National Entrance Screening Test 2016

NEST 2016

INFORMATION BROCHURE
&
SYLLABUS

Entrance Test for Admission to

National Institute of Science Education and Research
(**NISER**) Bhubaneswar
and
University of Mumbai - Department of Atomic Energy
Centre for Excellence in Basic Sciences
(**UM-DAE CBS**) Mumbai

Integrated MSc programme 2016-21

Introduction to NEST 2016

The National Entrance Screening Test or NEST is a compulsory test for admission to the 5-year Integrated MSc programme in basic sciences - Biology, Chemistry, Mathematics and Physics - at National Institute of Science Education and Research (NISER), Bhubaneswar and University of Mumbai - Department of Atomic Energy Center for Excellence in Basic Sciences (UM-DAE CBS), Mumbai. Both NISER and CBS are autonomous institutions established by Department of Atomic Energy (DAE), Government of India, in 2007.

These institutes have started with the mandate to provide high quality teaching in basic sciences by a faculty of distinguished scientists embedded in a vibrant research environment and to create a national pool of scientists ready to take up research challenges in the frontiers of basic and applied sciences. The Integrated MSc programme at these institutes follows a semester-based course structure and continuous assessment within a flexible and innovative academic curriculum, exposing the students to research early in their programme. The placements of the graduated students from NISER and CBS provide testimony of success to this initiative.

NISER and CBS are both residential institute equipped with state-of-art teaching and research laboratories, modern computational facilities and computer centres and excellent libraries. All the students are accommodated at in-campus hostels, for both girls and boys, and are provided with an environment conducive to science education and research.

All the candidates admitted to 5-year Integrated MSc programme at NISER and CBS are eligible for INSPIRE, Govt. of India, scholarship of ₹5,000/- per month and ₹20,000/- per year for carrying out summer projects.

Besides, top performers at NISER and CBS, securing overall grades above certain threshold at the end of final semester, will be eligible to appear directly for the interview for admission to Bhabha Atomic Research Centre (BARC) Training School.

The details of the Integrated MSc programme, courses, research activities, facilities and faculty profile at NISER and CBS can be found on their respective websites (*www.niser.ac.in* and *www.cbs.ac.in*).

Eligibility criteria for admission

Educational qualification: Candidates seeking admission to NISER and UM-DAE CBS for the academic session 2016-17 should be from science stream (having any combination of Biology/ Chemistry/ Mathematics/ Physics) at class XII and must write the NEST 2016 examination. Candidates who have passed class XII examination or equivalent from any recognised Board in India in 2014 or 2015 or are appearing in 2016 are eligible for admission. Admission will be offered strictly on the basis of Merit List of NEST 2016. Candidates securing at least 60% marks in aggregate or equivalent grade in class XII examination will be eligible for admission to NISER and CBS. However, there is no restriction on appearing for NEST. For candidates belonging to scheduled castes (SC), scheduled tribes (ST) and physical disabilities (PD) categories, the minimum requirement of marks is 55% in aggregate. Where only letter grades are available, a certificate from the Board specifying equivalent percentage of marks is required. In the absence of such a certificate, the decision of the Admissions Committee of the concerned Institution will be final.

Age limit: General and OBC category candidates born on or after **August 01, 1996** are eligible for admission to the integrated M.Sc. programme of NISER/CBS. The age limit is relaxed by 5 years for SC / ST / PD candidates. However, there is no restriction on appearing for NEST 2016.

Necessary certificates supporting eligibility criteria have to be furnished at the time of admission. Please also note that the offer of admission is subject to verification of all original certificates at the time of admission/counselling.

Reservation of seats

For the integrated MSc programme 2016-21, the total number of seats at NISER and CBS are 132 and 47, respectively. Indian nationals belonging to certain categories are admitted under the seats

reserved for them in accordance with the rules of the Government of India. The categories and the extent of reservation are as follows:

Other Backward Classes belonging to the Non-Creamy Layer (OBC–NCL)
27% of seats are reserved for OBC–NCL. The class should have been mentioned in the central list of OBCs (http://www.ncbc.nic.in/User_Panel/CentralListStateView.aspx) as of June 1, 2015 and the certificate should have been obtained from a competent authority on or after June 1, 2015.

Candidates belonging to the creamy layer of OBC are NOT entitled for reservation. Such candidates are treated as belonging to the General (unreserved) category. The Socially and Educationally Backward Classes (SEBC) as notified by some of the State Governments are as such NOT eligible to avail any reservation unless they satisfy the OBC-NCL criteria.

Scheduled Caste (SC) / Scheduled Tribe (ST)
15% seats are reserved for SC and 7.5% seats for are reserved for ST categories. The benefit of reservation will be given only to those castes and tribes that are mentioned in the respective lists of corresponding states published by the Government of India (http://socialjustice.nic.in/sclist.php and (http://tribal.nic.in/Content/listofScheduled TribesinIndia.aspx).

The number of seats reserved for SC, ST, OBC (Non-Creamy-Layer) and PD is according to the Government of India norm. To claim seats under reserved category, relevant documents must be furnished at the time of admission. For OBC candidates, the OBC (NCL) certificate must have been issued on or after **June 01, 2015**.

Person with Disabilities
3% of seats are reserved in every category, i.e., General, OBC-NCL, SC and ST. Benefit would be given to those who have at least 40% impairment irrespective of the type of disability i.e., locomotor, visual or dyslexic. Leprosy- cured candidates who are otherwise fit to pursue the course are also included in this sub- category. Candidates are advised to ensure that the certificate is in accordance with the latest guidelines of the Government of India (visit the web site of the Ministry of Social Justice and Empowerment, Department of Disability Affairs for latest information).

Supernumerary Quota for students from Jammu and Kashmir
Two seats in each institution are reserved for candidates from the state of Jammu and Kashmir.

The students who belong to Jammu & Kashmir and who appear for the Class XII or equivalent exam through the State Board of Jammu & Kashmir and from Central Board of Secondary Education (CBSE) affiliated schools located in Jammu & Kashmir are only eligible under the Supernumerary quota. (For further details please see http://mhrd.gov.in/hi/sites/upload_files/mhrd/files/upload_document/SSSJKGuidelines.pdf).

If selected, the candidate must produce the original certificate at the time of admission failing which the offer of admission will be cancelled.

Unfilled seats in the OBC-NCL category can be allotted to General category candidates, whereas seats remaining vacant under the SC and ST categories shall NOT be allotted to candidates belonging to other categories. The reservation for PD candidates is horizontal and hence, unfilled seats will be allotted to candidates belonging to the respective categories i.e., unfilled SC (PD) seats will be allotted to candidates belonging to the SC category and so on.

The Examination

The NEST 2016 will be conducted at 56 major towns and cities all over India on **May 28, 2016 (Saturday), 10:00 am – 1:00 pm**. Based on the performance in NEST 2016, a common Merit List of the candidates will be prepared and posted on NEST 2016 website on **June 17, 2016**. The successful candidates will be asked to participate in an admission/counselling process and the admission will strictly be according to the Merit List until all the seats are filled.

Examination centres: A list of NEST examination centres is given in page-6. Candidates must choose 2 (two) centres in order of their preference while filling up of application form. It is allowed to select two centers from the same city, such as Delhi-East and Delhi-North. Every effort will be made to allot the centre of first preference. Please note that *ultimately the allotment of an examination centre by the Chief Coordinator has to be regarded as final and request for change of centre will, in general, not be entertained.* The centre (venue) address will be mentioned on the NEST admit card.

Examination rules: Candidates must reach the test centre at least half an hour before the start of the examination. The examination is of 3 hrs duration and will start at 10:00 am. Candidates will not be allowed to enter the examination hall after 10:30 am. The earliest a candidate can leave the examination hall is 11:30 am, unless it becomes necessary to leave before on medical grounds. The earliest one can carry the question paper out is 12.00 noon. Use of log tables and calculators in the examination hall is not allowed. Candidates must bring their own pen, pencils (HB), eraser and sharpener. Exchange/sharing of these items with other candidates is strictly prohibited. Candidates MUST bring their Admit Card and their school photo Identity Card or any photo ID issued by Government agencies to the examination hall. Any candidate found adopting unfair means will be expelled from the examination hall without warning. Mobile phone and other similar electronic gadgets are strictly not allowed inside examination hall.

Question type: The question paper will consist of 5 (five) sections of objective (MCQ) type questions carrying 50 marks in each section. Section 1 is the general section and is compulsory for all candidates. There will be no negative marking in general section. Sections 2 through 5 will contain subject specific questions from Biology, Chemistry, Mathematics and Physics. Candidates are permitted to attempt as many subject-sections as they wish. However, only the best three subject-scores along with the score in the general section will be counted for evaluation and merit list preparation. The questions are designed to test candidates' subject comprehension and analytic ability. In the subject sections, there will be negative marking for incorrect answers. Some questions may have one or more correct answers for which marks can only be earned by marking all correct answers and no wrong answer. For NEST question papers of last few years, refer to the NEST 2016 website.

Language of the question paper will be English only.

Answering questions: The answers to each question are to be marked on an OMR (Optical Mark Recognition) sheet. Details of how to answer on OMR sheet will be given in question paper and OMR sheet.

Syllabus: The syllabus for NEST 2016 primarily follows the NCERT/ CBSE science syllabus of class XI-XII. The detailed syllabus for NEST examination is provided at the end of this document. The syllabus can also be downloaded on the www.nestexam.in website under the 'Syllabus' tab. There is, however, no specific syllabus for the general section. This section tests candidate's familiarity with, but not detailed understanding of, major historical milestones in subjects like astronomy, biology, chemistry, mathematics, physics, computer science and environmental science. Questions will be designed to test analytic abilities and comprehension of scientific passages. Some of the questions in this section may require knowledge of class X mathematics.

Note: Previous NEST question papers (2007 to 2015) are available on NEST website.

How to apply

To apply for NEST 2016, candidates must fill-up the online application form through www.nestexam.in on or after January 4, 2016. Candidates are strongly advised to read through the detailed online application procedure available on the website. **There is no offline application mode available for NEST 2016.**

Application Fee: The application fee for the male candidates of General/OBC category is 700/-. The application fee for SC/ST/PD categories and all female candidates is 350/-. Payments can be made by DD or using credit card/debit card/net-banking through online payment gateway.

- *Demand Draft*: DD for required amount may be prepared from any bank and should be drawn in favour of the <u>NISER-NEST</u> and payable at Bhubaneswar. Candidate must write her/his name and application number at the back of the DD before dispatching. The DD should be sent along with a printout of the application summary obtained at the end of the application process. Please DO NOT staple the DD with the summery page. The DD has to be sent preferably by speed post at the address given below and must reach NEST office on or before March 15, 2016.

- *Online payment portal:* The multi–modal payment portal offers payment by credit card/debit card/net-banking of multiple banks. A detailed step-by-step instruction for payment through online portal is available on www.nestexam.in and also inside the online application page for NEST 2016. Candidates opting for online payment need not send any document to NEST office (GO GREEN initiative) and hence online payment is highly recommended.

Please refer to the instruction sheet (the 'How to Apply' tab on www.nestexam.in) for details on all payment methods.

Admit card: The admit card for NEST 2016 will be available for downloading from **April 15, 2016**. Admit cards will not be dispatched to any applicant. Applicants <u>must</u> download their admit cards from NEST website (after login). The download link will be available only till the day of examination. Safe-keeping of one copy of admit card is therefore strongly advised because the successful candidates have to produce the admit card in original during the admission.

Address for correspondence

Demand Drafts and/or any NEST-2016 related queries by postal mail must be sent at

The Chief Coordinator, NEST 2016
National Institute of Science Education and Research (NISER)
At/PO-Jatni, District- Khurda, PIN- 752050, Odisha, India

For any query requiring quicker response, please contact at

Phone: (0674) 2494102 (<u>Mon-Fri, 10:00-13:00 & 14:30-17:00</u>)

Email: nest@nestexam.in
The official website of NEST 2016 is: www.nestexam.in

Applications incomplete in any respect will not be accepted.

Important Dates

- Start of Online application for NEST 2016: **January 04, 2016**
- Closing of Online application: **March 04, 2016**
- Download of Admit Card begins: **April 15, 2016**
- NEST 2016 examination: **May 28, 2016 (Saturday) 10:00am – 1:00pm**
- Announcement of results in NEST website: **June 17, 2016**

Important things to remember

- Candidates must reach the examination venue at least half an hour (30 minutes) before the start of the examination.
- Candidates will not be allowed to enter the examination hall half an hour (30 minutes) after the start of the examination, i.e. 10:30 am.
- Candidates will be allowed to leave the examination hall only after one hour from the start of the examination, i.e. 11:00 am.
- Candidates leaving the examination hall after 12 noon will be allowed to carry the question paper.
- Use of log tables and calculators in the examination hall are not allowed. Candidates must bring their own pen, pencil, eraser and other stationeries.
- Candidates MUST bring their Admit Card and Identity Card to the examination hall.
- Mobile phone and other electronic gadgets are not allowed inside examination hall.

Check-list for online application

✓ Correct e-mail address is provided

✓ Properly scanned passport size photograph is uploaded

✓ Properly scanned signature is uploaded

✓ Name of issuing Bank and DD number are correctly entered, if paid by DD.

✓ Name & application number are written on the backside of the DD (if fee paid by DD)

✓ Two different examination centres are chosen according to preference.

If any of the above is found missing, the application will be considered incomplete and will be rejected.

List of NEST 2016 Test Centres with centre codes

Test Centre	Code	Test Centre	Code
Agartala (TR)	01	Jamshedpur (JH)	31
Ahmedabad (GJ)	02	Jodhpur (RJ)	32
Allahabad (UP)	03	Kanpur (UP)	33
Balangir (OD)	04	Kochi (KL)	34
Balasore (OD)	05	Kolkata-North (WB)	35
Bengaluru (KA)	06	Kolkata-South (WB)	36
Berhampur (OD)	07	Koraput (OD)*	37
Bhopal (MP)	08	Lucknow (UP)	38
Bhubaneswar (OD)	09	Madurai (TN)	39
Burdwan (WB)	10	Mangalore (KA)	40
Calicut (KL)	11	Mumbai (MH)	41
Chandigarh (CH)	12	Nagpur (MH)	42
Chennai (TN)	13	Patna (BR)	43
Coimbatore (TN)*	14	Pune (MH)	44
Cuttack (OD)	15	Raipur (CG)	45
Dehradun (UK)	16	Ranchi (JH)	46
Delhi-East (DL)	17	Rourkela (OD)	47
Delhi-North (DL)	18	Sambalpur (OD)	48
Delhi-South (DL)	19	Shillong (ML)	49
Dhanbad (JH)*	20	Shimla (HP)	50
Dharwad (KA)	21	Siliguri (WB)	51
Durgapur (WB)*	22	Srinagar (JK)	52
Ghaziabad (UP)	23	Thiruvananthapuram (KL)	53
Guwahati (AS)	24	Thrissur (KL)	54
Gwalior (MP)*	25	Tiruchirappalli (TN)*	55
Hyderabad (AP/TS)	26	Udaipur (RJ)	56
Imphal (MN)*	27	Varanasi (UP)	57
Indore (MP)	28	Vijayawada (AP)*	58
Jaipur (RJ)	29	Visakhapatnam (AP)	59
Jammu (JK)	30	-	-

* Centres introduced in NEST 2016

Rules and minimum eligibility criteria for awarding a merit list rank

This section lists rules employed for the preparation of merit list in National Entrance Screening Test (NEST) 2016.

I. Number of Seats

Number of seats available at the two institutes for admission in the year 2016 would be as follows

Category	NISER	CBS
General	65	22
Supernumerary: J&K	2	2
OBC	35	12
SC	20	7
ST	10	3
PD (part of other categories)	4	1
Total	132	47

A student with certain category rank will take a general seat if he/she secures a suitable general ranking.

For example, if the topper of the exam (General rank 1) happens to be an OBC candidate, he/she would get OBC rank 1, as well. In such case, he/she would be admitted against the General rank so that all OBC seats remain available even after his/her admission.

II. Scoring system
1. In NEST-2016 examination, there would be five sections with 50 points each.
2. Section 1 (General section) is compulsory.
3. Candidates can attempt 'as many' from the remaining subject sections.
4. During preparation of merit list, score for the general section would be considered along with three best scores from the remaining subject sections. In other words, the worst score among sections 2 through 5 would be eliminated from the merit list calculation.
5. As merit list calculation will be performed on marks obtained in the general section and in (best) three subject sections, the 'total' marks for NEST-2015 becomes 200 (50 x 4 = 200).

III. 'Section-wise' and 'total' cut-off marks
1. Total score of each candidate will be the direct sum of his/her score in the general section and his/her best three scores in the subject sections.

2. For each section, "20% of the average of the best 100 scores in that section" will be considered as Section-wise Minimum Admissible Score (SMAS).

   For example, if the average of the best 100 scores in General section is 40 out of 50, then SMAS for general section would be 40*0.20 = 8 marks. Similarly for other sections.

3. SMAS for different sections can obviously be of different numerical value.

4. A candidate must score equal or more than respective SMAS in General section as well as in at least three subject sections. These subjects sections will then be counted for merit list calculation. If a candidate secures SMAS in all four subject sections, then the best three subject scores will be counted.

5. If a candidate does not secure SMAS in the general section, he/she would not be allotted any merit rank and would not be deemed eligible for admission.

6. If a candidate does not secure SMAS in at least three subject sections, he/she would not be allotted any merit rank and would not be deemed eligible for admission.

7. SMAS for OBC students would be 90% of respective SMAS for general category students.

   For example, if in the general section the SMAS is 8 for general category students, then SMAS for OBC students would be 7 (90% of 10, rounded off).

8. SMAS for SC/ST/PD students would be 50% of respective SMAS for general category students.

   For example, if in the general section the SMAS is 8 for general category students, then SMAS for SC/ST/PD students would be 4 (50% of 10).

9. Additionally, a candidate is required to score equal or above a total minimum admissible score (MAS), to get a merit rank. MAS for NEST-2016 is 100, which is 50% of total marks, i.e, 200.

10. A candidate scoring less than 100 (MAS) in total would not be allotted any merit rank and would not be deemed eligible for admission, even if he/she secures SMAS in all sections.

11. A candidate scoring equal or more than MAS but not securing SMAS in the general section or in at least three subject sections would not be allotted any merit rank. It is important that both MAS and SMAS conditions are fulfilled to get a merit rank.

    Example: Suppose the SMAS for the general section and all subject section is 8 for a general category candidate. If a certain general category candidate scores 40 out of 50 in general section, 40/50 in Physics, 35/50 in Chemistry, 2/50 in Math and 5/50 in Biology, then his/her total score is 40+40+35+2+5=142, which is more than the MAS (100). But as he/she has not scored at least 8 (SMAS) in three subject sections, he/she will not get any merit rank.

    On the other hand, if a candidate scores 12/50 in general section, 20/50 in Physics, 11/50 in Chemistry, 20/50 in Math and 10/50 in Biology, then his/her total score is 12+20+11+20=63. The worst subject score of 10/50 has been rejected. The total of 63 is less than MAS (100). So he/she will not get any merit rank, in spite of the fact that he/she has secured SMAS in all the sections.

12. MAS for OBC students would be 90% of MAS for general category students.

13. MAS for SC/ST/PD students would be 50% of MAS for general category students.

IV. Ranks

1. For candidates who satisfy all clauses given in sections 3.1 to 3.13 above, a merit list would be prepared in descending order of total scores.

2. If total score of two or more candidates becomes equal (i.e. in the case of degeneracy), candidates with higher score in the general section will get a better rank.

3. If the degeneracy persists, then the best scores in the subject section of the two students would be compared. The student with the better score in any of the subject section would get a better rank.

4. If the degeneracy still persists, the students would be given same provisional rank at the time of declaration of the result and the degeneracy would be broken by comparing class 12th marks and date of birth in that order, during admission/counselling.

   For example, consider the marks of following five students.

Rank	Student	Gen	Bio	Chem	Maths	Phy	Total
1	A	31	31	31	31	20	124
2	B	41	0	26	30	23	120
3	C	39	26	32	15	23	120
4	D	39	30	6	28	23	120
4	E	39	1	26	25	30	120

In this example, student A gets rank 1 as his total is more than other students. Please note that A has scored more than SMAS in all subjects and hence best three subject scores are

considered. Other four students have equal totals. Amongst them, student B has better score in general section than the other and thus he gets rank 2. Student C has scored 32 in Chemistry, whereas D and E have their highest subject section score as 30 (D for Bio and E for Phy). Thus C gets 3rd rank. Degeneracy for D and E is not broken and both students get the same provisional rank.

V. Admission

The institutes may restrict number of students invited for admission to some reasonable limit. Getting a merit rank by satisfying SMAS and MAS criteria does not automatically entitle a candidate to be called for admission.

Please note: NEST committee reserves the right to relax any of the defined cut-offs in extenuating circumstances.

SYLLABUS FOR NEST–2016

General Section:

There is no specific syllabus for the General section. The aim is to test candidate's aptitude for a career in science. Questions are designed to test the candidate's familiarity with (and not a detailed understanding of) major historical milestones in mathematics, physics, chemistry, biology, astronomy, computer science and environment. There will be some questions designed to test the grasp of mathematics up to 10th standard and application capabilities of the same to simple problems. Some questions in this section aim to test the candidate's general ability to comprehend qualitative and quantitative aspects of a given scientific passage. This is done by giving a passage on some scientific topic and questions based on the concepts elaborated in the passage will be asked. Some questions aim to find whether the candidates can interpret graphical representation of information.

Biology

Cell Biology
Cell theory and cells as unit of life. Basic concepts of biomolecules – Proteins, Carbohydrates, Lipids, Nucleic acids. Tools and techniques of cell studies - use of microscope and calibration (microscopy), elements of microscope. Biomembranes - transport mechanism, cellular respiration. Cell organelles - structure and functions. Discovery and structure of DNA, processes of replication, transcription, genetic code and translation. Principles of the basic techniques in molecular biology. Enzymes- catalysis, kinetics, activation energy, competitive and non-competitive inhibition.

Genetics and Evolution
Fundamentals of genetics and evolution. Evidences and theories of organic evolution. Organization of the heredity material in chromosomes. Equational division. Reduction division. Mitosis and meiosis compared and contrasted. Significance of meiosis. Mendel's laws of inheritance. Discovery of linkage, sex-linked inheritance. Crossing-over, stage at which crossing-over occurs. Neurospora genetics. Mutation - discovery, types of Mutation and Mutations in diploids. Role of mutations in evolution. Elaboration of Mendel's laws of inheritance. Monohybrid or Dihybrid crosses. Human genetics - human chromosomes, sex-determination, sex-linked inheritance.

Ecology
Physical and biological factors influencing organisms. Food chains, pyramids of numbers and biomass. Biological equilibrium. Interspecific associations. Bio-diversity. Flora and fauna. Basics of microbial systems, Ecosystems.

Humans and Environment
Soil, rainfall and temperature with reference to natural resources. Our natural resources - their uses and abuses. Environmental pollution and preventive measures. Biodiversity and conservation.

Biotechnology
Principles of recombinant DNA technology. Applications of biotechnology.

Biology of Animal systems
Digestive System - Modes of nutrition. Different vitamin compounds and their deficiencies. Structure of alimentary canal and associated glands, digestive enzymes and gastrointestinal hormones. Absorption of products of digestion, peristalsis, balanced diet.

Respiratory System - Gaseous exchange in animals. Structure of respiratory organs, mechanism of breathing, gaseous transport, tissue respiration.

Circulatory System - Open and closed systems. Functions of blood and 1ymph. Microscopic structure of blood and blood vessels. Structures and working of heart. Distribution of arteries and veins. Circulation of blood coagulation. Blood groups.

Excretory System - Elimination of nitrogenous waste. Osmoconformers and osmoregulators. Structure and function of kidney tubules. Arrangement of excretory organs.

Nervous System - General account of brain, spinal cord and nerves. Reflex actions (simple and conditioned). Sense organs (eye and ear).

Reproductive System - Sexual and asexual reproduction. General arrangement and functions of reproductive organs.

Developmental Biology - Basic features of development in animals. Types of eggs, fertilization, cleavage, blastula. Stem cells- definition, types, uses, advantages and disadvantages, induced pluripotent stem cells. Different hormones and their roles.

Diversity of Animal Life — Principles of classification, binomial nomenclature. General classification of animal phyla up to classes (invertebrates) and upto sub-classes / order (vertebrates), General characters of fishes, amphibians, reptiles, birds and mammals.

Immunology - Basics of immune mechanisms and diseases- active and passive immunity, T and B cell responses, antigen presentation, principles of vaccination, monoclonal antibodies and their uses, immunology of AIDS.

Biology of Plant systems

Anatomy and Physiology of Plants - Meristems. Plant growth and development. Internal and external regulators of growth and development in plant. Plant reproduction. Internal structure of root, stem, secondary growth and leaves. Xylem and Phloem - their cell elements and functions. Internal structure of dicot and monocot leaves. Photosynthesis - history, importance, factors and mechanism, stomatal mechanism, transpiration and respiration. Comparative study of dicot and monocot anatomy. Absorption and cell-water relations, transport of water and minerals, tropic and turgor movements. Significance of life-cycles with special reference to alternation of generations as exemplified in Funaria, Selaginella and Pinus (no structural details). Plant hormones.

Systematics - Principles of classical and new systematics. Binomial nomenclature. Familiarity with taxa. Plant breeding and tissue culture.

Chemistry

Physical Chemistry

Measurements in chemistry: SI units for fundamental quantities, significant figures in calculations.

Mole concept: Avogadro number and mole concept, molar masses, mole fraction, molarity, molality, percent composition, stoichiometry. Equivalent weight and normality. Calculations based on mole concept and stoichiometry of different reactions. Oxidation-reduction reactions.

Gaseous and liquid states: Absolute scale of temperature. Gas laws, ideal gas equation, real gases and deviation from ideality, liquefaction of gases, van der Waals equation. Kinetic theory of gases; average, root mean square and most probable velocities and their relation with temperature. Law of partial pressures. Vapour pressure. Diffusion of gases.

Atomic structure and chemical bonding: Bohr model, spectrum of hydrogen atom, quantum numbers. Wave particle duality, de Broglie hypothesis. Uncertainty principle. Orbitals and quantum numbers; shapes and energy of s, p and d orbitals. Electronic configurations of elements (up to atomic number 36), filling of orbitals - Aufbau principle. Pauli's exclusion principle and Hund's rule. Hybridization involving s, p and d orbitals. Atomic orbital overlap and chemical bonds; ionic, covalent and coordinate bonds; bond parameters. Orbital energy diagrams for homo-nuclear diatomic species. Lewis structures. Hydrogen bond. Polarity in molecules, dipole moment (qualitative aspects). VSEPR theory and shapes of molecules. Valence Bond Theory. Molecular orbital theory of homo-nuclear diatomic molecules (qualitative idea).

Thermodynamics: Thermodynamic states. First law of thermodynamics. Internal energy, work and heat, pressure-volume work. Enthalpy and enthalpy change, Hess's law, heat of - reaction, fusion and vapourization. Second law of thermodynamics, entropy, free energy, criterion of spontaneity.

Chemical equilibrium: Laws of chemical Equilibrium, law of mass action. Equilibrium constant – factors affecting equilibrium constant and its applications. Le Chatelier's principle - effect of concentration, temperature and pressure. Significance of ΔG and ΔG^{o} in chemical equilibrium. Relationship of K and ΔG. **Ionic equilibrium.** Acids and bases (Bronsted and Lewis concepts), salts. K_a, K_b, K_w, degree of dissociation, pH and their relationships. Solubility product, common ion effect. Hydrolysis of salts. Buffer

solutions.

Electrochemistry: Redox reactions and electrode potential, Electrochemical cells, Galvanic cells and cell reactions. Standard electrode potential. Nernst equation and its relation to ΔG and K. Electrochemical series, emf of galvanic cells. Electrolysis and Faraday's laws of electrolysis. Electrolytic conductance, specific, equivalent and molar conductivity, Kohlrausch's law. Concentration cells. Batteries (primary and secondary), fuel cells, corrosion.

Chemical kinetics: Rates of chemical reactions. Order of reaction, rate constant. First order and pseudo first order reactions. Factors affecting rate of reaction – concentration, temperature (Arrhenius equation), catalyst.

Solid state: Classification of solids, amorphous and crystalline solids, crystalline state, crystal lattice and unit cells; seven crystal systems (cell parameters a, b, c, α, β, $\square$)), close packed structure of solids (cubic), packing in fcc, bcc and hcp lattices. Packing efficiency, nearest neighbours, ionic radii. Simple ionic compounds, Imperfection in solids, point defects. Electrical and magnetic properties, band theory of metals.

Solutions: Solution of solid and gas in liquid. Concentration of solution. Ideal and nonideal solutions. Colligative properties. Vapour pressure of solution, Raoult's law. Molecular weight determination from lowering of vapour pressure, elevation of boiling point and depression of freezing point. Abnormal molecular mass, vant Hoff factor. Osmosis – Osmotic pressure, reverse osmosis.

Surface chemistry:

(a) Adsorption – Physisorption and chemisorptions. Factors affecting adsorption of gases on solids. Adsorption isotherm. Catalysis – homogeneous and heterogeneous, Activity and selectivity. Enzyme catalysis.
(b) Colloidal state – Types, preparation and properties of colloids. Tyndall effect, Brownian movement, electrophoresis, coagulation. Application of colloids. Micelles.

Inorganic Chemistry

Classification of elements and periodicity in properties: Modern periodic table, classification of elements, periodic trends in properties of elements – valence, oxidation state, atomic/ionic radius, ionization energy, electron gain energy, electronegativity, valency, chemical reactivity. Diagonal relationship. Anomalous behaviours of Li, Be, B, C.

Hydrogen: Isotopes, preparation, isolation, properties and uses. Hydrides – ionic, covalent and interstitial. Properties of water and heavy water. Hydrogen peroxide – Preparation, structure, reactions, uses. Hydrogen as fuel cell.

s- Block elements (Alkali and alkaline earth elements) – General characteristics and trends in properties.
(a) Group 1: Preparation, properties and reactions of alkali metals with emphasis on chemistry of Na and K and their compounds - oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates. Uses.
(b) Group 2: Preparation, properties and reactions alkaline earth metals with emphasis on the chemistry of Mg and Ca and their compounds - oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates. Uses.

p- Block elements: General characteristics and trends in properties.
(a)Group 13: Chemistry of Boron and its compounds - borax, boric acid and diborane.
(b) Group 14, 15 and 16: Chemistry of carbon, sulphur, nitrogen and phosphorus. Allotropy. Chemistry of oxides and oxyacids of these elements. Phosphines, phosphorus chlorides, ammonia, peroxide and ozone; silicones, silicon tetrachloride and silicates.
(c) Group 17: Chemistry of halogens, chemistry of chlorine in detail. Interhalogen compounds. HX and oxyacids of halogens.
(d) Group 18: Isolation, properties and reactions of inert gases with emphasis on chemistry of Xenon.

d-Block elements: (Mainly 3d elements) General characteristics and trends in properties. Variable oxidation states and their stabilities, colour (excluding the details of electronic transitions) and calculation of spin-only magnetic moment. Catalytic properties. Interstitial compounds, alloy formation.

Preparation and properties of potassium dichromate and permanganate.

f- Block elements: (mainly lanthanides) General characteristics and trends in properties. Variable oxidation states. Lanthanide contraction and its consequences.

Coordination compounds: Nomenclature of mononuclear coordination compounds. Isomerism. Hybridization and geometries of mononuclear coordination compounds. Magnetic properties. Werner's theory, VBT, CFT.

Metals and metallurgy: Occurrence of metals. General methods of extraction involving chemical principles – thermodynamic, electrochemical and redox principles. General operation stages involved in metallurgical operation. Metallurgy of *p*-block element (emphasis on Al). Metallurgy of Fe-triad (more emphasis on Fe metallurgy). Metallurgy of coinage metals (Cu, Ag with more emphasis on Cu). Refining.

Organic Chemistry

Basic concepts: Representation of organic compounds. Hybridisations of carbon. Sigma and pi-bonds. Shapes of simple organic molecules. Inductive effect, electromeric effect, resonance effect, hyperconjugation. Keto-enol tautomerism. Determination of empirical and molecular formulae (only combustion method). Hydrogen bond - definition and effect on physical properties of alcohols and carboxylic acids. Acidity and basicity of organic acids and bases. Methods of purification of compounds.

Reactive intermediates: Homolytic and heterolytic bond cleavages. Formation, structure and stability of - carbocation, carbanion and free radical.

Isomerism: Structural and stereoisomerism. Geometrical isomerism. Chirality. Enatiomers. Optical isomerism of compounds containing up to two asymmetric centres, (*R, S* and *E, Z* nomenclature excluded). Racemic mixture. Conformations of ethane and butane (Newman projections).

Nomenclature: IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono-functional and bi-functional compounds), including benzene derivatives. .

Alkanes: Preparation, properties and reactions. Idea of homologous series Combustion and halogenation of alkanes. Mechanism of photohalogenation. Wurtz reaction.

Alkenes and Alkynes: Preparation, properties and reactions of alkenes and alkynes. Isomerization. Acidity of alkynes. Acid catalysed hydration of alkenes and alkynes (excluding the stereochemistry), Reactions of alkenes with $KMnO_4$, sulphuric acid. Reduction of alkenes and alkynes. Preparation of alkenes and alkynes by elimination reactions (excluding stereochemistry). Electrophilic addition reactions of alkenes with X_2, HX, HOX and H_2O (X=halogen). Makownikoff rule. Peroxide effect. Polymerization of alkenes. Addition reactions of alkynes. Metal acetylides. Ozonolysis

Aromatic compounds: Aromaticity. Huckel theory of aromaticity. Structure of benzene. Isomerism in substituted benzenes. Electrophilic substitution reaction on benzene- General mechanism. Orientating influence of substituents in electrophilic substitution reaction of monosubstituted benzenes. Electrophilic substitution reactions of benzene and substituted benzenes - halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation (No mechanism).

Haloalkanes (Alkyl halides): Preparation from alkanes, alcohols, olefins. Grignard reagents and their reaction with aldehydes/ketones/esters/nitriles. Nucleophilic substitution reactions of alkyl halides with different nucleophilic species. S_N1 and S_N2 reactions with mechanism. Halogen exchange reaction. Polyhalogen compounds.

Haloarenes: Nucleophilic aromatic substitution in haloarenes and substituted haloarenes (excluding Benzyne mechanism and Cine substitution).

Alcohols: Preparation from – olefins, alkyl halides, carboxylic acids, aldehydes/ketones. Hydroboration reaction. Dehydration, oxidation to aldehydes and ketones. Reaction with sodium, phosphorus halides, $ZnCl_2$/ HX, H_2SO_4. Identification of p-, sec- and tert- alcohols. Uses of methanol and ethanol.

Phenols: Preparation of phenol from halobenzene, cumene and benzene sulphonic acid. Acidity. Reactions of phenols - halogenation, nitration, sulphonation, with Zn. Reimer-Tieman reaction, Kolbe reaction.

Ethers: Preparation by Williamson's Synthesis, dehydration of alcohols. Reaction with H_2O, HX.

Aldehydes and Ketones - Preparation of aldehydes and ketones from – Alcohols, olefins, acid chlorides, arylalkanes, nitriles, esters, Friedel-Crafts reaction. Reactions with – Alcohols, HCN, $NaHSO_3$. Reactions- oxidation, reduction, oxime and hydrazone formation. Aldol condensation, Perkin reaction. Cannizzaro reaction. Haloform reaction. Tests to distinguish aldehydes and ketones.

Carboxylic acids - Acidity and structure-acidity relationship. Preparation of acids. Preparation of amides, acid chlorides, esters and anhydrides. ester hydrolysis. Reactions of acids with - thionyl chloride, P-halides, ammonia, alkalis, metals, halogens, reducing agents. Decarboxylation. Halogenation.

Amines - Basicity and structure-basicity relationship. Identification of p-, sec- and tert-amines. Preparation of amines from - nitro compounds, nitriles, amides, haloalkanes/aromatic compounds. Reaction with – Acids, alkylating agents, acylating agents, nitrous acid. Diazotization of aromatic primary amines - Reactions of aromatic diazonium salts - azo coupling reaction, Sandmeyer and related reactions. Carbylamine reaction of p-amines.

Carbohydrate: Classification of carbohydrates. mono- and di- saccharides (glucose and sucrose). Characteristic tests. Structure of glucose. Reactions of glucose- Oxidation, reduction, hydroxylamine, HI, acetic anhydride. Cyclic structure of glucose. Structures of - Sucrose, maltose, starch and cellulose . Glycoside formation and hydrolysis of sucrose.

Amino acids and proteins: a-amino acids. General structure of peptides and proteins. Peptide bond. Characteristic tests. Separation of amino acids using physical properties. Denaturation of proteins. Enzymes.

Polymers: Classification. Homo and co-polymers, Addition and condensation polymerizations. Polythene, nylons, polyetsres, Bakelite, melamine-formaldehyde, rubber – natural and synthetic.

Mathematics

Algebra

Algebra of complex numbers, addition, multiplication, conjugation, polar representation, properties of modulus and principal argument, triangle inequality, cube roots of unity, geometric interpretations.

Quadratic equations with real coefficients, relations between roots and coefficients, formation of quadratic equations with given roots, symmetric functions of roots.

Arithmetic, geometric and harmonic progressions, arithmetic, geometric and harmonic means, sums of finite arithmetic and geometric progressions, infinite geometric series, sums of squares and cubes of the first n natural numbers.

Logarithms and their properties.

Permutations and combinations, Binomial theorem for positive integral index, properties of binomial coefficients. Matrices as a rectangular array of real numbers, equality of matrices, addition, multiplication by a scalar and product of matrices, transpose of a matrix, determinant of a square matrix of order up to three, inverse of a square matrix of order up to three, properties of these matrix operations, diagonal, symmetric and skew-symmetric matrices and their properties, solutions of simultaneous linear equations in two or three variables.

Addition and multiplication rules of probability, conditional probability, Bayes Theorem, independence of events, computation of probability of events using permutations and combinations.

Trigonometry

Trigonometric functions, their periodicity and graphs, addition and subtraction formulae, formulae

involving multiple and sub-multiple angles, general solution of trigonometric equations.

Relations between sides and angles of a triangle, sine rule, cosine rule, half-angle formula and the area of a triangle, inverse trigonometric functions (principal value only).

Analytical geometry

Two dimensions - Cartesian coordinates, distance between two points, section formulae, shift of origin. Equation of a straight line in various forms, angle between two lines, distance of a point from a line. Lines through the point of intersection of two given lines, equation of the bisector of the angle between two lines, concurrency of lines. Centroid, orthocentre, incentre and circumcentre of a triangle.

Equation of a circle in various forms, equations of tangent, normal and chord. Parametric equations of a circle, intersection of a circle with a straight line or a circle, equation of a circle through the points of intersection of two circles and those of a circle and a straight line.

Equations of a parabola, ellipse and hyperbola in standard form, their foci, directrices and eccentricity, parametric equations, equations of tangent and normal. Locus Problems.

Three dimensions - Direction cosines and direction ratios, equation of a straight line in space, equation of a plane, distance of a point from a plane.

Differential calculus

Real valued functions of a real variable, into, onto and one-to-one functions, sum, difference, product and quotient of two functions, composite functions, absolute value, polynomial, rational, trigonometric, exponential and logarithmic functions.

Limit and continuity of a function, limit and continuity of the sum, difference, product and quotient of two functions, L'Hospital rule for evaluation of limits of functions.

Even and odd functions, inverse of a function, continuity of composite functions, intermediate value property of continuous functions. Derivative of a function, derivative of the sum, difference, product and quotient of two functions, chain rule, derivatives of polynomial, rational, trigonometric, inverse trigonometric, exponential and logarithmic functions.

Derivatives of implicit functions, derivatives up to order two, geometrical interpretation of the derivative, tangents and normals, increasing and decreasing functions, maximum and minimum values of a function, Rolle's Theorem and Lagrange's Mean Value Theorem.

Integral calculus

Integration as the inverse process of differentiation, indefinite integrals of standard functions, definite integrals and their properties, Fundamental Theorem of Integral Calculus.

Integration by parts, integration by the methods of substitution and partial fractions, application of definite integrals to the determination of areas involving simple curves.

Formation of ordinary differential equations, solution of homogeneous differential equations, separation of variables method, linear first order differential equations.

Vectors

Addition of vectors, scalar multiplication, dot and cross products, scalar triple products and their geometrical interpretations.

Physics

General: Units and dimensions, dimensional analysis. least count, significant figures. Methods of

measurement (Direct, Indirect, Null) and measurement of length, time, mass, temperature, potential difference, current and resistance.

Design of some simple experiments, such as: i) Searle's method to determine Young's modulus, ii) determination of 'g' by simple pendulum, iii) speed of sound using resonance tube, iv) coefficient of friction using angle of repose, v) determination of focal length of a convex lens by plotting a graph between 'u' and 'v', vi) refractive index of material of prism using the method of minimum deviation, vii) verification of Ohm's law, viii) resistance of galvanometer using half deflection method, ix) specific heat of a liquid using calorimeter, x) I-V characteristic curve for p-n junction in forward and reverse bias.

Graphical representation and interpretation of data. Errors in the measurements and error analysis.

Mechanics: Kinematics in one and two dimensions (Cartesian coordinates only), projectiles. Uniform circular motion. Relative velocity. Newton's laws of motion. Inertial and uniformly accelerated (linear only) frames of reference. Static and dynamic friction. Kinetic and potential energy. Linear and circular simple harmonic motion. Work and power. Conservation of linear momentum and mechanical energy.

Systems of particles. Centre of mass and its motion. Centre of gravity. Impulse. Elastic and inelastic collisions.

Law of gravitation. Centripetal acceleration and centrifugal force. Gravitational potential and field. Acceleration due to gravity. Motion of planets and satellites in circular orbits. Escape velocity.

Rigid body, moment of inertia, parallel and perpendicular axes theorems, moment of inertia of uniform bodies with simple geometrical shapes. Angular momentum, Torque. Conservation of angular momentum. Dynamics of rigid bodies with fixed axis of rotation. Rolling without slipping of rings, cylinders and spheres. Equilibrium of rigid bodies. Collision of point masses with rigid bodies.

Hooke's law and stress – strain relations. Elastic limit, plastic deformation. Young's modulus, bulk and shear moduli.

Pressure in a fluid. Pascal's law. Buoyancy. Surface energy and surface tension, capillary rise. Viscosity – Stoke's and Poiseuille's law, Terminal velocity. Qualitative understanding of turbulence. Reynolds number. Streamline flow, equation of continuity. Bernoulli's theorem.

Sound and mechanical waves: Plane wave motion, longitudinal and transverse waves, superposition of waves. Progressive and stationary waves. Vibration of strings and air columns. Resonance (qualitative understanding). Beats. Speed of sound in gases. Doppler effect.

Thermal physics: Thermal expansion of solids, liquids and gases. Calorimetry, latent heat. Heat conduction in one dimension. Elementary concepts of convection and radiation. Newton's law of cooling. Ideal gas laws. Specific heats (C_V and C_P for monoatomic and diatomic gases). Isothermal and adiabatic processes, bulk modulus of gases. Equivalence of heat and work. First and second law of thermodynamics and its applications (only for ideal gases). Entropy. Blackbody radiation - absorptive and emissive powers. Kirchhoff's law. Wien's displacement law, Stefan's law.

Electricity and magnetism: Coulomb's law. Electric field and potential. Electrical potential energy of a system of point charges and of electrical dipoles in a uniform electrostatic field; Electric field lines. Flux of electric field. Gauss's law and its application in simple cases, such as to find field due to infinitely long straight wire. uniformly charged infinite plane sheet and uniformly charged thin spherical shell.

Capacitance - Calculation of capacitance with and without dielectrics. Capacitors in series and parallel. Energy stored in a capacitor.

Electric current. Ohm's law. Series and parallel arrangements of resistances and cells. Kirchhoff's laws and simple applications; Heating effect of current.

Biot-Savart's law and Ampere's law. Magnetic field near a current carrying straight wire, along the axis of a circular coil and inside a long straight solenoid. Force on a moving charge and on a current carrying wire in a uniform magnetic field.

Magnetic moment of a current loop. Effect of a uniform magnetic field on a current loop. Moving coil galvanometer, voltmeter, ammeter and their conversions.

Electromagnetic induction - Faraday's law, Lenz's law. Self and mutual inductance. RC, LR and LC circuits with and A.C. Sources.

Optics: Rectilinear propagation of light. Reflection and refraction at plane and spherical surfaces, Deviation and dispersion of light by a prism. Thin lenses. Combination of mirrors and thin lenses. Magnification. Wave nature of light - Huygen's principle, interference limited to Young's double slit experiment. Elementary idea of diffraction – Rayleigh criterion. Elementary idea of polarization – Brewster's law and the law of Malus.

Modern physics: Atomic nucleus. Alpha, beta and gamma radiations. Law of radioactive decay. Decay constant. Half-life and mean life. Binding energy and its calculation. Fission and fusion processes. Energy calculation in these processes.

Photoelectric effect. Bohr's theory of hydrogen like atoms. Characteristic and continuous X-rays, Moseley's law. de Broglie wavelength of matter waves. Heisenberg's uncertainty principle.