



भारतसरकार Government of India
अंतरिक्षविभाग Department of Space
भारतीय अंतरिक्ष अनुसन्धान संगठन Indian Space Research Organisation
भारतीय सुदूर संवेदनसंस्थान , Indian Institute of Remote Sensing
देहरादून Dehradun



Notification

IIRS/P&GA/GA/IIRS-JET/2020 dated 29/01/2020

IIRS-Junior research fellow Eligibility Test (IIRS-JET)-2020

1: About IIRS, Dehradun

Indian Institute of Remote Sensing (IIRS), a Unit of Indian Space Research Organisation (ISRO), is a premier institute for capacity building and research in the field of **Remote Sensing and Geoinformatics**. The Institute has a multi-disciplinary and problem oriented research agenda focusing on developing land-ocean-atmosphere applications and understanding Earth's surface and subsurface processes using primarily the space-based technologies. The research programmes are intricately linked to overall goal of ISRO towards operationalization of space-based services for national development. Young and motivated candidates are invited for the temporary positions of Junior Research Fellows (JRF) under various research projects of IIRS from time to time.

2: Necessity for conducting the IIRS-JRF Eligibility Test (IIRS-JET)

As per the guidelines of Department of Space for the recruitment of the temporary positions of JRF in ISRO Centres/Units the candidates apart from meeting the minimum educational criteria must also have qualified NET or equivalent qualification. Any national level examination conducted by Central Government Department / Agencies and institutions such as DST, DBT, DAE, DOS, DRDO, MHRD, ICAR, ICMR, IIT, IISc., IISER etc. for admission to Ph.D. programme are considered Equivalent to NET. The following examinations are also equated to NET.

- i. CSIR-UGC National Eligibility Test including NET-Lectureship.
- ii. Graduate Aptitude Test in Engineering (GATE) conducted by MHRD.
- iii. Joint Admission Test (JAM) conducted by MHRD.
- iv. Graduate Pharmacy Aptitude Test (GPAT) conducted by MHRD.
- v. Biotechnology Eligibility Test & Test conducted in Bio-informatics by Bio-informatics National Consortium.
- vi. Joint Entrance Screening Test (JEST), Joint Graduate Entrance Examination for Biology & Interdisciplinary Life Sciences (JGEEBILS) conducted by the Department of Atomic Energy.
- vii. JRF Entrance Examination conducted by the Indian Council of Medical Research.
- viii. All India Competition Examination (AICE) conducted by the Indian Council of Agricultural Research.
- ix. NET or equivalent qualified in any period.

3: About the IIRS-JET

3.1 Who Should Apply?

- a: The IIRS-JET is purely an “eligibility test” of qualifying nature. This test gives a unique opportunity to candidates to qualify and fulfill one of the minimum eligibility conditions laid down by the Department of Space for the candidates before applying for any temporary post of JRF at IIRS 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 candidate is from science streams and is interested in applying for the post of JRF at IIRS on basis of specialization and/or aptitude towards earth observation/ space technology) may apply for the IIRS-JET.
- b: The candidates who have already qualified NET or equivalent examination are not required to appear for the IIRS-JET since they already meet such condition for applying for the positions of JRF at IIRS as and when advertised.
- c: The IIRS-JET is an independent test merely to provide an opportunity to candidates (as mentioned at para 3.1.a) to bring them at par with other candidates to meet the minimum eligibility conditions for applying to JRF positions at IIRS.
- d: The eligibility conditions for the IIRS-JET such as qualification, age etc. mentioned below is only for applying and appearing for the test. Therefore, by virtue of the candidate appearing and qualifying the IIRS-JET does not automatically qualify him/her for the post of JRF at IIRS as and when advertised. The marks secured by the candidate appearing in the IIRS-JET is only for qualifying purpose and shall not be considered during the recruitment and selection of JRF at IIRS.

3.2 Recruitment of JRF at IIRS is a separate and independent process for which the candidates have to apply against the advertisement released by IIRS based on its requirement. Thus, the candidates who albeit may have qualified the IIRS-JET, but will also have to independently apply against the specific advertised post of JRF; 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.

3.3 Scheme of Examination:

- a: The IIRS-JET will be a computer-based test and will consist of 100 multiple choice questions (MCQ) of one mark each. The duration of test will be 02 HRS (i.e., 120 Minutes). The paper will consist of three sections as given below:

	Number of Questions	Marks	Duration (Minutes)
Section-1 (Subject*)	50	50	60
Section-2 (Basic Mathematics & Science)	25	25	30
Section-3 (Aptitude & General English)	25	25	30
Total	100	100	120

*Candidate has to select one of the following optional themes.

1. Remote Sensing & Geoinformatics
2. Earth Observation Applications in Atmospheric Science
3. Earth Observation Applications in Agriculture
4. Earth Observation Applications in Disaster Management
5. Earth Observation Applications in Forestry & Environmental Science
6. Earth Observation Applications in Geosciences
7. Earth Observation Applications in Ocean Science
8. Earth Observation Applications in Urban & Regional Planning
9. Earth Observation Applications in Water Resources
10. Programming for Geospatial Analysis and Modelling

b: Test Centre: Dehradun

3.4 Salient Features of the IIRS-JET

- a: **There will be no negative marking.**
- b: The score sheet will be issued to the candidate after the Written Test (computer-based test).
- c: The candidates who qualify i.e., who score 60% or above in the IIRS-JET will be considered qualified for applying for the post of JRF at IIRS as and when advertised.
- d: The marks obtained by the candidate in the IIRS-JET is merely of qualifying nature i.e., to meet the eligibility criteria for the candidates at par with NET or equivalent exam qualified candidates; and the marks obtained in the IIRS-JET shall not be considered during the recruitment/selection of the JRFs at IIRS.
- e: The score obtained by the candidate shall be valid for three years from the date of declaration of the result. The candidate found qualified in the IIRS-JET may apply for the post of JRF at IIRS as and when the vacancies are advertised.

4: Minimum percentage / CGPA required in the qualifying degree:

a: ME / M.Tech. degree:

M.E. / M.Tech or its equivalent degree should be in first class with an aggregate minimum of 60% or CGPA /CPI grading of 6.5 on a 10 scale or equivalent.

b: M.Sc. degree:

M.Sc. degree should be 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 equivalent.

c: B.E. / B.Tech. degree:

B.E. / B.Tech. degree should be 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 equivalent.

5: Eligible subject(s)/discipline(s)/fields of Graduation/Post Graduation degree:

a: M.Sc./M.Sc.(Tech.)/M.E./M. Tech in one of the fields as below:

Agriculture/ Agriculture Engg./ Agricultural Physics/ Agro-Meteorology/ Applied Geology/ Applied Geophysics/ Applied Mathematics/ Applied Physics/ Agronomy/ Atmospheric Science/ Botany/ Civil Engg./ Climate Change/ Climate Change Adaptation/ Computer Science/ Computer Science & Engg./ Disaster Management/ Earth Science/ Earthquake Engg./ Ecology/ Environmental Engg./ Environmental Science/ Environmental Management/ Forestry/ Geoinformatics/ Geomatics/ Geoengineering/ Geography (with Bachelor's Degree in Science)/ Geology/ Geophysics/ Horticulture/ Hydrology/ IT/ Marine Science/ Mathematics/ Meteorology/ Oceanography/ Physics/ Plant Physiology/ Planning/ Remote Sensing & GIS/ Remote Sensing/ Software Engg./ Soil Science/ Soil Science & Agricultural Chemistry/ Soil & Water Conservation/ Spatial Information Technology/ Water Resource Engg./ Water Resource Management/ Wildlife Science/ Zoology, or equivalent*;

OR

b: M. Plan. with B.E./B.Tech./B. Plan./B.Arch. (Civil Engg./ Planning/ Architecture, or equivalent*);

OR

c: B.E. /B.Tech./B. Plan in one of the fields as below:-

Agriculture Engg./ Civil Engg./ Computer Science/ Computer Science & Engg./ IT/ Planning/ Software Engg./ Geoinformatics/ Remote Sensing, or equivalent*.

Note:

i: Candidate having any of the above qualifying degree must have at least any two subjects out of Physics/ Chemistry/ Mathematics/ Statistics/ Computer Science at intermediate (10+2) level.

ii: *Equivalency to be decided by IIRS during the screening of applications.

iii: Candidates in the final semester/year of the qualifying degree can also apply for the IIRS-JET. However, such candidates must submit the proof of marks/grades (cumulative marks/CGPA) till the pre-final semester/year at the time of submitting the online application, without which the application will be treated as incomplete and will be rejected.

d: Syllabus: As per Annexure-A

6: Age limit:

- a: Age for any general candidate eligible to apply for the post of JRF at IIRS is 28 years but relaxable for 5 years in case of SC/ST candidates and 3 years in case of OBC candidates.
- b: **Before applying for the IIRS-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 posts of JRF at IIRS is same as that of the IIRS-JET. Therefore, before applying for the IIRS-JET, they must clearly understand that although they may be eligible as per their current age for appearing in the IIRS-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 IIRS must fulfil the minimum essential qualification and minimum eligibility conditions as mentioned in the recruitment advertisement whenever released.**
- c: The closing date (last date) of the online applications will be the cutoff date for all purposes, such as eligibility, age etc. of the candidates.

7: Process:

- a: **Screening of Applications:** The applications received will be screened and verified on the basis of minimum eligibility qualification and age of the candidates based on certificates, mark sheets and supporting documents submitted by the candidates at the time of submitting the online application. The eligible/ screened-in candidates will be called for appearing in the IIRS-JET.
- b: **Date and Venue of the IIRS-JET:**
The Written Test (computer-based test) will be conducted on (Tentative Date) **March 21, 2020 [Saturday] at Dehradun.** However, the IIRS reserves the right to cancel/change the written test date/ venue and re-allot the candidates to any other test center. The Admit Cards for the Test to the eligible/ screened-in candidates will be sent only by e-mail about two-weeks before the Test. **The eligible/ screened-in candidates for written test will also be able to download their Admit Cards from the IIRS website (<https://www.iirs.gov.in>).**

8: How to apply:

Candidates must submit their through online only. Interested candidates may visit the IIRS website <https://www.iirs.gov.in> for detailed information and guidelines. The candidates may apply online on the above website from **February 01, 2020** [10:00 Hours] to **February 23, 2020** [23:59 Hours]. The applicant has to provide (mandatory) E-mail ID for future correspondence/reference.

9: Application Fee:

- a: There will be a non-refundable Application Fee of Rs. 1000/- (Rupees One Thousand only) for each application. Fee must be paid online through Credit Card/ Debit Card/ Internet Banking only through SBI E-pay facility at the time of submitting the online application.
- b: No other mode of payment will be acceptable and the fee will not be refundable under any circumstances.
- c: Please note that the applications without payment of Application Fee shall not be considered.
- d: **Payment Guidelines:**
 - 1. Fee will be accepted online through Credit Card / Debit Card / Internet Banking only through Integrated **SBI E-Pay** facility. No other mode of payment will be acceptable and the fee will not be refundable under any circumstances.
 - 2. Please preserve your registration number and login credentials safely after submitting your application form.
 - 3. During the payment process, **DO NOT DOUBLE CLICK ON THE BUTTONS OR REFRESH** the pages. Verify all your details before proceeding for payment.
 - 4. Candidates are advised to take print of their application after successfully submitting it.
 - 5. Example process of submission of Application Fee is shown at the end as **Annexure-B**.

10: Submission of Application:

Upon online registration, applicants will be provided with an online Registration Number, which should be carefully preserved for future reference. The candidates are also advised to take a printout of the online application for future reference.

The applicant need not send any documents such as print out of online application, receipt of cash payment, copies of certificates/mark lists in proof of educational qualification, work experience, age etc. to IIRS.

Note: In case of submission of duplicate/multiple applications by candidates, the last application against which the ‘application fee’ is received within the last date of payment of application fee only will be considered.

11: General Conditions / Instructions:

1. Applications will be received online only and all further communications will be made to the applicants through email/ IIRS website only. Therefore, the applicants are advised to check their e-mail and visit the IIRS website from time to time. IIRS will not take responsibility for non-receipt of intimation regarding Admit Card/ any communication due to technical reasons or whatsoever to the candidates.
2. Online application can be submitted through IIRS website <https://www.iirs.gov.in> from **February 01, 2020 [10:00 HRS] to February 23, 2020 [23:59 HRS]**.
3. Any request for change of address/e-mail id for communication shall NOT be entertained.
4. The application is not for any recruitment.
5. No accommodation to attend the IIRS-JET shall be provided or arranged by IIRS.
6. CGPA shall be converted into percentage of marks as per the candidate’s university norms.
7. Candidates in the final semester/year of the qualifying degree can also apply for the IIRS-JET. However, such candidates must submit the proof of marks/grades (cumulative marks/CGPA) till the pre-final semester/year at the time of submitting the online application, without which the application will be treated as incomplete and will be rejected.
8. IIRS/ISRO reserves the right to postpone/ reschedule/ cancel the test, if it so decides.
9. Travelling Allowance will NOT be paid for candidates appearing for the IIRS-JET.
10. Before appearing for the test, each candidate’s identity shall be established. At that time, all the candidates shall have to mandatorily produce original documents to establish his/her identity along with the Admit Card. The candidate’s photo identity proof such as PAN Card/Passport/Driving License/ Voter’s Card/ Bank Passbook with photograph/ Photo embossed Credit Card/ AADHAR card with a photograph should be produced in original to the IIRS officials for verification and a copy of the same must be submitted. The candidate’s identity will be verified with respect to his/her details given in the online application. If identity of the candidate is in doubt or failure on the part of the candidate to produce original Photo ID, the candidate may not be allowed to appear in the test.
11. The printout of the Admit Card is to be produced at the time of test, failing which the candidate would not be allowed to appear in the test.

12. Only Indian Nationals should apply.
13. Canvassing in any form will result in disqualification.
14. No interim correspondence will be entertained. In case of any clarification, candidates may mail to **ijet2020@iirs.gov.in**
15. The last date for receipt of online application will be the cut-off date for all purposes like age, qualification, etc.
16. Candidates in their own interest are advised to register online and submit their application well in time before the last date for submission, to avoid the possibility of disconnection / inability / failure to log on to the IIRS website on account of heavy load on server. IIRS does not assume any responsibility for the candidates not being able to submit their application within the last date on account of the aforesaid reasons or for any other reasons beyond the control of IIRS.
- 17. It may be noted that “Government strives to have a workforce that reflects gender balance and women candidates are encouraged to apply.”**
18. If any information furnished in the online application is found wrong/false/incomplete, the candidate will NOT be called for Written Test.
19. **Here-in-after, any further information/ corrigendum/ addendum related to this advertisement shall be made available only on our website (<https://www.iirs.gov.in>).**

Important dates to Remember:

Opening Date for Online Application: February 01, 2020 (10:00 HRS)
Last Date to Apply : February 23, 2020 (23:59 HRS)
Date of IIRS-JET : March 21, 2020 [Saturday]
Website : <https://www.iirs.gov.in>

Syllabus for the IIRS-JRF Eligibility Test (IIRS-JET)
Indian Institute of Remote Sensing
Indian Space Research Organisation
Dehradun

IIRS-JET is a national level exam conducted by Indian Institute of Remote Sensing (IIRS), ISRO, for the eligibility of the candidates to apply for the post of Junior Research Fellow (JRF) in the area of Remote Sensing (RS), Geographic Information System (GIS) and their Applications.

Scheme of Examination

- Examination will be computer-based having multiple choice type questions.
- Total duration of the Test shall be 120 Minutes (100 Questions).
- There are NO negative marks.
- The paper will be of 100 marks, consisting of 3 sections, namely:
 - Basic Mathematics and Science (25 questions - 25 Marks) - 30 minutes
 - Aptitude and General English (25 questions - 25 Marks) - 30 minutes
 - Subject (Optional Theme*) (one) (50 questions - 50 Marks) - 60 minutes

**Note: Candidate can appear for examination for only one of the 10 optional themes.*

The cut-off marks for qualifying the Test shall be of 60 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 IIRS advertised for recruitment during that period with the above score card.

Syllabus for the IIRS- JRF Eligibility Test (IIRS-JET)

SECTION-1: SUBJECT (Choose any one of the options) (50 MARKS)

Option-1: Remote Sensing & Geoinformatics

Remote Sensing & Photogrammetry

Physics of Remote Sensing - Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Signatures & Visual Image Interpretation keys, RS Data Acquisition Mechanisms, EO platforms and sensors, Weather & Communication Satellites, Spectral, Spatial, Temporal and Radiometric resolution. Imaging and Non-Imaging, Active and Passive, Multispectral, hyperspectral sensors. Data Types and Errors, Fundamentals of Digital Image & its Preprocessing(Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment. Concept of Image fusion and its applications. Concept of Change detection and its applications. Advanced classifiers (ANN, Fuzzy, image segmentation etc.)

Basic concepts of photogrammetry, Basic characteristics of a map, different types of map and scale, Basic Geodesy, Map projections, parallax, relief displacement, stereoscopic measurements, orthoimages, DEM/DTM. Satellite Stereo sensors, Terrain Modelling: Concept and applications of DSM, DTM, DEM, bare earth DEM, DTM derivatives. Introductory concepts of LiDAR Remote sensing. Hyper-spectral Remote Sensing: Basic Principles (including sensors and platforms for data acquisition.

Basic principles of Thermal remote sensing, Thermal Properties of Terrain: Thermal Capacity, Thermal conductivity, Thermal Inertia, Kinetic heat, Temperature, radiant energy and flux, , Thermal Infrared remote sensing applications. Microwave Remote sensing concepts: Backscattering, Range Direction, Azimuth Direction, Incident Angle, Depression Angle, Polarization, Dielectric Properties, Surface Roughness and Interpretation, resolutions Speckle and Its Reduction, Passive and active microwave sensors. SLAR and Scatterometer, Basic concepts of SAR polarimetry. Applications of microwave remote sensing images

GIS

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, shapefile, grid, dxf, dwg, geotiff, GML), Attribute types (nominal, ordinal, interval, ratio), Spatial data models (Raster and 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.

Non-spatial data models (Flat file, Hierarchical, Network, Relational and Object Oriented), 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.

Raster & Vector based spatial analysis, Map overlay, Spatial Join, Buffering analysis. Spatial analysis (raster based): Local, Neighbourhood, Zonal and Global operations. Network analysis. Spatial modelling and multi-criteria analysis. Concept of Web GIS, & Mobile GIS

GNSS

Basic concept of GNSS, Various Global/Regional Satellite constellations, GNSS signals, Pseudo Range Measurement Sources of GNSS errors, DOP. 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.

OR

Option-2: Earth Observation Applications in Atmospheric Science

Atmospheric composition and thermal structure, interaction of EMR with atmosphere, radiation basic laws, scattering, absorption, Beer-Lambert law. Atmospheric circulation, hydrostatic equation, Equation of continuity, momentum equation, Basic equations and fundamental forces, air pollution, composition. Weather and climate, tropical meteorology, Monsoon system, El Nino Southern Oscillation (ENSO), clouds types, rainfall processes, thermodynamics.

Solar spectral distribution and interaction with atmosphere, Emission and absorption of terrestrial radiation, atmospheric windows, energy balance of earth-atmosphere system, Solar constant and radiative balance at top of the atmosphere, Radiative heating or cooling of atmosphere, terrestrial radiation, Mean heat balance of earth-atmosphere system, atmospheric greenhouse effect, instrumentation and measurement.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Atmospheric Science

Physics of Remote Sensing - Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Signatures & Visual Image Interpretation keys, RS Data Acquisition Mechanisms, EO platforms and sensors, Weather & Communication Satellites, Spectral, Spatial, Temporal and Radiometric resolution. Imaging and Non-Imaging, Active and Passive

sensors. Optical, SAR, Thermal Sensors. Fundamentals of Digital Image & its Preprocessing (Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment

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, shapefile, grid, dxf, dwg, geotiff, GML), Attribute types (nominal, ordinal, interval, ratio), Spatial data models (Raster and 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. Spatial analysis (raster/vector based) Map overlay, Spatial Join, Buffering analysis.

Basic concept of GNSS, Various Global/Regional Satellite constellations.

Meteorological satellite sensors and products, Satellite image interpretation, spectral properties, cloud image interpretation, remote sensing of atmosphere using visible, thermal infrared and microwave radiometer observations, satellite meteorology, scatterometer, atmospheric motion vectors, winds, rainfall, trace gases, aerosols using EO sensors, air pollution, atmospheric sounding: retrieval of temperature and water vapor profiles.

OR

Option-3: Earth Observation Applications in Agriculture

Agricultural Crops and Soil Science

Fundamentals of Agronomy, Crop Production (major kharif and rabi crops), rainfed agriculture, Pest and diseases of field crops and horticultural crops, weather and Climate, measurement of weather parameters, Earth's atmosphere, solar radiation and energy balance, crop physiology, climate change impact on vegetation and agriculture, fundamentals of soil science: physico-chemical properties, soil forming factors and soil forming processes, land evaluation, soils of India: salient characteristics and their land use, environment monitoring and management, ecosystem processes and climate change, ecosystem dynamics, statistical methods.

Soil and Water Conservation

Natural resource management, land degradation processes, soil erosion types and processes, soil hydrological properties and their measurement, soil & water conservation measures, watershed management, watershed morphology, soil hydrology, irrigation & water

management, land degradation types, extent and their characteristics, salt affected soils, soil reclamation measures, soil quality and environmental and soil pollution.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Agriculture

Physics of Remote Sensing - Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Signatures & Visual Image Interpretation keys, RS Data Acquisition Mechanisms, EO platforms and sensors, Weather & Communication Satellites, Spectral, Spatial, Temporal and Radiometric resolution. Imaging and Non-Imaging, Active and Passive sensors. Optical, SAR, Thermal Sensors. Fundamentals of Digital Image & its Preprocessing (Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment

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, shapefile, grid, dxf, dwg, geotiff, GML), Attribute types (nominal, ordinal, interval, ratio), Spatial data models (Raster and 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. Spatial analysis (raster/vector based) Map overlay, Spatial Join, Buffering analysis.

Basic concept of GNSS, Various Global/Regional Satellite constellations

Overview of remote sensing and GIS applications in agriculture and soils; remote sensing data for agriculture and soils, understanding vegetation and soil spectral response curve, basic knowledge of optical, microwave (active and passive) and thermal remote sensing applications in agriculture, microwave remote sensing for kharif crop inventory, crop condition and cropping system analysis, crop management, crop yield models, crop informatics, precision agriculture, satellite agrometeorology, agromet variables and parameters, agricultural water and drought management, land surface processes and climate change, soil resource mapping, digital soil mapping techniques, optimal land use planning, digital terrain analysis for watershed characterization, watershed monitoring, soil erosion modelling using GIS, remote sensing in land degradation and desertification characterization and mapping, microwave remote sensing in soil moisture studies

OR

Option-4: Earth Observation Applications in Disaster Management

Definitions of Natural Disasters and Manmade disasters; Various types of Natural disasters and their basic understanding (Floods, Earthquakes, landslides, Tsunamis, Cyclones, droughts etc.); concept of Hazard, vulnerability, susceptibility and risk, Disaster Management cycle; Disaster

risk reduction (DRR), mitigation, preparedness and disaster early warning; Disaster management framework of India and recent initiatives by Govt. of India such as National Disaster Management Act, National Disaster Management Policy, NDMA, NIDM, NDRF, guidelines issued by NDMA for handling various disasters etc.; International Initiatives such as Sendai Framework in the field of Disaster Management.

Drought: its types and impact, soil erosion - causes, types and agents of soil erosion; soil erosion control structures, water harvesting techniques, wind erosion, wind erosion control measures.

Forest fire and environmental hazards: Vegetation types and fire incidences, fire regimes, Types of forest fire, fire triangle. Pollution, particulate emission and their movement.

Geological hazards: Major tectonic features of the Oceanic and Continental crust; Seismic belts of the earth; Environment Impact Assessment; Natural hazards - preventive/precautionary measures - landslides, earthquakes, river and coastal erosion; Landslides - classification, causes and prevention; Slope Stability; Impact assessment of anthropogenic activities such as open cast mining and quarrying, river valley projects, etc.

Hydrological and coastal Hazards: Concept of Hydrology, Hydrological Cycle, Element of Hydrological cycle: Rainfall, interception, infiltration, Soil Moisture, Evapotranspiration etc. Introduction to flood hydrology, flood flow estimation and routing, urban flooding, flood inundation mapping and modeling, GLOF, flood damage assessment, flood hazard and flood risk zone mapping using remote sensing and GIS techniques. Climate change induced disasters (sea level rise, tropical cyclones, etc.). Coastal hazards such as cyclone, storm surges, tsunami, sea-level rise and coastal vulnerability

Atmospheric Hazards: Earth's atmosphere, composition and structure of atmosphere, temperature and pressure variation with altitude, cyclones, anticyclones and general circulation system of earth, types of precipitation, types of monsoon, atmospheric pollution; Global warming – indicator, agent and causes, Global warming and its impacts; Greenhouse gases and effect.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Disaster Management

Physics of Remote Sensing - Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Signatures & Visual Image Interpretation keys, RS Data Acquisition Mechanisms, EO platforms and sensors, Weather & Communication Satellites, Spectral, Spatial, Temporal and Radiometric resolution. Imaging and Non-Imaging, Active and Passive sensors. Optical, SAR, Thermal Sensors. Fundamentals of Digital Image & its Preprocessing (Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment

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, shapefile, grid, dxf, dwg, geotiff, GML), Attribute types (nominal, ordinal, interval, ratio), Spatial data models (Raster and 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. Spatial analysis (raster/vector based) Map overlay, Spatial Join, Buffering analysis.

Basic concept of GNSS, Various Global/Regional Satellite constellations

Earth observation data for disaster management; Optical, Thermal and microwave remote sensing sensors for Atmospheric, environmental and hydro-meteorological and geological hazard monitoring and modeling.

OR

Option-5: Earth Observation Application in Forestry & Environmental Science

Natural resources: Types, distribution and status of vegetation of India and the world; Factors affecting vegetation distribution; Major biomes of the world; Biogeography and life zones; Major systems of plant classification; Plant identification methods; Forest phenology and its drivers; Renewable and non-renewable resources; Social forestry; Agroforestry; Non-timber forest produce

Forest ecology: Definitions; Forest ecosystem structure and functions; Nutrient cycling; Forest productivity estimation; Landscape ecology; Population and community studies; Phytosociology; Ecological succession; Food chains and food webs; Ecological pyramids; Energy flow in ecosystem

Plant physiology: Photosynthesis; Photosynthetic pathways and their significance; Photoperiodism; Transpiration; Plant adaptations

Forest inventory planning: Sampling design; Sampling concepts and methods; Growing stock and biomass estimation; Measures of central tendency; Correlation and regression analysis; Trees outside forests; Forest working plan; Forest mensuration

Conservation and Ecosystem services: Wildlife conservation; Protected areas and their status in India; Wildlife corridors; Biodiversity assessment; Global biodiversity hotspots; Importance of wetlands; Ramsar convention; Wetlands and their conservation; UN Agenda-21 and Aichi Targets; UN Sustainable Development Goals; Assessment and valuation of ecosystem services; Use of plant and plant parts; IUCN; CITES; Rare, endangered and threatened species; Keystone species; Umbrella species; Flagship species

Forest disturbances: Deforestation; Forest degradation; Forest fire - types and its effect on vegetation; Insect pest/diseases; Invasive plants; Threats to wildlife and biodiversity; Habitat fragmentation; Extinction of species

Climate change and Environmental impact assessment: Greenhouse gases; Global warming; Acid rain; Biogeochemical cycles; Forest ecosystem and climate linkages; Climate change impacts on forest ecosystems; IPCC climate change scenarios; Environmental impact assessment – purpose and process; Environmental policy and strategy; Forest, environment and wildlife acts/laws; Kyoto Protocol; REDD⁺, Environmental movements of India;

Environmental pollution: Sources of pollution; Nature of pollutants; Air pollution and its effects; Water pollution and its effects; Eutrophication; Land pollution; Solid wastes; Vehicular pollution; Radiation hazards

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Forestry

Physics of Remote Sensing - Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Signatures & Visual Image Interpretation keys, RS Data Acquisition Mechanisms, EO platforms and sensors, Weather & Communication Satellites, Spectral, Spatial, Temporal and Radiometric resolution. Imaging and Non-Imaging, Active and Passive sensors. Optical, SAR, Thermal Sensors. Fundamentals of Digital Image & its Preprocessing (Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment

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Basic concept of GNSS, Various Global/Regional Satellite constellations

Applications of remote sensing and GIS in forestry and ecology; National forest cover assessment using satellite data; Vegetation type/land use mapping; Forest cover monitoring. Vegetation Indices.

OR

Option-6: Earth Observation Applications in Geosciences

Earth System Science

Concepts of Earth System Science; Earth and the solar system; Origin and evolution of the Earth; Earth materials, Surface features and processes.

Geomorphic processes and landform evolution; Applied geomorphologic mapping; Geomorphic classification systems; Glacier-climate interaction; glacier dynamics; Periglacial and glacial landforms.

Various mineral resources and their formation process; Prospecting and exploration of economic mineral deposits - sampling, ore reserve estimation; geostatistics; mining methods; various surface indicators for mineral exploration.

Basics of crystallography, mineralogy, geochemistry and petrology.

Basics of structural geology, stratigraphy and geotectonics; Introduction to active tectonics and neotectonics.

Earthquake geology and palaeoseismology; Seismo-Tectonics of the Indian plate; Seismic zones of India vis-à-vis recent earthquakes; Geodynamics of Himalaya.

Groundwater and Engineering Geology:

Basics of hydrogeology; Role of landforms and geological structures in groundwater occurrences; Hydrogeological classification of rocks in India; Groundwater targeting in different geologic terrains using EO data and GIS techniques.

Geophysical methods for groundwater exploration; Groundwater quality and pollution assessment including sea-water intrusion; artificial groundwater recharge methods;

Engineering properties of rocks and soil; Rock mass classification; Construction materials; Mass movement types and classifications of landslides; Landslide characteristics, causes and processes; Remote sensing applications in landslides; dams and reservoirs site selection in different geological settings; Environmental impact assessment of dams and reservoirs.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Geosciences

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(Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment

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Basic concept of GNSS, Various Global/Regional Satellite constellations

Image elements for geological interpretation; Remote sensing applications in interpreting structure & tectonics, lithological mapping, mineral resources, geological hazards, groundwater potentials and environmental monitoring.

Satellites and sensors for terrestrial geosciences

Thermal properties of geological materials; Radar wave properties and interaction with terrain & geology; Spectroscopy of rocks and minerals.

Various methods and applications of Digital Image Processing (DIP) in geology; Basic concepts and principles of multispectral, hyperspectral, thermal Infra-red and microwave data processing and their applications in geology.

Applications of GIS in various geological studies. Geological database creation in GIS; Integrated data analysis; Terrain mapping and analysis

Geophysical methods (electro-magnetic, resistivity, gravity, seismic) of exploration and its integration with remote sensing based information for geoscientific applications.

OR

Option-7: Earth Observation Applications in Ocean Science

Basics of Oceanography: Physical and Chemical properties of Ocean: temperature, salinity, density, pressure, heat budget, Carbon Cycle, Nitrogen Cycle.

Dynamical Oceanography: Equation of motion, Coriolis force, Equation of continuity, Geostrophic flow, Wind-driven circulation, Ekman Transport, upwelling, Buoyancy, Vorticity, Thermohaline circulation, Mixed layer, Waves, Internal waves, Kelvin waves, Rossby waves and Tides.

Marine Biology: Pelagic and Benthic zones of the Ocean, Biotic and Abiotic factor effecting marine life, Planktons, Primary productivity, Food Chain.

Coastal Processes and Marine Ecology: Classification of coasts and the processes of their formations, landforms due to erosional and depositional activities. Climate change and sea level rise. Coastal disasters like tsunami, cyclone, storm surge etc. Basic coastal ecological components like Mangroves, corals and sea grasses. Importance of coast and concept of coastal zone management. Issues pertaining to Indian Coast and their mitigation strategy.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Ocean Science

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Basic concept of GNSS, Various Global/Regional Satellite constellations

Applications in Oceanography: Passive and Active sensors for Oceanographic study: Optical sensors, Thermal sensors, Passive microwave sensors, Active microwave sensors (Altimeter, Scatterometer, Synthetic Aperture Radar). Retrieval of Oceanographic parameters from satellite sensors: Phytoplankton concentration, Suspended Sediment Concentration, Diffused attenuation coefficient, Sea Surface Temperature, Sea Surface Salinity, Sea Surface Height, Significant Wave Height, Wind speed over ocean, Geostrophic Current, Wave spectrum, Estimation of column primary productivity, Coastal Bathymetry, Identification of Potential Fishing Zone (PFZ).

Applications in Coastal Processes and Marine Ecology: Remote sensing and GIS applications for coastal study. Study of coastal hazards/disasters using geospatial techniques, Study of Coastal ecological components from space-borne sensors. Use of Remote sensing and GIS for Coastal zone management. Parameters retrieved using RS techniques for coastal zone study. Gap areas and future sensor requirement for coastal zone studies and management.

OR

Option-8: Earth Observation Applications in Urban & Regional Planning

Urbanization in India, definition of urban and regional areas, census classification of urban areas, trends in urban population, urban sprawl: causes and effects, population trend in India, types of urban densities, migration, land-man ratio, household size, terminology and concepts of urban and regional planning, Guidelines for Urban and Regional Planning (URDPFI Guidelines), urban and regional planning models, characteristics of development/ master/ zonal plans, urban growth models, Regional studies: concepts, resource regions in India, Decentralized planning, Base maps characteristics and scales, urban land use/ land cover classification system and mapping, concepts of Smart Cities and AMRUT, basics of urban hydrology, urban flooding and urban drainage planning, classification of urban roads, types of parking, various types of road and traffic surveys, weather and climate, urban climate, urban heat island, urban pollution, urban multi-hazards, risk and vulnerability assessment, types and sources of renewable energy. Basic statistical techniques and their interpretation, spatial metrics, population projection techniques. Overview of Sustainable Development Goals.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Urban & Regional Planning

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Application of remote sensing data [Optical (MX/stereo), Microwave, LiDAR, Hyperspectral and Thermal] for urban and regional area analysis, planning and governance; urban features

extraction, material characterization; base maps, urban sprawl and growth modeling, prediction of future growth pattern using CA-ANN, MCE-CA Models; use of Night-Time Light Data in urban studies; 3D modeling techniques and visualization for urban surface profiling; DEM/DSM Generation for urban areas; urban climate, pollution, flooding and hazard, urban utilities and infrastructure management, GPR applications in utility mapping, urban heritage; property tax assessment; tourism resources, urban green spaces, land suitability analysis, slums mapping, solid waste management, renewable energy harnessing.

OR

Option-9: Earth Observation Applications in Water Resources

Basics of Hydrology and water cycle: Introduction to hydrological cycle and its components (Precipitation, Interception, Infiltration, ET, Runoff etc.); Concept of the basin/watershed; Water resources of India; Water availability and use in Indian river basins; Water quality.

Basics of surface, snow and ground water hydrology and hydraulics: Concepts and measurements of precipitation, surface runoff, infiltration, evapotranspiration; Hydrograph; Snow & Glacier hydrology; Watershed hydrology; Soil erosion; Fundamentals of open channel flow and flow in porous media; flow routing, discharge measurement; Basics of open channel and ground water hydraulics

Concepts of Flood and Drought Assessment and Management: Flood peak estimation; Flood routing; 1D/2D flow simulations; Dam break; Flood inundation modelling; Drought indices; Flood and Drought information systems.

Concepts of Water Resources Planning and Management: Reservoir and canal design; Site suitability and EIA of water resources projects; Basic concepts of irrigation water management; Concept of impact of climate change on hydrological cycle components and water sector Conjunctive use of surface and ground water.

Basic concepts of Remote Sensing, GIS & GNSS and its Application in Water Resources

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Basic concept of GNSS, Various Global/Regional Satellite constellations

Overview of remote sensing and GIS applications in hydrology; Hydrological cycle parameters (Precipitation, ET, soil moisture, etc.) retrieval using satellite data; surface water, snow, ice sheet and glacier mapping using remote sensing, rainfall-runoff modelling using GIS, watershed characterization using digital elevation models, flood mapping and irrigation studies using remote sensing.

OR

Option-10: Programming for Geospatial Analysis & Modelling

Basic concepts of remote sensing, GIS & GNSS

Physics of Remote Sensing - Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Signatures & Visual Image Interpretation keys, RS Data Acquisition Mechanisms, EO platforms and sensors, Weather & Communication Satellites, Spectral, Spatial, Temporal and Radiometric resolution. Imaging and Non-Imaging, Active and Passive sensors. Optical, SAR, Thermal Sensors. Fundamentals of Digital Image & its Preprocessing (Radiometric & Geometric Correction), Image Enhancement (Radiometric, Spatial and Spectral), Image Classification (Unsupervised & Supervised), Accuracy assessment

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Basic concept of GNSS, Various Global/Regional Satellite constellations

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

Data Handling

- Console input-output handling (Simple and Parameterized)
- File data handling (input and output)
- Database handling

Programming language platforms

- Desktop based
- Web based
- Mobile Based
- Hybrid

Coding Practices

- Object Oriented Programming
- Programming frameworks
- Batch Processing
- Debugging and Exception Handling
- Code Optimization and
- Handling memory leaks

Advanced Topics

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

Architecture

- Procedural pattern
- Client Server
- Master Slave

- Distributed architecture
- Model-view-controller pattern
- Service Oriented Architecture(Web 2.0)

Programming/Scripting Languages

- Python, Java, FORTRAN, etc.
- PHP, Javascript, XML,HTML etc.

SECTION-2: BASIC MATHEMATICS AND SCIENCE (25 MARKS)

2.1 BASIC MATHEMATICS

Number Systems

Real Numbers: Euclid's division lemma, Fundamental Theorem of Arithmetic - statements after reviewing work done earlier and after illustrating and motivating through examples, Proofs of irrationality of $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, Decimal representation of rational numbers in terms of terminating/non-terminating recurring decimals.

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 graphical method of their solution, consistency/inconsistency. Algebraic conditions for number of solutions. Solution of a pair of linear equations in two variables algebraically – by substitution, by elimination and by cross multiplication method. Simple situational problems. Simple problems on equations reducible to linear equations.

Quadratic Equations: Standard form of a quadratic equation $ax^2 + bx + c = 0$, ($a \neq 0$). Solutions of quadratic equations (only real roots) by factorization, and by using quadratic formula. Relationship between discriminant and nature of roots. Situational problems based on quadratic equations related to day to day activities to be incorporated.

Arithmetic Progressions: Motivation for studying Arithmetic Progression Derivation of the n^{th} term and sum of the first n -terms of an A.P. and their application in solving daily life problems.

Coordinate Geometry

Lines (In two-dimensions): Concepts of coordinate geometry, graphs of linear equations. Distance formula. Division of a line segment in a given ratio (internally).

Geometry

Triangles: Definitions, types, area calculation in different type of triangle, counter examples of similar triangles and related problems.

Circles: Definition, Tangent to a circle at point of contact and from a point outside, equations, radius and circumference, Construction of a triangle similar to a given triangle, and related problems.

Trigonometry

Introduction to Trigonometry: Trigonometric ratios of an acute angle of a right-angled triangle. Proof of their existence (well defined); motivate the ratios whichever are defined at 0° and 90° . Values (with proofs) of the trigonometric ratios of 30° , 45° and 60° . Relationships between the ratios.

Trigonometric Identities: Proof and applications of the identity $\sin^2 A + \cos^2 A = 1$. Only simple identities to be given. Trigonometric ratios of complementary angles.

Heights and Distances (Angle of elevation, Angle of Depression): Simple problems on heights and distances. Problems should not involve more than two right triangles. Angles of elevation / depression should be only 30° , 45° , and 60° .

Mensuration

Areas Related to Circles: Motivate the area of a circle; area of sectors and segments of a circle. Problems based on areas and perimeter / circumference of the above said plane figures. (In calculating area of segment of a circle, problems should be restricted to central angle of 60° , 90° and 120° only. Plane figures involving triangles, simple quadrilaterals and circle should be taken)

Surface Areas and Volumes:

- Surface areas and volumes of combinations of any two of the following: cubes, cuboids, spheres, hemispheres and right circular cylinders/cones. Frustum of a cone.
- Problems involving converting one type of metallic solid into another and other mixed problems. (Problems with combination of not more than two different solids be taken).

Statistics and Probability

Statistics: Statistical parameters estimation (Mean, median and mode) of grouped and ungrouped data. Cumulative frequency graph, distributions.

Probability: Classical definition of probability, different types of events, simple problems on probability theory.

2.2 BASIC SCIENCE

Chemistry

Matter Theory: 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 reactions and equations: Chemical reactions- types of chemical reactions, displacement reactions, redox reactions, combination and decomposition of reactions, Chemical Equations.

Acids, bases and salts: Introduction of acids and bases, properties of acids and bases, concept of pH scale, pH scale and its importance, important chemical compounds,

Metals and non-metals: Physical properties of metals and non-metals, chemical properties of metals, metals in nature, electrovalent bonding of metals, formation and properties of ionic compounds.

Carbon and its compounds: Covalent bonding in non-metals, carbon compounds, introduction to hydrocarbons, properties of hydrocarbons, nomenclature of organic compounds, alcohols and carboxylic acids.

Periodic classification of elements: Classification of elements, similarities of element's properties, modern periodic table of elements.

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, 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.

Electromagnetic Theory

Basics of Electromagnetic theory

Electromagnetic Waves: Basic idea of displacement current, Electromagnetic waves, their characteristics, their Transverse nature (qualitative ideas only). Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

Dual Nature of Radiation and Matter

Dual Nature of Radiation and Matter: Dual nature of radiation, Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light. Matter waves-wave nature of particles, de-Broglie relation, Davisson-Germer experiment (experimental details should be omitted; only conclusion should be explained).

Atoms and Nuclei

Atoms: Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum.

Nuclei: Composition and size of nucleus, Radioactivity, alpha, beta and gamma particles/rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number; nuclear fission, nuclear fusion.

Optics

Ray Optics and Optical Instruments: *Ray Optics:* Reflection of light, spherical mirrors, mirror formula, refraction of light, total internal reflection and its applications, optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lensmaker's formula, magnification, power of a lens, combination of thin lenses in contact, refraction of light through a prism. Scattering of light - blue colour of sky and reddish appearance of the sun at sunrise and sunset. *Optical instruments:* Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Wave Optics: Wave front and Huygen's principle, reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light, diffraction due to a single slit, width of central maximum, resolving power of microscope and astronomical telescope, polarization, plane polarized light, Brewster's law, uses of plane polarized light and Polaroids.

SECTION-3: APTITUDE AND GENERAL ENGLISH (25 MARKS)

3.1 Aptitude

Problems on basic arithmetic and reasoning viz numbers, percentage, area, volume, profit & loss, distance, velocity, time & work, clocks & calendars, permutation & combination, compound interest, simple interest, H.C.F. & L.C.M., odd man out, analogy, similarities & differences, classification, series completion, coding and decoding, statement conclusion, spatial visualization, spatial orientation, discrimination, observation, relationship concepts, judgment and arithmetical reasoning.

3.2 General English

Questions in this component will be designed to test the candidate's understanding and knowledge of English language and will be based on error recognition, fill in the blanks (using verbs, preposition, articles, etc.), vocabulary, grammar, sentence structure, synonyms, antonyms, sentence completion, phrases and idioms and comprehension.
