

***National Entrance Screening Test 2013***

**NEST-2013**

**Information Brochure**

Entrance Test for Admission to

**National Institute of Science Education and Research  
(NISER) Bhubaneswar**

**&**

**University of Mumbai - Department of Atomic Energy  
Center for Excellence in Basic Sciences  
(UM-DAE CBS) Mumbai**

*Academic Session 2013-14*

## Introduction to NEST-2013

The National Entrance Screening Test or NEST is a compulsory test for admission to the 5 year Integrated M.Sc. 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 (UN-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 M.Sc. programme at these institutes follow 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 placement of the first batch of students out from NISER and CBS provides 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 centers 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 M.Sc. programme at NISER and CBS are eligible for DST-INSPIRE, Government of India, fellowship of Rs. 5,000 per month and Rs. 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 BARC Training School.

The details of the Integrated M.Sc. programme, courses, research activities, facilities and faculty profile at NISER and CBS can be found in their respective websites — [www.niser.ac.in](http://www.niser.ac.in) and [www.cbs.ac.in](http://www.cbs.ac.in)

Integrated Science Education and Research Center (ISERC), Visva Bharati, is also participating in NEST-2013 and will admit students for its Integrated M.Sc. course from the Merit List. The eligibility criteria are the same as that for NISER / CBS and the students admitted to ISERC are also eligible for DST-INSPIRE fellowship. For the details of ISERC's vision and programme, check its website at [www.visva-bharati.ac.in](http://www.visva-bharati.ac.in)

## Eligibility criteria for admission

**Educational qualification** — Candidates seeking admission to NISER and UM-DAE CBS for the academic session 2013-14 should be from science stream (having any combination of Biology / Chemistry / Mathematics / Physics) at class XII and must write the NEST-2013 examination. Candidates who have passed class XII examination or equivalent from any recognized Board in India in 2011 or 2012 or are appearing in 2013 can apply for NEST-2013. Admission will be offered strictly on basis of Merit List of NEST-2013. Candidates securing at least 60% marks in aggregate or equivalent grade in class XII examination will finally be eligible for admission to NISER and CBS. Where only letter grades are available, a certificate from the Board specifying equivalent percentage marks is required. In the absence of such a certificate, the decision of the Admission Committee of the concerned Institution will be final.

**Age limit** — General and OBC category candidates born on or after July 22, 1993 are eligible to apply. The age limit is relaxed by 5 years for SC / ST / Physically Disabled (PD) candidates.

Necessary certificates supporting eligibility criteria have to be furnished at the time of admission.

*Please note that the offer of admission is subject to verification of all original certificates at the time of counselling.*

## Number of seats & reservation

For academic session 2013-14, the total number of seats at NISER, CBS and ISERC is 60, 35 and 21 respectively. 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 the details of reserved seats and category certificates refer to the websites of the participating Institutions.

## NEST-2013 examination

The NEST-2013 will be conducted at about 40 major towns and cities all over India on **May 25, 2013, (Saturday) 10:00am — 1:00pm**. Based on the performance in NEST-2013, a common Merit List of the candidates will be prepared and posted in NEST-2013 website on **June 17, 2013**. The successful candidates will be called for counselling and admission will be strictly according to the Merit List until all the seats are filled. Separate merit list for different category candidates will be made available before counselling.

**Examination centers** — The NEST examination centers are given in Annexure-I. Candidates must choose 2 (two) centers according to their preference during filling up of application form (online / offline). Every effort will be made to allot the first preference center. Please note that *ultimately the allotment of an examination center by the Chief Coordinator has to be regarded as final and request for change of center will in general not be entertained*. The center address will be mentioned in the NEST admit card.

**Examination rules** — Candidates must reach the test center at least half an hour before the start of the examination. The exam will start at 10:00 am. Candidates will neither be allowed to enter the examination hall half an hour after the start nor to leave the same before one hour from the start. Use of log tables and calculators in the examination hall are not allowed. Candidates must bring their own pen, pencil, eraser and other stationaries and exchange/sharing of such 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 in the examination hall. Any candidates found adopting unfair means will be expelled from the examination hall without warning.

**Question type** — The question paper will consist of 5 (five) sections. Section 1 is compulsory for all candidates to attempt and will have questions on general science to test candidates' awareness towards basic scientific facts. There will be no negative marking in this general section. Sections 2 through 5 will contain questions from Biology, Chemistry, Mathematics and Physics. Candidates are required to answer any three of these four sections. The questions will be of objective (MCQ) type designed to test candidates' subject comprehension and analytic ability. In the subject sections, there will be negative marking for incorrect answers. Some questions can have one or more correct answers for which marks can only be earned by marking all correct answers. For the past few years' NEST question papers, refer to the NEST-2013 website.

Language of the question paper will be English only.

**Answering questions** — The answers to each questions are to be marked on an OMR (Optical Mark Recognition) sheet. The top half of the OMR sheet will be for filling personal details like name, roll number, application number, question set etc. and has to be filled in either by writing or by darkening bubbles using black ball-point pen. The lower half of OMR is for the answering questions of various sections, where the candidate is expected to darken the bubble(s) against correct answer(s) using dark lead pencil. The use of pencil makes later changing of choice(s) possible.

**Syllabus** — The syllabus for NEST-2013 typically follows the NCERT / CBSE science syllabus of class XI-XII. The detailed syllabus for NEST examination is given in the Annexure-II. 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. Some of the questions in this section may require knowledge of class X mathematics.

## How to apply

To apply for NEST-2013, candidates can fill-up application form either online (preferably) or offline.

**Online application** — Candidates may go to the NEST-2013 website [www.nestexam.in](http://www.nestexam.in) and follow the instruction to fill-up the online application form. Photo and signature of the candidate are also required to be uploaded. To pay application fees, option for payment by Demand Draft and Electronic Transfer will be asked from which any one mode of payment has to be selected. The amount of application fees and details of each of these mode of payments are given below. To complete the application procedure, the DD number / transaction details of Electronic Transfer has to be furnished. The DD for application fee must be sent by post, preferably speedpost, to the Chief Coordinator at the address below on or before the last date of application. In case of any difficulty or need for guidance, send email to [nest@nestexam.in](mailto:nest@nestexam.in) stating clearly the problem(s) encountered. Incomplete application in any respect will be summarily rejected. Online application opens on **January 07, 2013** and last date of application is **March 08, 2013**.

**Offline application** — Candidates may send request letter to the Chief Coordinator NEST-2013 at the address below for paper-copy of the application form. The candidate should fill up the form, attach photo, sign and return the completed application form along with the application fees (in the form of DD) to the Chief Coordinator by post, preferably speedpost. Incomplete application form or form without DD will be summarily rejected. The last date for requesting paper application form is **February 20, 2013** and last date for receiving application is **March 08, 2013**.

**Application Fee** — The application fee for the male candidates of General / OBC category is Rs. 700. The application fee for SC/ST/PD and all female candidates is Rs. 350. The fee can be paid either by Demand Draft or Electronic Transfer.

- **Demand Draft** — DD for required amount may be made from any bank and should be drawn in favour of The Chief Coordinator, NEST-2013 and payable at Bhubaneswar. Candidate must write her/his name and application number on the back of the DD. The DD has to be sent preferably by speedpost at the address given below and must reach on or before March 08, 2013.
- **Electronic Transfer** — The candidate may transfer the required amount electronically to NEST-2013 account from any bank. After the transfer is complete, candidate must enter the transfer details in appropriate place in online application form (for online application) or printed application form (for offline application). The transfer should be made to:  
Account name: NISER - NEST  
Account number: 147601000015979  
Bank name & branch: Indian Overseas Bank, Chandrasekharpur Branch (Bhubaneswar)  
IFSC / RTGS code: IOBA 0001476

### **Applications incomplete in any respect or not accompanied by requisite fee will not be accepted**

**Admit card** — The admit card for NEST-2013 will be available for downloading and dispatch from **April 08, 2013**. The recommended method for obtaining admit card is downloading from NEST website, particularly for those who have applied online. Admit cards will be sent by post to the mailing address of the candidates who have applied offline. It is, therefore, important that the postal address with pincode in offline paper application form be clearly and correctly written. Please note that *NEST office will not be responsible if admit card fails to reach the candidate in time because of postal delay or incorrect mailing address*. In case the admit card is not received by May 01, 2013, the NEST office at the address given below must be notified. It may be possible to re-send the admit card but only electronically if email address of the candidate is provided. Safe-keeping of the admit card is strongly advised because the successful candidates have to produce the admit card in original during the counselling and admission.

## Address for correspondence

The request for paper application form, completed paper application form, Demand Draft and any NEST-2013 related queries by postal mail must be sent at —

The Chief Coordinator, NEST-2013  
NISER, Institute of Physics Campus  
Sachivalaya Marg, P.O. Sainik School  
Bhubaneswar – 751005, Odisha.

For any queries requiring quicker response, contact at —

Phone: (0674) 230 4036  
Email: [nest@nestexam.in](mailto:nest@nestexam.in)  
Website: [www.nestexam.in](http://www.nestexam.in)

### ***Important Dates***

- Start of Online / Offline application for NEST-2013: **January 07, 2013**
- Last date for receiving request for paper application form: **February 20, 2013**
- Closing of Online / Offline application: **March 08, 2013**
- Download / Dispatch of Admit Card begins: **April 08, 2013**
- NEST-2013 examination: **May 25, 2013 (Saturday) 10:00am — 1:00pm**
- Announcement of Results in NEST website: **June 17, 2013**

***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.
- Candidates will be allowed to leave the examination hall only after one hour from the start of the examination.
- Use of log tables and calculators in the examination hall are not allowed. Candidates must bring their own pen, pencil, eraser and other stationaries.
- Candidates **MUST** bring their Admit Card and their school Identity Card in the examination hall.

***Check-list***

- Name and mailing address with pin-code are entered / clearly written and legible
- Email address is correctly and legibly entered at proper place
- Passport size photograph is uploaded properly / pasted in correct place
- Signature is uploaded properly / signed at proper place
- Name of issuing Bank and DD number is included / clearly written in proper place
- Name & application number written on the backside of the DD
- Three examination centers are chosen according to preference

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

**Send Demand Draft and paper (offline) Application Form to the  
NEST office address, preferably by Speed Post, before 08.03.2013**

## Annexure - I

### *List of Examination Centers for NEST-2013*

Center Name	Center Code	Center Name	Center Code	Center Name	Center Code
Agartala, Tripura	01	Delhi East	15	Nagpur, Maharashtra	29
Ahmedabad, Gujarat	02	Delhi North	16	Patna, Bihar	30
Allahabad, UP	03	Delhi South	17	Pune, Maharashtra	31
Belgaum, Karnataka	04	Guwahati, Assam	18	Raipur, Chhatisgarh	32
Bengaluru, Karnataka	05	Hyderabad, AP	19	Ranchi, Jharkhand	33
Berhampur, Odisha	06	Indore, MP	20	Sambalpur, Odisha	34
Bhopal, MP	07	Jaipur, Rajasthan	21	Shilong, Meghalaya	35
Bhubaneswar, Odisha	08	Jammu, J&K	22	Shimla, HP	36
Burdwan, WB	09	Kochi, Kerala	23	Silchar, Assam	37
Calicut, Kerala	10	Kolkata North, WB	24	Siliguri, WB	38
Chandigarh	11	Kolkata South, WB	25	Srinagar, J&K	39
Chennai, Tamilnadu	12	Lucknow, UP	26	Udaipur, Rajasthan	40
Cuttack, Odisha	13	Madurai, Tamilnadu	27	Varanasi, UP	41
Dehradun, Uttaranchal	14	Mumbai, Maharashtra	28	Vishakapatnam, AP	42

## Annexure – II

### Syllabus for NEST-2013

#### General

There is no specific syllabus for the General section. This section aims to test the candidate's general ability to comprehend qualitative and quantitative aspects of a given scientific passage and interpretation of graphs of simple systems. This will be done by giving a passage on some scientific topic and questions based on the concepts elaborated in the passage will be asked. It is also 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 also be some questions to test grasp of mathematics up to 10th standard and application capabilities of the same to simple problems.

#### Biology

##### **Cell Biology**

Cell theory and cells as unit of life. 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.

##### **Anatomy and Physiology**

Digestive System — Modes of nutrition. 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 lymph. 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.

##### **Diversity of Animal Life**

Principles of classification, binomial nomenclature. General classification of animal phyla upto classes (invertebrates) and upto sub-classes / order (vertebrates), with detailed study of the types as indicated: (i) Protozoa - Amoeba, Entamoeba, Paramecium, Plasmodium, Parasitic trypanosomes. (ii) Porifera (iii) Coelenterata - Hydra. (iv) Platyhelminthes - Taenia and Fasciola (v) Aschelminthes - Ascaris (vi) Annelida - Pheretima and Nereis (vii) Arthropoda - Crustaceans and Insects (viii) Mollusca (ix) Echinodermata (x) Chordata - General characters of fishes, amphibians, reptiles, birds and mammals.

##### **Genetics and Evolution**

Fundamentals of genetics and evolution. Human genetics - human chromosomes, sex-determination, sex-linked inheritance. Evidences and theories of organic evolution.

Organisation 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.

### **Ecology**

Physical and biological factors influencing organisms. Food chains, pyramids of numbers and biomass. Biological equilibrium. Interspecific associations.

### **Botany**

Anatomy and Physiology of Plants — Meristems. Plant growth and development. Internal and external regulators of growth and development in plant. 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, turgor and turgor movements. Significance of life-cycles with special reference to alternation of generations as exemplified in Funaria, Selaginella and Pinus (no structural details).

Systematics — Principles of classical and new systematics. Binomial nomenclature. Familiarity with taxa.

### **Humans and Environment**

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

## **Chemistry**

### **Physical Chemistry**

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

General topics — Concept of atoms and molecules. Dalton's atomic theory. Mole concept. Chemical formulae. Balanced chemical equations. Calculations (based on mole concept) involving common oxidation-reduction, neutralisation and displacement reactions. Concentration in terms of mole fraction, molarity, molality and normality.

Gaseous and liquid states — Absolute scale of temperature. ideal gas equation. Deviation from ideality, 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. Qualitative quantum mechanical picture of hydrogen atom, shapes of s, p and d orbitals. Electronic configurations of elements (up to atomic number 36). Aufbau principle. Pauli's exclusion principle and Hund's rule. Orbital overlap and covalent bond. Hybridisation involving s, p and d orbitals only. Orbital energy diagrams for homonuclear diatomic species. Hydrogen bond. Polarity in molecules, dipole moment (qualitative aspects only). VSEPR model and shapes of molecules (linear, angular, triangular, square planar, pyramidal, square pyramidal, trigonal bipyramidal, tetrahedral and octahedral).

Energetics — First law of thermodynamics. Internal energy, work and heat, pressure-volume work. Enthalpy, Hess's law. Heat of reaction, fusion and vapourization. Second law of thermodynamics. Entropy. Free energy. Criterion of spontaneity.

Chemical equilibrium — Law of mass action. Equilibrium constant. Le Chatelier's principle (effect of concentration, temperature and pressure). Significance of  $\Delta G$  and  $\Delta G^{\circ}$  in chemical equilibrium. Solubility product, common ion effect, pH and buffer solutions. Acids and bases (Bronsted and Lewis concepts). Hydrolysis of salts.

Electrochemistry — Electrochemical cells and cell reactions. Standard electrode potentials. Nernst equation and its relation to  $\Delta G$ . Electrochemical series, emf of galvanic cells. Faraday's laws of electrolysis. Electrolytic conductance, specific, equivalent and molar conductivity, Kohlrausch's law. Concentration cells.

Chemical kinetics — Rates of chemical reactions. Order of reactions. Rate constant. First order reactions. Temperature dependence of rate constant (Arrhenius equation).

Solid state — Classification of solids. Crystalline state, seven crystal systems (cell parameters  $a$ ,  $b$ ,  $c$ ,  $\alpha$ ,  $\beta$ ,  $\gamma$ ), close packed structure of solids (cubic), packing in fcc, bcc and hcp lattices. Nearest neighbours, ionic radii. Simple ionic compounds, point defects.

Solutions — Raoult's law. Molecular weight determination from lowering of vapour pressure, elevation of boiling point and depression of freezing point.

Nuclear chemistry — Radioactivity. Isotopes and isobars. Properties of alpha, beta and gamma rays. Kinetics of radioactive decay (decay series excluded), carbon dating. Stability of nuclei with respect to proton-neutron ratio. Brief discussion on fission and fusion reactions.

### **Inorganic Chemistry**

Study of different groups in periodic table —

Group 1A (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)

Group 2A (preparation, properties and reactions alkaline earth metals with emphasis on  $Mg$  and  $Ca$  and their compounds such as oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates)

Group 3A (chemistry of Boron and its compounds – diborane)

Group 8A (preparation, properties and reactions inert gases with emphasis on chemistry of Xenon)

Group 7A (halogen chemistry with special emphasis on chemistry of chlorine)

Study of nonmetals —  $C$ ,  $S$ ,  $N$ ,  $P$  (especially oxides and oxyacids compounds of these elements, in addition phosphines for  $P$ , ammonia for  $N$ ) and  $O$  (peroxide and ozone),  $Si$  (silicones and silicates). (Allotropes of  $C$ ,  $S$ ,  $N$  should be covered.)

Transition elements (3d series) — Definition, general characteristics, variable oxidation states and their stabilities, colour (excluding the details of electronic transitions) and calculation of spin-only magnetic moment.

Coordination compounds — nomenclature of mononuclear coordination compounds. cis-trans and ionisation isomerisms, hybridization and geometries of mononuclear coordination compounds (linear, tetrahedral, square planar and octahedral).

Metals and metallurgy — General methods involving chemical principles. General operation stages involved in metallurgical operation. Metallurgy of  $p$ -block element (emphasis on  $Al$ ). Metallurgy of  $Fe$ -triad ( $Fe$ ,  $Co$ , and  $Ni$  with more emphasis on  $Fe$  metallurgy). Metallurgy of coinage metals ( $Cu$ ,  $Ag$  with more emphasis on  $Cu$ ).

### **Organic Chemistry**

Concepts — Hybridisation of carbon. Sigma and pi-bonds. Shapes of simple organic molecules. Structural and geometrical isomerism. Optical isomerism of compounds containing up to two asymmetric centres, ( $R$ ,  $S$  and  $E$ ,  $Z$  nomenclature excluded). IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono-functional and bi-functional compounds). Conformations of ethane and butane (Newman projections). Resonance and hyperconjugation. Keto-enol tautomerism. Determination of empirical and molecular formulae of simple compounds (only combustion method). Hydrogen bonds - definition and their effects on physical properties of alcohols and carboxylic acids. Inductive and resonance effects on acidity and basicity of organic acids and bases. Polarity and inductive effects in alkyl halides. Reactive intermediates produced during homolytic and heterolytic bond cleavage. Formation, structure and stability of carbocations, carbanions and free radicals.

Preparation, properties and reactions of alkanes — Homologous series, physical properties of alkanes (melting points, boiling points and density). Combustion and halogenation of alkanes. Preparation of alkanes by Wurtz reaction and decarboxylation reactions. Preparation, properties and reactions of alkenes and alkynes - physical properties of alkenes and alkynes (boiling points, density and dipole moments). Acidity of alkynes. Acid catalysed hydration of alkenes and alkynes (excluding the stereochemistry of addition and elimination). Reactions of alkenes with  $KMnO_4$  and ozone. Reduction of alkenes and alkynes. Preparation of alkenes and alkynes by elimination reactions. Electrophilic addition reactions of alkenes with  $X_2$ ,  $HX$ ,  $HOX$  and  $H_2O$  ( $X$ =halogen). Addition reactions of alkynes; Metal acetylides.

Reactions of benzene — Structure and aromaticity. Electrophilic substitution reactions - halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation. Effect of o-, m- and p- directing groups in monosubstituted benzenes.

Phenols — Acidity, electrophilic substitution reactions (halogenation, nitration and sulphonation). Reimer-Tieman reaction, Kolbe reaction.

Characteristic reactions of the following (including those mentioned above) —

Alkyl halides - rearrangement reactions of alkyl carbocation, Grignard reactions, nucleophilic substitution reactions Alcohols - esterification, dehydration and oxidation, reaction with sodium, phosphorus halides,  $ZnCl_2$  / concentrated  $HCl$ , conversion of alcohols into aldehydes and ketones. Ethers - Preparation by Williamson's Synthesis. Aldehydes and Ketones - oxidation, reduction, oxime and hydrazone formation. aldol condensation, Perkin reaction. Cannizzaro reaction. Haloform reaction and nucleophilic addition reactions (Grignard addition). Carboxylic acids - formation of esters, acid chlorides and amides, ester hydrolysis. Amines - basicity of substituted anilines and aliphatic amines, preparation from nitro compounds, reaction with nitrous acid, azo coupling reaction of diazonium salts of aromatic amines, Sandmeyer and related reactions of diazonium salts. carbylamine reaction. Haloarenes - nucleophilic aromatic substitution in haloarenes and substituted haloarenes (excluding Benzyne mechanism and Cine substitution).

Carbohydrate — Classification. mono- and di- saccharides (glucose and sucrose). Oxidation, reduction, glycoside formation and hydrolysis of sucrose.

Amino acids and peptides — General structure (only primary structure for peptides) and physical properties. Some examples for separation of amino acid mixture using physical properties.

## 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. Identification of independent, dependent and control variables. Identification of sample size, range and interval. Identification of appropriate measurement techniques and instruments.

Graphical representation, interpretation and analysis 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 frames of reference. Static and dynamic friction. Kinetic and potential energy. Work and power. Conservation of linear momentum and mechanical energy.

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

Law of gravitation. 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.

Linear and angular simple harmonic motions.

Hooke's law, Young's modulus.

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

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

### ***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.