiability:** Continuity and differentiability, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit functions. Concept of exponential and logarithmic functions. Derivatives of logarithmic and exponential functions, logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives. Rolle's and Lagrange's Mean Value Theorems (without proof) and their geometric interpretation.

**Applications of Derivatives:** Applications of derivatives, rate of change of bodies, increasing/decreasing functions, tangents and normals, use of derivatives in approximation, maxima and minima (first derivative test motivated geometrically and second derivative test given as a provable tool), Simple problems (that illustrate basic principles and understanding of the subject as well as real-life situations).

**Integrals:** Integration as inverse process of differentiation, Integration of a variety of functions by substitution, by partial fractions and by parts, simple integrals of the following type to be evaluated. Definite integrals as a limit of a sum, fundamental theorem of Calculus (without proof), Basic properties of definite integrals and evaluation of definite integrals.

**Applications of the Integrals:** Applications in finding the area under simple curves, especial lines, circles/parabolas/ellipses, area between the two above said curves.

**Differential Equations:** Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given. Solution of differential equations by method of separation of variables, homogeneous differential equations of first order and first degree. Solutions of linear differential equations.

## Mathematical Reasoning

Mathematically acceptable statements. Connecting words/ phrases - consolidating the understanding of "if and only if (necessary and sufficient) condition", "implies", "and/or", "implied by" "and", "or", "there exists" and their use through a variety of examples related to real life and Mathematics. Validating the statements involving the connecting words-difference between contradiction, converse and contrapositive.

## Statistics & Probability

**Statistics:** Measures of dispersion; mean deviation, variance and standard deviation of ungrouped/grouped data. Analysis of frequency distributions with equal means but different variances.

**Probability:** Random experiments: outcomes, sample spaces (set representation). Events: occurrence of events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability, connections with the theories of earlier classes. Probability of an event, probability of 'not', 'and' & 'or' events. Conditional probability, multiplication theorem on probability, independent events, total probability, Bayes' theorem, random variables and its probability distributions, means and variance of random variable, repeated independent (Bernoulli) trials and Binomial distributions.

## **Linear Programming**

Constraints, objective function, optimization, different types of Linear Programming Problems (LPPs) and its Mathematical Formulation of LPPs, graphical method of solution for problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (up to three non-trivial constraints).

### **1.4.7 Satellite Imagery Analysis & Photogrammetry**

#### **1.4.7.1 Maths (Part II)**

##### **Sets and Functions**

**Sets:** Sets and their representations, empty set, finite & infinite sets, subsets, subsets of the set of real numbers especially intervals (with notations). Power set, universal set, Venn diagrams, union and intersection of sets, difference of sets, complement of a set

**Relations & Functions:** Ordered pairs, Cartesian product of sets, number of elements in the Cartesian product of two finite sets. Cartesian product of the reals with itself (unto  $\mathbb{R} \times \mathbb{R} \times \mathbb{R}$ ), definition of relation, pictorial diagrams, domain, co-domain and range of a relation, function as a special kind of relation from one set to another, pictorial representation of a function, domain, co-domain & range of a function, real valued function of the real variable, domain and range of these functions, constant identity, polynomial, rational, modulus, signum and greatest integer functions with their graphs, Sum, difference, product and quotients of functions.

Types of relations: reflexive, symmetric, transitive and equivalence relations. One to one and onto functions, composite functions, inverse of a function. Binary operations.

**Trigonometric Functions:** Positive and negative angles, measuring angles in radians & in degrees and conversion from one measure to another. Definition of trigonometric functions with the help of unit circle. Signs of trigonometric functions and sketch of their graphs. Expressing  $\sin(x+y)$  and  $\cos(x+y)$  in terms of  $\sin x$ ,  $\sin y$ ,  $\cos x$  &  $\cos y$ . Identities related to  $\sin 2x$ ,  $\cos 2x$ ,  $\tan 2x$ ,  $\sin 3x$ ,  $\cos 3x$  and  $\tan 3x$ . General solution of trigonometric equations of the type  $\sin\theta = \sin \alpha$ ,  $\cos\theta = \cos \alpha$  and  $\tan\theta = \tan \alpha$ .

**Inverse Trigonometric Functions:** Definition, range, domain, principal value branches. Graphs of inverse trigonometric functions. Elementary properties of inverse trigonometric functions.

## Algebra

**Principle of Mathematical Induction:** Processes of the proof by induction, motivating the application of the method by looking at natural numbers as the least inductive subset of real numbers. The principle of mathematical induction and simple applications.

**Complex Numbers and Quadratic Equations:** Need for complex numbers, especially  $\sqrt{-1}$ , to be motivated by inability to solve every quadratic equation, Brief description of algebraic properties of complex numbers, Argand plane and polar representation of complex numbers. Statement of fundamental theorem of algebra, solution of quadratic equations in the complex number system.

**Linear Inequalities:** Linear inequalities. Algebraic solutions of linear inequalities in one variable and their representation on the number line. Graphical solution of linear inequalities in two variables. Solution of system of linear inequalities in two variables-graphically.

**Permutations & Combinations:** Fundamental principle of counting. Factorial  $n$  ( $n!$ ). Permutations and combinations, derivation of formulae and their connections, simple applications.

**Binomial Theorem:** History, statement and proof of the binomial theorem for positive integral indices. Pascal's triangle, General and middle term in binomial expansion, simple applications.

**Sequence and Series:** Sequence and Series. Arithmetic progression (A.P.), arithmetic mean (A.M.), Geometric progression (G.P.), general term of a G.P., sum of  $n$  terms of a G.P., geometric mean (G.M.), relation between A.M. and G.M. Sum to  $n$  terms of the special series.

**Matrices:** Concept, notation, order, equality, types of matrices, zero matrix, transpose of a matrix, symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, simple properties of addition, multiplication and scalar multiplication. Non-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists; (Here all matrices will have real entries).

**Determinants:** Determinant of a square matrix (up to  $3 \times 3$  matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

## Coordinate Geometry

**Straight Lines:** Slope of a line and angle between two lines. Various forms of equations of a line: parallel to axes, point-slope form, slope-intercept form, two point form, intercept form and normal form. General equation of a line. Distance of a point from a line.

**Conic Sections:** Sections of a cone: circle, ellipse, parabola, hyperbola, a point, a straight line and pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse and hyperbola. Standard equation of a circle.

**Three-dimensional Geometry:** Coordinate axes and coordinate planes in three dimensions. Coordinates of a point. Distance between two points and section formula. Direction cosines and direction ratios of a line, equation of a line in space, angle between (i) two lines, (ii) two planes. (iii) a line and a plane, shortest distance between two lines, Co-planarity of two lines, distance of a point from a plane.

**Vectors:** Vectors and scalars, magnitude and direction of a vector, direction cosines/ratios of vectors. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, additions and subtractions of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio, scalar and vector products of vectors, projection of a vector on a line, scalar triple product of vectors.

## **Calculus**

**Introduction to Limits and Derivatives:** Derivative introduced as rate of change both as that of distance function and geometrically, intuitive idea of limit. Definition of derivative, relate it to slope of tangent of the curve, derivative of sum, difference, product and quotient of functions. Derivatives of polynomial and trigonometric functions.

**Continuity and Differentiability:** Continuity and differentiability, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit functions. Concept of exponential and logarithmic functions. Derivatives of logarithmic and exponential functions, logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives. Rolle's and Lagrange's Mean Value Theorems (without proof) and their geometric interpretation.

**Applications of Derivatives:** Applications of derivatives, rate of change of bodies, increasing/decreasing functions, tangents and normals, use of derivatives in approximation, maxima and minima (first derivative test motivated geometrically and second derivative test given as a provable tool), Simple problems (that illustrate basic principles and understanding of the subject as well as real-life situations).

**Integrals:** Integration as inverse process of differentiation, Integration of a variety of functions by substitution, by partial fractions and by parts, simple integrals of the following type to be evaluated. Definite integrals as a limit of a sum, fundamental theorem of Calculus (without proof), Basic properties of definite integrals and evaluation of definite integrals.



**Applications of the Integrals:** Applications in finding the area under simple curves, especial lines, circles/parabolas/ellipses, area between the two above said curves.

**Differential Equations:** Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given. Solution of differential equations by method of separation of variables, homogeneous differential equations of first order and first degree. Solutions of linear differential equations.

### **Mathematical Reasoning**

**Mathematical Reasoning:** Mathematically acceptable statements. Connecting words/phrases - consolidating the understanding of "if and only if (necessary and sufficient) condition", "implies", "and/or", "implied by" "and", "or", "there exists" and their use through a variety of examples related to real life and Mathematics. Validating the statements involving the connecting words-difference between contradiction, converse and contrapositive.

### **Statistics & Probability**

**Statistics:** Measures of dispersion; mean deviation, variance and standard deviation of ungrouped/grouped data. Analysis of frequency distributions with equal means but different variances.

**Probability:** Random experiments: outcomes, sample spaces (set representation). Events: occurrence of events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability, connections with the theories of earlier classes. Probability of an event, probability of 'not', 'and' & 'or' events. Conditional probability, multiplication theorem on probability, independent events, total probability, Bayes' theorem, random variables and its probability distributions, means and variance of random variable, repeated independent (Bernoulli) trials and Binomial distributions.

### **Linear Programming**

Constraints, objective function, optimization, different types of Linear Programming Problems (LPPs) and its Mathematical Formulation of LPPs, graphical method of solution for problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (up to three non-trivial constraints).

#### **1.4.7.2. Physics (Part II)**

Units of measurement, Dimensions of physical quantities, Scalar and vector quantities, Laws of Motion, Elastic behaviour, Stress-strain relationship, Thermal equilibrium, Laws of thermodynamics, Kinetic theory of gases, Periodic motion, Resonance, Doppler effect, Electric Charges, Coulomb's law, Electric field, Electric potential, Electric current, Ohm's law, Electrical resistance, Carbon resistors, color code for carbon resistors, series and parallel combinations of resistors; Concept of magnetic field, Ampere's law, Magnetic dipole and its magnetic dipole moment, Torque, Electromagnetic waves and

their characteristics, Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X rays, gamma rays) including elementary facts about their uses, Reflection of light, Refraction of light, Total internal reflection, lenses, Magnification, Power of a lens, Dispersion, Scattering of light, Wave optics, Resolving power, Dual nature of radiation, de Broglie relation, Radioactivity, Mass-energy relation, Nuclear fission and fusion, Semiconductors, Logic gates (OR, AND, NOT, NAND and NOR).

#### **1.4.7.3 Chemistry (Part II)**

Classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids, electronic configuration of elements, oxidation states, Coordination compounds, coordination number, Bonding, Organic and non-organic compounds, Polymers, Properties of metals and non-metals, Reactivity series, Basic metallurgical processes, corrosion and its prevention, Difference between saturated hydrocarbons and unsaturated hydrocarbons, Soaps and detergents.

#### **1.4.7.4 Computer Fundamentals**

Fundamentals of computer and its operation, general abbreviations and terminologies. Data types, Logic functions, Number representation and computer arithmetic (fixed and floating point). Types of software's, operating system fundamentals. Databases, types of databases, file structure. Fundamentals of Computer Networks. Basic concepts of TCP/IP Protocol, hubs, switches and routers. Basics of web technologies.

### **1.4.8 Geoinformatics**

*Note: Same syllabus as 1.4.6 (i.e. Satellite Imagery Analysis & Photogrammetry)*

### **1.4.9 Urban and Regional Studies**

#### **Urban and Regional Planning Concepts**

Urban and Regional Planning Models, Land use models, Concept and definition of Master Plan, Development Plan, Structure Plan etc., various concepts in urban planning, various criteria of delineation of a region in India, Concept of Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Concept of Green cities and energy efficient cities.

#### **Urbanization and Population**

Urbanization in India, Census classification of urban areas, Definition of urban area, trends in urban population, Urban sprawl: causes and effects, sub-urban development, types of urban structures, New Towns. Population trend in India, types of urban densities, migration, land-man ratio, household size.

#### **Urban Survey and Urban Land Use**

Different types of urban maps, various scales of urban maps, Types of Maps published by Survey of India, scales of statistical measurements, Purpose of sample survey, Human Geography. Definition of land use, various techniques of land use survey, use of land use maps and cadastral maps in urban planning, Effect of land use on land values and related activities.

### **Housing and Infrastructure**

Housing situation in India, Demand and supply, Causes of formation of slums, impact of slums on urban facilities and environment, various urban improvement schemes of Government of India, 74th Constitutional Amendment Act. Solid waste management in India, Various waste disposal techniques, Various types of urban pollutions, Effect of pollution on urban environment, concept of green spaces, impact of urbanization on urban hydrology. Classification of urban roads, types of parking, various types of road and traffic surveys.

## **2. M.Sc. / PG Diploma-Geoinformatics Entrance Examination**

### **2.1 Basic Science (25 Marks)**

*Same syllabus as 1.1*

### **2.2 Basic Mathematics (25 Marks)**

*Same syllabus as 1.2*

### **2.3 General Knowledge, Aptitude test and Reasoning (25 Marks)**

*No define syllabus*

### **2.4 Geoinformatics (25 Marks)**

*Same syllabus as 1.4.7 (i.e. Satellite Imagery Analysis & Photogrammetry)*