NESAC JRF Eligibility Test (N-JET)-2021

No. NESAC/RMT-NJET/03/2021   Date: November 09, 2021

North Eastern Space Applications Centre (NESAC) is an autonomous body set up under the joint initiative of Department of Space (DOS) and the North Eastern Council (NEC). The main function of the Centre is to provide developmental support to the North Eastern Region (NER) of our country using space science and technology. From time to time, NESAC had been recruiting Junior Research Fellows (JRFs) under several national and state level projects in various stream.

About N-JET:

As per the guidelines of Department of Space for the recruitment of the temporary positions of JRF in ISRO/DOS Centres/Unit the candidates apart from meeting the minimum educational criteria must also have qualified NET or equivalent qualification.

N-JET is one of the eligibility test apart from NET/GATE etc. for applying to the post of Junior Research Fellow (JRF)/Senior Research Fellow (SRF) at NESAC for taking up research in the area of either Remote Sensing (RS) and Geographic Information System (GIS) or in the area of Atmospheric Science. Eligibility for applying for N-JET is Master degree in Science from recognised University of India in First Class in the respective disciplines for which candidate is willing to apply.

The N-JET (NESAC-JRF Eligibility Test) is purely an "eligibility test" of qualifying nature. This test gives a unique opportunity to the candidates to qualify and fulfil one of the minimum eligibility conditions laid down by the Department of Space, before applying for any temporary post of JRF/SRF at NESAC in the area of either Remote Sensing (RS) and Geographic Information System (GIS) or in the area of Atmospheric Science as and when advertised. Therefore, the candidates who do not possess the minimum eligibility condition (of NET or equivalent) for applying to the post of JRF (i.e., who do not possess NET or equivalent qualification as mentioned above due to either no such national level qualifying examination exists at present, or where the candidate is from science streams and is interested in applying for the post of JRF/SRF at NESAC on the basis of specialization and/or aptitude towards earth observation/ space technology) may apply for the N-JET. The test is open to all candidates having M.Sc degree. Eligibility for applying for N-JET is Master degree in Science from a recognized University of India in First Class in the respective disciplines for which the candidate is willing to apply.

Those candidates willing to apply for N-JET (NESAC JRF Eligibility Test) shall apply only through our website: www.nesac.gov.in

For RS & GIS Specialisation:

M.Sc in RS & GIS/ Botany/ Ecology/ Forestry/ Environmental Science/ Agriculture (any stream)/ Geology/ Geography (with Bachelor's Degree in Science)/ Applied Geography/ Geoinformatics/ Spatial Information Science/ Life Science or equivalent in first class with an aggregate minimum of 65% (average of all semesters) or CGPA/CPI grading of 6.84 on a 10 scale or equiavalent.

OR

M.E./M.Tech/M.Plan in RS & GIS/ Urban and Regional Planning/ Water Resources/ Geoinformatics/ Spatial Information Science or equivalent in first class with an aggregate minimum of 60% (average of all semesters) or CGPA/CPI grading of 6.5 on a 10 scale or equiavalent **with** pre-eligibility qualification of B.E./B.Tech/B.Plan/B.Arch in first class with an aggregate minimum of 65% (average of all semesters) or CGPA/CPI grading of 6.84 on a 10 scale or equiavalent.

For Atmospheric Science Specialisation:

M.Sc in Physics/ Atmospheric Science/ Mathematics/ Chemistry/ Meteorology/ Space Science or equivalent in first class with an aggregate minimum of 65% (average of all semesters) or CGPA/CPI grading of 6.84 on a 10 scale or equiavalent.

Scheme of examination:

1) The exam will be conducted through offline mode and will consist of 100 objective type MCQs (Multiple Choice Questions) of one mark each thus maximum marks as 100, with no negative marking and the duration of the exam shall be of 02 hours. Detailed Syllabus is given in **ANNEXURE-I.**

2) The cut off marks for qualifying the written test shall be of 50 marks.

3) The tests will be conducted in two (02) broad disciplines i.e. Atmospheric Sciences & RS&GIS. RS&GIS is further divided into 09 specializations as follows:

Break up of 100 marks in N-JET question paper:

3.1 For Candidates appearing for RS&GIS specialization

Part A - I	RS&GIS (Common)	25 marks	
Part A - II	RS&GIS (Specialized) OR Life Sciences (Botany/Ecology) OR Forestry OR Environmental Sciences OR Agriculture OR Geology OR Geography/Applied Geography/ Urban and Regional Planning OR Water Resources OR Geoinformatics	50 marks	75 marks
Part B	General and Research Aptitude	25 marks	
TOTAL		**100 marks**	

3.2 For Candidates appearing for Atmospheric Science specialization

Part A	Atmospheric Sciences	75 marks
Part B	General & Research Aptitude	25 marks
TOTAL		**100 marks**

Validity of the Score:

The Score of the Test will be valid for the period of 03 (three) years from the date of declaration of the results and the qualified candidates can apply for the post of JRF at NESAC which will be advertised for recruitment during that period with the above score card. Any candidate who do not wish to apply for JRF presently, may also appear for N-JET.

How to apply:

The application form will be hosted in the NESAC web-site www.nesac.gov.in from **10.11.2021**. Last date for submission of On-line Application Forms is **25.11.2021**. **Candidates need to apply through online mode only** at our website www.nesac.gov.in .

Age Limit: Maximum Age for appearing N-JET 2021 is 28 years as on **25.11.2021** but relaxable by 5 years in case of SC/ST and 3 years in case of OBC candidates. Age relaxation as per Government of India norms are applicable to Ex-Servicemen, Persons with Disabilities (PWD). Candidates claiming age relaxation have to submit valid documentary proof.

Before applying for the N-JET, all the candidates and especially those whose current age is closer to the maximum cut-off age may carefully note that maximum cut-off age eligibility criteria for the post of JRF at NESAC is same as that of the N-JET. Therefore, before applying for the NESAC-JET, they must clearly understand that although they may be eligible as per their current age for appereing in the NESAC-JET, but they may become age barred later when they apply for the post of JRF at future advertised date or on the future date of walk-in Interview. It is also to reiterate that the recruitment of JRF is an independent and separate process. Those applying for JRF positions at NESAC must fulfil the minimum essential qualification and minimum eligibility conditions as mentioned in the recruitment advertisement whenever released.

Centre for the Test: Guwahati and Shillong

General Conditions:

1. Only those who have completed their master degree are eligible to apply. Students awaiting for final result need not to apply.

2. Candidates need to upload their documents while applying through online mode.

3. Candidate should upload the merged degree and marksheets in one PDF file for one particular qualification e.g. for M.Sc degree & marksheets of all the semesters should be merged and uploaded.

4. Students with only B.Tech degree are not eligible to appear for N-JET.

5. Applications will be received online only and all further communications will be made to the applications through email/ NESAC website only. Therefore, the applications are advised to check their e-mail and visit NESAC website from time to time. NESAC will not take responsibility for non-receipt of intimation regarding Admit Card/ any communication due to technical reasons or whatsoever to the candidates.

6. Online application can be submitted through NESAC website www.nesac.gov.in from **10.11.2021 [16:00 HRS]** to **25.11.2021 [23:59 HRS].**

7. The application is not for any recruitment.

8. Any request for change of address/e-mail ID for communication shall NOT be entertained.

9. Travelling Allowance will NOT be paid for candidates appearing for the N-JET 2021.

10. Only Indian Nationals need to apply.

11. Canvassing in any form will result in disqualification.

12. No interim correspondence will be entertained. In case of any clarification, candidates may mail to applications@nesac.gov.in

13. **25.11.2021** will be cut-off date for all purposes like age, qualification, etc.

14. If any information furnished in the online application is found to be wrong/false/incomplete, the candidate will NOT be called for the Test.

15. Here-in-after, any further information/Corrigendum/Addendum related to this advertisement shall be made available only on our website www.nesac.gov.in

GOVERNMENT STRIVES TO HAVE A WORKFORCE WHICH REFLECTS GENDER BALANCE AND WOMEN CANDIDATES ARE ENCOURAGED TO APPLY.

It is for the candidate to ensure that he / she fulfills the eligibility criteria and complies with the requirements and adheres to the instructions contained in this advertisement as well as in the application form. Candidates are, therefore, urged to carefully read the advertisement and complete the application form and submit the same as per instructions given in this regard.

NOTE:

1. The candidates who have already qualified NET or equivalent examination are not required to appear for the N-JET since they already meet such condition for applying for the positions of JRF at NESAC as and when advertised.
2. The NESAC-JET is an independent test merely to provide an opportunity to candidates (as mentioned above) to bring them at par with other candidates to meet the minimum eligibility conditions for applying to JRF/SRF positions at NESAC.
3. (This is not a recruitment notification) Recruitment of JRF at NESAC is a separate and independent process for which the candidates have to apply against the advertisement released by NESAC based on its requirement. Thus, the candidates who albeit may have qualified the N-JET, but will also have to independently apply against the specific advertised post of JRF/SRF; and like any other eligible candidate, his/her application will be screened for meeting the minimum essential qualification, age and other eligibility conditions at the time of such recruitment against the advertisement.
4. NESAC reserves the right to postpone/ reschedule/ cancel the test, if it so decides.

1) SYLLABUS OF PART A-I - REMOTE SENSING & GIS (Common) – 25 Marks

FUNDAMENTALS OF REMOTE SENSING

1 **Introduction to Remote Sensing**
   - Remote sensing- definitions and concept
   - Example of the imaging by human eye
   - Key properties of a remote sensing system: Source, target, sensor
   - Active and passive remote sensing
   - Analog and digital images
   - Bands and wavelengths
   - Visualization: True color and false color
   - Remote Sensing platforms: space based, airborne, UAV, ground measurements
   - Orbits of satellites and swath
   - Imaging techniques: Pushbroom, whiskbroom, snapshot, frame based
   - Data types for geospatial data
   - Concept of Resolution-Spectral, Spatial and Temporal

2 **Physics of Remote Sensing**
   - Light as an electromagnetic wave
   - Electromagnetic Spectrum
   - Electromagnetic radiation and its interaction with matter and atmosphere
   - Remote sensing in different domains of the spectrum: reflectance, emission and scattering
   - Energy balance equation
   - Reflectance
   - Emission: Radiation laws
   - Scattering: Rayleigh, Mie, Non-selective

3 **Remote Sensing Sensors and their Specifications**
   - Imaging spectrometers vs. spectroradiometers
   - Hyperspectral cameras
   - Multispectral cameras
   - Panchromatic cameras
   - Remote sensors and platforms - active and passive remote sensing techniques
   - Optical, infrared, LiDAR and microwave sensors
   - Some common satellite sensors used in different application areas

4 **Data from Remote Sensing Sensors**
   - Data formats
   - Interleaving: BIL, BSQ, BIP
   - Band visualization
   - False colour composites

5 **Image Interpretation and Land use analysis**
   - Fundamentals and elements of visual photo interpretation.
   - Satellite image vs. aerial photo interpretation, development of interpretation keys.
   - Mapping terrain elements: Land use-land cover, drainage and physiographic features.
   - Importance of Ground Validation in Remote Sensing

6 **Photogrammetry and Cartography**
  - Aerial Photogrammetry
  - Satellite Photogrammetry
  - Image Matching
  - Terrain Analysis
  - Cartography

7 **Corrections associated with Remote Sensing Data**
  - Conversion of DN values to surface reflectance
  - Radiometric Corrections: Striping error, shot noise, column/line dropout
  - Geometric Corrections: source sensor geometry, topographic effects, GCPs and transformation
  - Atmospheric Effects: Aerosol corrections, Water vapour corrections

8 **Satellite Data Enhancement and Visualization Tools**
  - Radiometric enhancement techniques: Contrast stretching: Linear, non-linear methods (logarithmic, exponential), piece wise, histogram equalization
  - Low Pass and High Pass Filtering
  - Adaptive gradient filers
  - Band ratio, Types of different indices
  Principal Component Analysis

ADVANCED TECHNIQUES IN REMOTE SENSING

9 **Basic Image Classifiers**
  - Regression vs. Classification
  - Separability measures
  - Unsupervised Classification and some algorithms: K-Means, ISODATA
  - Supervised Classification: Data and labels
  - Some supervised classification algorithms: Minimum Distance, Maximum Likelihood, Parallelepiped classification
  - Accuracy Assessment: Confusion Matrix, kappa coefficient

10 **Thermal Remote Sensing**
  - Thermal Infrared and Thermal Scanners
  - Thermal Properties of Terrain, Thermal IR Environmental Considerations
  Applications of Thermal Remote Sensing

11 **Microwave Remote Sensing**
  - Factors affecting Microwave measurements: Target and RADAR specific: Surface roughness, Radar, angle of incidence, polarization
  - Side-looking airborne radar (SLAR)
  - Real aperture radar
  - Radar equation
  - Range and azimuth resolution
  - Synthetic aperture radar
  - Applications of SAR

GEOGRAPHICAL INFORMATION SYSTEM

12 **Introduction to GIS**
  - Basic concepts about spatial information, Spatial vs. non-spatial data
  - GIS as a means of database management

- Components of GIS, Hardware/software requirements for GIS
- Comparison between Raster and Vector Data

13 **Raster Analysis**
- Spatial Data: Definition, Analysis, Processes & Steps, Software and Tools for Performing Spatial Data analysis
- Concept of geographically tagged data
- Rectification and Georeferencing
- Raster Calculator Applications
- Reclassification
- Overlay Analysis
- Introduction to Spatial Interpolation

14 **Vector Analysis**
- Definition of vectors
- Topology
- Analyzing Geographic Relationship, Distance Measurements, Measuring and Mapping Change
- Vector and Raster Data Query: Logical Expressions, Types of Operations
- Buffering, Overlay Analysis, Network Analysis
- Principles and components of multiple-criteria decision making

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2) SYLLABUS OF PART A-II - REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM (Specialized) - 50 Marks

1: Fundamentals of Information Technology and GIS

1.1 Introduction to Information systems and IT
1.2 Basic of Data Arrangement and access, file Environment, DBMS, Logical Data model, Data Warehouses, Meta Data and Global Databases, Spatial Databases available
for natural resources and Terrain.
1.3 Information System, Data, knowledge, and Decision support.
1.4 DSS, Data visualization Technologies, knowledge Management and Organizational knowledge Bases, Data mining.

2: Fundamentals of Remote Sensing and Image Interpretation

2.1 Remote Sensing – history & development, definition, concept and principles
2.2 Energy Resources, radiation principles, EM Radiation and EM Spectrum
2.3 Platforms/Sensors – Types and their characteristics
2.4 Satellites and their characteristics – Geo-stationary and sun-synchronous
2.5 Earth Resources Satellites -LANDSAT, SPOT, IRS, IKONOS satellite series
2.6 Optical mechanical scanners – MSS, TM, LISS, WiFS, PAN
2.7 Concept of Resolution – Spatial, Spectral, Temporal, Radiometric
2.8 Basic concept and principles of Thermal, microwave and hyperspectral sensing
2.9 Basic principles, types, steps and elements of image interpretation
2.10 Techniques of visual interpretation and interpretation keys
2.11 Multidate, multispectral and multidisciplinary concepts
2.12 Instruments for visual interpretation
2.13 Remote Sensing Data Products and their procurement
2.14 Ground Truth Collection – Spectral Signatures

3: Aerial Photography and Photogrammetry

3.1 Introduction to aerial photography – Basic information and specifications of aerial photographs
3.2 Aerial cameras – Types and their characteristics
3.3 Introduction to digital photogrammetry- Orthophotos and digital orthophotography
3.4 Principles of stereo photogrammetry
3.5 Model deformation and rectification
3.6 Simple plotting Instruments – simple and stereoplotters
3.7 Aerial triangulation, control and mapping

4: Cartography and Global Positioning System

4.1 Digital cartography - elements of digital cartography Relation between digital cartography, RS & GIS
4.2 Map Projection – concept and classification
4.3 Azimuthal, cylindrical , conical and rectangular projection system
4.4 Choice of map projection – Satellite image and map projection
4.5 Thematic maps and base maps
4.6 Map digitization and Map Compilation
4.7 Introduction to Global Positioning System (GPS) – Fundamental concepts
4.8 GPS system elements and signals
4.9 GPS measurements and accuracy of GPS
4.10 Classification of GPS receivers

5: DIGITAL IMAGE PROCESSING

5.1 Introduction to digital image processing- Concept of digital image, steps in DIP
5.3 Digitization of photographic image, converting digital image to visual form image
5.4 Digital image data formats, Image data storage and retrieval
5.5 Radiometric correction of remotely sensed data
5.6 Geometric correction of remotely sensed data
5.7 Image registration – definition principle and procedure
5.8 Image enhancement Techniques - an overview
5.9 Pattern recognition and image classification, Unsupervised classification – advantage, disadvantage and limitations
5.10 Supervised classification - training site selection, Classifiers used in supervised classification – Minimum distance to mean, Parallelepiped, maximum likelihood
5.11 Classification accuracy assessment

6 : GEOGRAPHICAL INFORMATION SYSTEMS

6.1 Introduction to GIS – definitions, concept and history of developments in the field of information systems
6.3 Hardware and software requirements for GIS
6.4 Coordinate System and Projections in GIS – Conic, cylindrical and planner
6.5 Data structure and formats
6.6 Spatial data models – Raster and Vector
6.7 Data base design - editing and topology creation in GIS, Linkage between spatial and non spatial data
6.8 Spatial data analysis – significance and type, Attribute Query, spatial query
6.9 Integration of RS and GIS data
6.10 Data analysis and modeling in GIS– types of GIS modeling
6.11 Decision support systems
6.12 Overview of image processing & GIS Packages – ARC GIS, ERDAS, MAP INFO, ILWIS,
     GEOMEDIA, IDRISI, QGIS
6.13 Recent Trends in GIS –Virtual 3D GIS, OLAP, Internet GIS, Open GIS

7 : THERMAL AND MICROWAVE REMOTE SENSING

7.1 Thermal radiation principles, thermal process and properties
7.2 Characteristics of thermal IR images and Factors affecting thermal images
7.3 Interaction of thermal radiation with terrain elements
7.4 Introduction to microwave remote sensing – Concept and principle, backscattering, cross
    section Wavelength, incidence angle, aspect angle.
7.5 Interactions between radar and surface materials - complex dielectric properties, roughness polarization
7.6 Passive microwave sensors & Active microwave sensors
7.7 Radar image interpretation
7.8 Applications of microwave remote sensing

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3) SYLLABUS OF PART A-II - LIFE SCIENCES (BOTANY & ECOLOGY) - 50 Marks

1. **Microbiology and Plant Pathology:** Structure and reproduction/multiplication of viruses, viroids, bacteria, fungi and mycoplasma. Important crop diseases caused by viruses, bacteria, mycoplasma, fungi and nematodes. Plant quarantine.

2. **Cryptogams:** Algae, fungi, lichens, bryophytes, pteridophytes - structure and reproduction from evolutionary viewpoint.

3. **Phanerogams: Gymnosperms:** Classification and distribution of gymnosperms; Geological time scale; Type of fossils and their study techniques.

4. **Phanerogams: Angiosperms**: Systematics, anatomy, embryology, palynology and phylogeny. Taxonomic hierarchy; International Code of Botanical Nomenclature; Origin and evolution of angiosperms; Various systems of classification of angiosperms; Stomata and their types; Glandular and non-glandular trichomes; Unusual secondary growth; Anatomy of C3 and C4 plants; Wood anatomy. Endosperm - its development and function; Polyembroyony and apomixes.

5. **Plant Resource Development:** Origin of cultivated plants; Vavilov'scentres of origin; Plants as sources for food, fodder, fibre, spices, beverages, edible oils, drugs, narcotics, insecticides, timber, gums, resins and dyes, latex, cellulose, starch and its products, Botanical Gardens and Herbaria.

6. **Morphogenesis:** Totipotency, polarity, symmetry and differentiation; Cell, tissue, organ and protoplast culture; Somatic hybrids and Cybrids; Micropropagation; Somaclonal variation and its applications.

7. **Cell Biology:** Prokaryotic and eukaryotic cells - structural details; Structure and function of extracellular matrix (cell wall), membranes-cell adhesion, membrane transport and vesicular transport; Structure and function of cell organelles; Cytoskelaton and microtubules; Nucleus, nucleolus, nuclear pore complex; Chromatin and nucleosome; Mitosis and meiosis; Numerical and structural variations in chromosomes and their significance.

8. **Genetics, Molecular Biology and Evolution:** Development of genetics; Gene versus allele concepts (Pseudoalleles); Quantitative genetics and multiple factors; Incomplete dominance, polygenic inheritance, multiple alleles; Linkage and crossing over; Sex chromosomes and sex-linked inheritance, sex determination and molecular basis of sex differentiation; Cytoplasmic inheritance. Structure of nucleic acids and proteins; Genetic code and regulation of gene expression; Organic evolution – evidences, mechanism and theories. Role of RNA in origin and evolution.

9. **Plant Breeding and Biostatistics:** Methods of plant breeding – introduction, selection and hybridization (pedigree, backcross, mass selection, bulk method); Mutation, polyploidy, male sterility and heterosis breeding; Use of apomixes in plant breeding; Standard deviation and coefficient of variation (CV); Tests of significance (Z-test, test and chi-square test); Probability and distributions (normal, binomial and Poisson); Correlation and regression.

10. **Physiology and Biochemistry:** Water relations, mineral nutrition and ion transport, mineral deficiencies; Photosynthesis – photochemical reactions; photophosphorylation and carbon fixation pathways; C3, C4 and CAM pathways; Respiration (anerobic and aerobic, including fermentation) – electron transport chain and oxidative phosphorylation; Photorespiration; Chemiosmotic theory and ATP synthesis; Nitrogen fixation and nitrogen metabolism; Enzymes, coenzymes; Energy transfer and energy conservation; Importance of secondary metabolites; Pigments as photoreceptors (plastidial pigments and phytochrome); Plant movements; Photoperiodism and flowering, vernalization, senescence; Growth substances – their chemical nature, role and applications in agri-horticulture; Growth indices, growth movements; Fruit and seed physiology; Dormancy, storage and germination of seed; Fruit ripening – its molecular basis and manipulation.

11. **Ecology and Plant Geography:** Concept of ecosystem; Ecological factors; Concepts and dynamics of community; Plant succession; Concept of biosphere; Ecosystems; Conservation; Pollution and its control (including phytoremediation); Plant indicators; Environment (Protection) Act. Forest types of India - Ecological and economic importance of forests, afforestation, deforestation and social forestry; Endangered plants, endemism, IUCN categories, Red Data Books; Biodiversity and its conservation; Protected Area Network; Convention on Biological Diversity; Farmers' Rights and Intellectual Property Rights; Concept of Sustainable Development; Biogeochemical cycles; Global warming and climatic change; Invasive species; Environmental Impact Assessment; Phytogeographical regions of India.

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4) SYLLABUS OF PART A-II - FORESTRY - 50 Marks

1. Forest policy and laws – National Forest Policies, Indian Forest Act 1927, Wildlife Protection Act 1972, Forest Conservation Act 1980 and penalties for forest offences, Forest Rights Act (FRA), 2006.

2. Forest mensuration – Measurement of dimension of trees, height and diameter/girth, volume estimations, stem form, bark thickness, standing/felled trees volume measurements and estimation, crop measurements, growth and increment, sample plots, sampling methods, kinds of enumeration, biomass estimation.

3. Forest survey – Chain survey, angles and bearings, plane table survey, maps and map reading.

4. Forest protection – Forest fire: Classification of forest fire, damage, controlled use of fire, protective and remedial measures, fire control policy. Protection of plants from injury by animals and injury by diseases. Classification of forest diseases and their control.

5. Forest Ecology – Forest types of India and distribution, succession, climax and retrogression, forest regeneration, diversity indices, biomass and productivity, nutrient cycling in forest ecosystem.

6. General Silviculture – Locality factors of trees and forests, successions, Site factors - climatic, edaphic, physiographic, biotic and their influence on forest vegetation, forest nursery management.

7. Silviculture of trees – Silviculture of important tree species, soil working and plant spacing.

8. Silviculture systems – High forests, coppice system, clearfelling, uniform, shelterwood and selection system.

9. Forest Working Plan – Preliminary Working Plan and main working plan, Working Plan Code 2014

10. Minor Forest Products – Gums and resins, dyes, beedi leaves, fibers and flosses, katha and cutch, management and importance of Non-Timber Forest Products.

11. Wood anatomy – Physical and mechanical properties of wood, defects in timber, wood seasoning and wood preservation,

12. Tree improvement – Genetic variation, geographic variation, genotype and phenotype, tree improvement methods.

13. Forest economics – Economics of plantation development, timber production and forest lands and marketing.

14. Forest management – Concept of sustained yield and normal forest, growing stock, rotation and regulation of yield.

15. Social forestry – Important social forest tree species, multipurpose tree species, community forestry, JFM and economic benefits.

16. Wildlife management – Conservation of Important wildlife of India, National Parks and Wildlife Sanctuaries in India.

17. Tribology – Tribals and forests, jhumias, livelihoods and tribal administration

18. Agroforestry – Agroforestry systems and classifications, traditional agroforestry, homegardens, benefits of agroforestry, rotational agroforestry and shifting cultivation.

19. Statistics – Frequency distribution, mean, median mode, experimental design, test of significance, correlation and regression

20. Forest hydrology and Watershed Management – Soil & water conservation, hydrological cycle and forest hydrology, hydrographs, runoff estimation, forest treatment and water yield, land capability classification, soil loss estimations, water harvesting techniques and structures, forests for water conservation, grassland management.

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5) SYLLABUS OF PART A-II - ENVIRONMENTAL SCIENCE - 50 Marks

1. Environmental chemistry- Atmospheric chemistry, water chemistry, soil chemistry.

2. Environmental biology- Community ecology, microbiology, biotechnology, biochemistry.

3. Earth Science- Atmospheric and earth surface processes, meteorology and climatology.

4. Statistics- Frequency distribution, mean, median mode, sampling design, test of significance, correlation and regression.

5. Environmental pollution- Different types of pollution and measures to control.

6. Ecosystem dynamics- Ecosystem functions, energetics, population dynamics, biodiversity and conservation.

7. Environmental hazards- Environmental hazards, risk and vulnerability and strategies for their mitigation.

8. Environmental monitoring- Physico-chemical and biological methods for water and soil analysis.

9. Environmental health- Environmental quality, exposure and human health.

10. Eco-toxicology- Toxicants in the environment, sources, transport routes and interaction with human.

11. Hydrology & Watershed management - Hydrological cycle, precipitation and abstraction, runoff, stream flow and erosion, hydrological forecasting and watershed management.

12. Environment and Energy- Energy requirement, use pattern, energy sources their problems and prospects and environmental implications.

13. Environmental Impact Assessment - EIA methodologies and socio-economic Impact analysis.

14. Environmental Laws- Environmental law in India and environmental movement.

15. Environmental management- Ecosystem analysis, modelling, monitoring and planning, eco-restoration and ecotourism.

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6) SYLLABUS OF PART A-II - AGRICULTURE – 50 Marks

1. Agronomy

Principle of crop ecology; Ecosystem concept and productivity; physiological limits of crop yield and variability in relation to ecological optima; crop adaptation; Agro-ecological and agro climatic region of India; Geographical distribution of crops; Physiological stress in crops; Remote sensing: Spectral indices and their application in agriculture. Concept of organic farming & farming system approach.
Principles and methods of fertilizer application; Integrated nutrient management and bio- fertilizers ;

2. Entomology

Concept, Components and Principles of Integrated Pest Management (IPM). Host Plant Resistance, Agronomic Manipulations, mechanical and physical methods, Chemical methods, biocontrol agents utilization, and behavior control strategy etc. IPM strategies for field and horticultural crops. Concept of damage determination. System approach, Agro ecosystem and cropping system vs. IPM. Constraints and Strategies of IPM implementation.
Silkworm species, their systematic position and salient features. Rearing techniques of mulberry, muga, eri and tasar silkworms. Nutritional requirements of silkworms. Sericulture: rearing house and appliances, silkworm breeds, seed production and its economics. Enemies and diseases of silkworms and their management. Sericulture organizations in India.

3. Plant Pathology

Concepts in Epidemiology. Development of disease in plant population. Monocyclic and polycyclic pathogens. Role of environment and meteorological factors in the development of plant disease epidemics. Survey, surveillance (including through remote sensing), and prediction and forecasting of diseases. Epidemic analysis and prediction models. Crop loss assessment: critical and multiple point models.

4. Plant Physiology

Abiotic Stresses affecting plant productivity. Drought characteristic features, water potential in the soil- plant-ari continuum. Development of water deficits, energy balance concept, transpiration and it's regulation. Physiological process affected by drought. Drought resistsnce mechanisms. Water use efficiency as a drought resistance trait. Yield and mineral nutrition- concept of nutrient use efficiency, mineral nutrition under adverse soil situations-drought, salinity, acidity etc.
Likely changes in climate in future and its impact of crop and ecosystems. The green house gases and global warming, CO as an important green house gas. Effect of elevated CO_2 on plant growth and development. Methane as a greenhouse gas.

5. Fruit Science

Commercial varieties of regional, national and international importance. Agri Export Zones (AEZ) Tropical and Dry Land Fruit Production Crops: Mango and Banana, Citrus and Papaya, Guava, Sapota Jackfruit, and Pineapple. Subtropical and temperate fruit production: Apple, Pear, Grapes, Plums, Peach, Ltichi, Kiwi fruit, Strawberry. Prospect of horticulture in North East.

6. Agricultural Meteorology

Role of meteorological parameters on growth and yield of crops;incidence and development of crop pests and disease.Micrometeorology of crops , Light interception by crop canopies as influenced by leaf area index, leaf arrangement and leaf transmissibility, radiation use- efficiency.Hydrological cycle; concept of water balance, concepts of evaporation. Crop weather models; crop growth simulation models for yield assessment.Weather forecasting and agro-advisories; crop yield forecasts; Meteorological satellites for weather forecasts.

7. Soil Science

Concept of land, soil ands soil science. Soil forming processes and factors. soil survey-types, techniques.
Soil erosion by water- types, effects, mechanics. Runoff- methods of measurement, factors and management, runoff farming. Soil conservation measures.
Cause of land degradation; Management of soil physical properties for prevention/ restoration of land degradation.
Soil fertility evaluation – Soil testing, plant and tissue tests and biological methods; Fertility status of major soil groups of India.
Pollution: types, causes, methods of measurement, standard and management.

8. Agricultural Statistics

Frequency distribution, mean, mode and median. Standard deviation, normal, binomial and Poisson's distribution, Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of Significance; t, F, Chi-square. Design of experiments.Use of software packages like SPSS, SAS, etc. for the test and designs of experiments for analysis.Concept of probality sampling. Simple random sampling. Stratified sampling, allocations in sample to strata, choice of strata, construction of strata boundaries and collapsing of strata.

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7) SYLLABUS OF PART A-II - GEOLOGY - 50 Marks

1. **Physical Geology**

   a. Origin, age and structure of the earth
   b. Atmosphere, hydrosphere, lithosphere & their constituents. Process of weathering& Mass wasting
   d. Geological Agents - Volcanoes, Earthquakes, Geosynclines and Mountains
   e. Plate Tectonics - Recent advances, pros and cons. Dynamic evolution of continental and oceanic crust. Principal tectonics features of the earth. Nature and types of Plate Margins, Geometry and Mechanism of Plate Motion. Tectonics of Pre-cambrian Orogenic Belts of India.
   f. Isostasy- Concept and theories; Evidence of continental-drift, Sea-Floor Spreading

2. **Geomorphology**

   a. Basic concepts of Geomorphology & Typical Landforms and their evolution. An elementary idea about morphogenesis and morphography; Morphometric analysis; Morphochronology.
   b. Geomorphic features formed/produced by various agents (erosion & Depositional) - Fluvial, Wind, Glacier, action of underground water. Origin of lakes & features relating to ocean &seas.
   c. Application of Geomorphology in Mineral Prospecting, Civil Engineering, Hydrogeology and Environmental studies.

3. **Structural Geology**

   a. Mechanical principles, properties of rocks and their controlling factors. Theory of rock failure. Concept of stress and strain; Two-dimensional strain and stress analyses; Types of strain ellipses and ellipsoids their properties and geological significance. Methods of strain measurements in naturally deformed rocks.
   b. Fold - mechanics of folding and buckling. Fold development and distribution of strains in folds. Parts of fold and its description. Flexure fold; flexural slip folds, flexural flow folds, passive folds.
   c. Fault- Causes and dynamics of faulting. Strike-slip faults, Normal faults, Thrust, Overthrust fault.
   d. Joint - description, morphology, genetic and geometric classification.
   e. Terminology of foliation. Classification and genesis of axial plane foliation, crenulation foliation, bedding foliation (transposition foliation) fracture cleavage (spaced cleavage). Significance of foliation in geology. Description of lineations in deformed rocks, their origin and significance.
   f. Unconformity, determination of order of superposition. Miscellaneous structures

4. **Crystallography& Mineralogy**

   a. Elements of crystal-forms and Symmetry
   b. Crystallographic laws, systems, classes, habits, twinning, Liquid Crystals.
   c. Mineralogy – physical & optical properties of Minerals
   d. Study of common rock forming minerals- silicate, olivine, pyroxenes, amphiboles, feldspars, quartz, mica, chlorites, garnets, carbonates etc.

5. **Petrology**

   a. Introduction, composition & constituents of magma, Magma: Its physics, nature, factors affecting magma and evolution. Petrology and melting of mantle.

Generation of magmas in different tectonic environments. Differentiation and assimilation.

b. Igneous Petrology - origin, classification (IUGS), structure & texture, common igneous rocks. Petrogenesis of the following igneous rock types: Ultramafic (Peridotite and Picrite, Komatiite), Basalts, Andesites, Granites, Syenite, Carbonatite, Anorthosite

c. Sedimentary Petrology - origin, classification, structure (Genesis and Stratigraphic Significance)& texture, common sedimentary rocks. Fundamentals of fluids laminar & turbulent flow. Reynodls number, Froude number, velocity profiles and bed roughness. Interpretation of Depositional Environments.

d. Metamorphic Petrology – processes of matamorphism, diffusion, nucleation; Metamorphic facies (low, medium, high & very high), classification, structure & texture, common metamorphic rocks

6. Economic & Mining Geology

a. Terminologies, formation process, geochemistry of ore deposits, modern concepts of ore genesis; ore deposits & plate tectonics.

b. Origin, mode of occurrence, distribution & economic uses of the following minerals
   - Gold, Iron, Copper, Manganese, Chromium, Aluminum, Lead, Zinc, Mica, Gypsum, Magnesite, Kyanite, Diamond, Coal, Petroleum, etc.

c. Application of rock mechanics in mining. Different mining methods. Mining hazards-mine inundation, fire and rock burst, safety measures.

7. Stratigraphy& Paleontology

a. Basic principles &elements of stratigraphy, chronological subdivisionsLithostratigraphy, Codes units, correlation and contacts. Biostratigorphy- units, biogeographical acme zone provinces, controlling factors,zonation and their time significance

b. Indian Stratigraphy –Pre-Cambrian, Palaeozoic, Gondawana, Mesozoic, Mesozoic, Cenozoic stratigraphy

c. Introduction to Paleontology, Modes of Preservation permineralization, replacement, carbonization, recrystallization, and the production of molds and casts.Environmental Indicators,Vertebrate & Invertebrate Paleontology, Use of Fossil Assemblages in Determining Age. Stratigraphy of North East India.

8. Remote Sensing in Geology and Geomorphology

a. Spectral Characteristics of solar radiation. RS Satellite characteristics-orbits and swaths. Sensors used in remote sensing.

b. Applications of Remote Sensing techniques in geological investigations-Mapping lithology, lineaments and minerals based on recognition elements (photographic and geotechnical elements). Convergence of evidence

c. Interpretation of topography and tectonic features and evaluation of ground water potential.

d. RS in geohazard studies and monitoring (landslides, floods, droughts, cyclones, earthquakes). Examples and case studies from India.

e. Characteristics of variouslansdforms in satellite images. Terrain evaluation for selection of dam, reservoir, industrial sites.

9. Hydrogeology

a. Hydrologic cycle and its components.
b. Ground water origin, types, importance, occurrence, renewable and non-renewable ground water resources.
c. Hydrologic properties of rocks; Hydraulic properties of aquifer and aquitard and their controlling factors. Darcy's law
d. Water table contour maps, hydrostratigraphic units of India. Artificial recharge of ground water, rain water harvesting. Water balance methods, water level fluctuations: causative factors and their measurement, Problem of over exploitation. Ground water legislation.
e. Various surface & subsurface geophysical & geological methods of groundwater exploration.

10. Environmental & Engineering Geology

a. Spectrum of environmental geology, global changes in the Earth system and climate. Anthropogenic impacts on the atmosphere, local impacts changing the landscape, role of geology in understanding atmospheric changes
b. Global warming in present atmosphere due to indiscrete exploitation of fossil fuel, volcanic eruptions and deforestation. Global climatic changes, causes impacts, assessment. Examples and case studies. Climate change impacts on water resources and agriculture.
c. Role of engineering geology in civil construction and mining industry, various stages of engineering geological investigation for civil engineering projects.
d. Engineering properties of rocks, rock discontinuities, features of active faults. RQD, engineering classification of rock mass.
e. Study of properties of common rocks with reference to their utility in engineering projects. Evaluation of dams and reservoir sites, tunnel alignments and transportation routes
f. Improvements of properties of rock mass: grouting, gutting, rock bolting, cable anchorage.
g. Engineering properties of soil, textural classification, stress distribution of soil with reference to foundation.

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8) SYLLABUS OF PART A-II - GEOGRAPHY AND URBAN & REGIONAL PLANNING - 50 Marks

Unit –I   **PHYSICAL GEOGRAPHY**

Geomorphology
- Theories and process of slope development
- Earth Movements (Seismic , folding and faulting)
- Landform Occurrence
- Geomorphic Hazards (earthquakes, volcanoes, landslides and avalanches)

Geography of Environment
- Ecosystem (Geographic Classification)
- Human Interaction and Impacts
- Environmental Hazards and Disasters (Global Warming, Urban Heat Island, Atmospheric Pollution, Water Pollution, Land Degradation)

Climatology
- Composition and Structure of Atmosphere
- Meteorological Hazards and Disasters (Cyclones, Thunderstorms, Hailstorms, Heat and Cold waves Drought and Cloudburst , Glacial Lake Outburst (GLOF), Climate Change: Evidences and Causes of Climatic Change

Unit - II   **URBAN AND REGIONAL PLANNING**

Demographic Studies
- Basic demographic concepts, components of population change
- Sources of population data
- Population Distribution (measures, patterns and determinants)
- Population Growth
- Migration (types, causes and consequences and models)
- Population Composition and Characteristics (age, sex, rural-urban, occupational structure and educational levels)
- Methods of Demographic/Population Analysis (Rates, Ratio, Proportion, percentages and density)
- Rate of Population Growth (Arithmetic, Geometric and Exponential growth rates, Decadal growth rate and Doubling time)

Regional Development and Planning
- Concept, nature and scope of Regional Planning; Different approaches to regional planning; Planning regions: concept and types; Planning regions of India

Urban Planning
- Concept and definition of Urbanisation
- Origin and growth of urban places

Characteristics and Processes of Urbanization (urban growth and change)
- Factors of urban growth, trends of urbanisation,
- Size, structure and functions of urban areas
- Urban Systems (primate city, rank size rule and central place)
- Models of Urban Land Use, Urban Transport & Sustainability related to Planning Contemporary urban issues: urban poverty; urban renewal; slums; traffic and transportation; housing; urban infrastructure; environmental pollution; urban crime; green and blue spaces
- Integrated Public & Urban Transport Planning and
- e- Governance.

Settlement Geography
- Rural Settlements (types, patterns and distribution)
- Problems of Rural Settlements (rural-urban migration; land use changes; land acquisition and transactions)

Unit - III   Geographical Techniques and Cartography
- Sources of Geographic Information and Data (spatial and non-spatial)
- Types of Maps, Techniques of Map Making (Choropleth, Isarithmic, Dasymetric, Chorochromatic, Flow Maps)
- Data Representation on Maps (Pie diagrams, Bar diagrams and Line Graph
- Map Projections- Types, properties and uses

Unit - IV   Geography of North East India
- Physiography of the region
- Drainage system
- Climate
- Types and distribution of Natural resources
- Population Characteristics
- Natural Disasters

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9) SYLLABUS OF PART A-II - WATER RESOURCES - 50 Marks

Precipitation

Forms of precipitation, weather systems for precipitation, characteristics of precipitation in India, Measurement of precipitation, preparation of data, presentation of rainfall data, Mean precipitation over an area, Depth-area-duration relationships, Frequency of point rainfall, Maximum rainfall intensity-duration-frequency relationship, Probable maximum precipitation.

Abstractions from precipitation

Evaporation processes, Empirical evaporation equations, Evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods of its reduction, transpiration, Evapo-transpiration and its measurement, Interception, depression storage, infiltration capacity.

Streamflow Measurement

Measurement of stage, measurement of velocity, Area-velocity method, dilution technique of flow measurement, electromagnetic method, ultrasonic method, indirect methods of flow measurement, stage-discharge relationship, hydrometry stations

Runoff

Runoff characteristics of stream, runoff volume, Flow-duration curve, Flow-Mass curve, surface water resources in India

Hydrographs

Factors affecting flood hydrographs, components of Hydrographs, baseflow separation, Effective rainfall, Unit hydrograph, derivation of unit hydrographs, Use and limitations of unit hydrographs, synthetic unit hydrographs.

Floods

Introduction of floods, rational method, Empirical formulae, Flood frequency analysis methods, Data for flood frequency studies, design flood, Design storm

Flood routing

Flood routing, basic equations use in flood routing, hydrologic channel routing, Hydraulic method of flood routing, Clark's method, Nash conceptual method, Flood control and its measures (structural and non-structural).

Groundwater

Groundwater sources, forms of subsurface water, types of aquifers, Aquifer properties, geologic formations as aquifers, GW recharge,

Erosion and reservoir erosion

Erosion processes, Sheet erosion, gully erosion, rill erosion, channel erosion, estimation of sheet erosion and gully erosion, movement of sediments from watershed, sediment yield from water shed, USLE, RUSLE, MUSLE, Structures for measurement sediments (Flumes/Weirs etc), Distribution of sediments in reservoir, factors affecting reservoir sedimentation, Life of a reservoir, reservoir sedimentation control in India

Dams

Types of reservoir (gravity, earthen dam, etc), Reservoir capacity, forces acting on the different types of reservoirs.

Open Chanel flow

Basics on Open channel flow, types of flow: steady and unsteady, linear and non-linear, uniform and non-uniform, critical flow diagram, geometry parameters of the channels.

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10) SYLLABUS OF PART A-II - GEOINFORMATICS – 50 marks

Introduction to GIS

- Difference between GIS and other Information Systems, GIS Components, Functions of GIS, Hardware & software requirements for GIS, GIS data sources, Spatial data and attribute data, Geographical data formats (coverage, geodatabase, shape file, grid, dxf, dwg,geotiff, GML), Attribute types (nominal, ordinal, interval, ratio), Spatial data models (Rasterand Vector), comparison of raster and vector data model, Spatial data input techniques and devices used (resolution, precision), Digitizing, Editing and structuring map data, Concept of Topology, Spaghetti vs. topological vector data, topological relationships, Sources of errors.

- Spatial data models and data structures- spatial database concepts-spatial analytical functionality. Non-spatial data models (Flat file, Hierarchical, Network, Relational and Object Oriented), spatial data quality, error and standards. Raster & Vector based spatial analysis, Map overlay, Spatial Join, Buffering analysis. Spatial analysis (raster based): Local, Neighborhood, Zonal and Global operations. Network analysis. Spatial modelling and multi-criteria analysis.

- Concept of Web GIS, & Mobile GIS.

Concepts of Databases

- Overview of DBMS (conceptual, logical and physical models), Advantages of Data Base
  Management System, ER model, RDBMS, Geodatabases, Database Design using RDBMS, Principal operations in a RDBMS (selection, insertion, updating and deletion), Database normalization rules. Attribute query and spatial query Spatial operations for data preparation, Graphing and reporting.

- RDBMS: Components, Concept, Database Schema, Tables and Relationships. Database Design Normalization (1NF, 2NF, 3NF Forms), Advantage of DBMS.

Information and Communication Technologies

- Scope and developments in information technology, systematic framework for Information Systems; Components of information systems; Information systems design, analysis and management, Information and communications technologies - Information decision support system

GIS Web Mapping

- Image acquisition, processing / analysis and output concepts and components, GIS programming and customization, Web Mapping and GeoVisualization, maps and multimedia systems-animated maps and multi- dimensional display, Map Animation, GIS for Location-Based Services -Service based WebGIS and applications -Information Management in WebGIS.

Fundamentals of Cartography, Geodesy and Global Positioning System

- GPS – Different segments – space control and user segments – satellite configuration – GPS signal structure. Various Global/Regional Satellite constellations, GNSS signals, Pseudo Range Measurement Sources of GNSS errors, GPS Data Processing, Datum/Ellipsoid (horizontal, vertical) - definition and basic concepts-Global Datum vs. Indian Geodetic Datum, Coordinate Systems.

Differential positioning concept, Differential GPS survey Methods. Augmentation Systems (GAGAN, WAAS, LAAS, etc.) & its applications.

Image Processing

- Contrast Enhancement: Linear and Non-linear methods; Spatial Enhancement: Noise and Spatial filters
- Image Transformation: Principal Component Analysis (PCA), Discriminant Analysis, Color transformations (RGB - IHS, CMYK)
- Image Segmentation and Classification: Simple techniques

Programming for Geospatial Analysis & Modelling

- Programming Language Concepts, Variables, Constants & Data Structures, Expressions (Logical, Boolean, Arithmetic and Algebraic) and Statements, Decision/Control Structures, Iteration/Repetition Structures, Functions, Modules & Recursion, Array and strings processing

Advanced Topics

- Parsing and scrapping, Semantic Web, Natural Language Processing (NLP), External Libraries and Modules, Programming for cluster computation (MPI), Big Data Handling, Artificial Intelligence, Machine Learning, Deep Learning.

Advanced Spatial analysis Techniques

☐Network Analysis
☐Principles and components of multiple-criteria decision making
☐Main multiple-criteria evaluation methods/techniques
☐Multiple-criteria decision making in spatial data analysis
   Introduction to AHP, Basic Principles of AHP
   3D analysis: Shadow Analysis, Volume Analysis,Visibility Analysis

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11) SYLLABUS FOR PART A - ATMOSPHERIC SCIENCE - 75 Marks

1. Mathematical Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions. Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions, Taylor & Laurent series, poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. Green's function. Partial differential equations. Elements of computational techniques, root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge Kutta method. Finite difference methods. Measures of central tendency and dispersion, moments, least squares method. Regression equation, coefficients of correlation, partial and multiple correlations and their applications.

2. Classical Mechanics

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics moment of inertia tensor. Non-inertial frames and pseudo forces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion, small oscillations, normal modes. Lorentz transformations, relativistic kinematics and mass–energy equivalence. Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance, Hamilton-Jacobi theory.

3. Thermodynamics

Laws of thermodynamics and their consequences. Equation of state, Law of conservation of energy, specific heats of a gas, Adiabatic process in the atmosphere, Standard and Dry adiabatic lapse rate, Equilibrium states, Potential temperature, Equation of state of dry air, Poisson's equation for dry air, Alternative forms of the energy equation, Entropy, Enthalpy. Adiabatic expansion of air. Maxwell relations, chemical potential, phase equilibrium, Phase space, micro and macro-states. Free energy and its connection with thermodynamic quantities. First and second order phase transitions. Diffusion equation, Brownian motion, Introduction to non-equilibrium processes.

The spectrum of Radiation, Quantitative description of Radiation, Blackbody Radiation, The Plank Function, Wien's displacement Law, The Stefan-Boltzmann Law, Radiative properties of Non Black Materials, Kirchhoff's Law, Radiative equilibrium, The Greenhouse Effect, Atmospheric Window, Albedo, Physics of Scattering, Absorption, Emission by Air molecules, gas and particles. Radiative Transfer in Planetary Atmosphere, Beers Law, Reflection and Absorption by a layer of the Atmosphere. Radiative transfer in a plane parallel atmosphere, Radiative forcing, Radiative Balance at the top of the Atmosphere, the role of radiation in climate.

4. Electronics and Electromagnetism

Semiconductor devices, device structure, device characteristics, frequency dependence and applications. Opto-electronic devices. Operational amplifiers and their applications. Digital techniques and applications. A/D and D/A converters. Transducers. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors, polarization, Fresnel's law, interference, coherence, and diffraction.

5. Fundamentals of Atmospheric Sciences

Elementary concepts of weather and climate, Earth-Sun relationship, structure and composition of the atmosphere. Atmospheric pressure, temperature and their variation with height, wind, relative humidity, solar and terrestrial radiation, clouds, different forms of precipitation. Basic ideas of general circulation, ecliptic and equatorial plane, rotation of the earth, seasons. Solar radiation, terrestrial radiation, heat, energy and water balance, evaporation and evapotranspiration. Radiation climatology of the earth's atmosphere, geographical and seasonal distribution of incoming solar radiation, outgoing radiation, net radiation, terrestrial heat balance. Structure, evolution and properties of atmospheric boundary layer. Convective, neutral and stable boundary layers. Surface boundary layer characteristics. Eddy transport of heat, moisture and momentum, Mixing length theory. Boundary layer turbulence.

Inertial and Non Inertial frames, Pressure Gradient Forces, Gravitational Force, Friction or Viscous Force, Centrifugal Force, Coriolis force, Momentum Equations, Cartesian Coordinate System, Spherical–Polar coordinate system. Geostropic Wind, Gradient Wind, Thermal wind, Vertical motion. Transformation of momentum & continuity equations. Circulation & Vorticity, Atmospheric waves and Instabilities.

Monsoon and its variability, Teleconnections of India summer monsoon with southern oscillation, El-Nino, La Nina, Indian Ocean dipole mode. Physics and life cycle of Tropical Cyclones and Thunderstorm, CAPE, CINE, Favorable conditions for severe thunderstorms, stability indices.

6. Fundamentals of Climate

Roles of various components of the Earth System in determining climate. Feedback processes in climate system, Environmental change concepts. Over view of Climate and Climate Change, Physics of the Greenhouse Effect and Global Radiation Budget, Greenhouse Effect of Trace Gases, Aerosols, Clouds, Radiation interactions, Atmospheric Pollution and Visibility, Urban heat island effect and Urban Climate change, Anthropogenic forcing of climate change, Hydrological cycle, Carbon cycle.

7. Surface based Remote Sensing observations and Satellite Meteorology

Working principle and applications of LIDARS, SODARS, Weather RADARS, Doppler radar, Microwave radiometer. Conventional measurements of pressure, temperature, humidity, wind, precipitation, visibility, clouds, soil temperature and moisture. Scattering by rain and ice crystals. Minimum detectable power, receiver noise, radar equations for different targets. Satellite orbits and attitude, principles of satellite motion, Kepler's laws, orbital elements, Types of orbits, Satellite derived products and their applications. Meteorological satellites, radiometers and their applications.

8. Computer Programming and Numerical Analysis

FORTRAN fundamentals: integer constant, floating point constant, variables, arithmetic operator, relational operator, FORTRAN arithmetic and expression, input/output and format statements, declaration and initialization, branching and looping, Arithmetic IF, Logical IF, Unconditional GO TO, Computed GO TO, DO statement, Nesting of DO Loops, Dimension Statement, arrays, multi-dimensional arrays, functions, sub-programs and subroutines.

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12) SYLLABUS FOR PART B - GENERAL & RESEARCH APTITUDE – 25 Marks

1. Current events of national and international importance and current developments in Science & Technology
2. English grammar and comprehension
3. Logical reasoning and analytical ability
4. General mental ability
5. Research **:** Meaning, Characteristics and Types; Steps of Research, Methods of Research, Research Ethics, Paper, Articles, Workshop, Seminar, Conference and Symposium, Thesis Writing : Its characteristics and format.

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