

**National Entrance Screening Test - 2012
(NEST-2012)**

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**

Academic Session: 2012-13

General Instructions

- Candidates must reach the examination center at least 30 minutes before the beginning of the test.
- Candidates will not be allowed to leave examination until one hour after the beginning of the test.
- Use of log tables, cell-phones and calculators in examination hall will not be permitted.
- Candidates MUST bring their admit card and their school identity card with them to examination hall.

Important Dates

- Last date for requesting application form: February 12, 2012.
- Last date for receipt of completed application form: March 12, 2012.
- On-line applications freeze: March 12, 2012.
- Dispatch of admit cards begins: April 15, 2012.
- Date of Examination: May 27, 2012 (Sunday) 2 PM to 5 PM.
- Announcement of test results on (<http://nestexam.in>): June 20, 2012.

Check List

- Does the address for correspondence include pin code and is it legible?
- Is a passport size photograph pasted at the correct place?
- Have you signed in the place marked for the signature?
- Is correct email and postal addresses written in proper place?
- Is the name of the bank and draft number written on application form?
- Is your name and application number written on the backside of the draft?
- Have the two centers of your choice been selected and marked correctly in the form?

If any of the above is missing, the application will be considered incomplete and will not be processed.

Ensure that your name and address is written legibly.

Send the application form and demand draft together by speed post or registered post.

National Entrance Screening Test-2012 (NEST-2012)

National Entrance Screening Test (NEST) is a compulsory test for students seeking 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 (CBS), Mumbai. Both NISER and CBS have been started by Department of Atomic Energy, Government of India in 2007. Their mandate is to train scientific manpower for carrying out cutting edge scientific research and for providing input to scientific programs of Department of Atomic Energy and other science institutions in the country conducting basic and applied research. The test is conducted in about 40 centers across India. This brochure gives the detailed procedure for applying for the test, syllabus of the test and various deadlines.

- 1. Eligibility:** Students securing at least 60% marks (or equivalent grade) in aggregate in Class XII (or equivalent) examination from any recognized Board in India are eligible to apply. Only for Scheduled Cast (SC), Scheduled Tribes (ST) candidates and for Persons with Disability (PD), the minimum requirement is 55%. Students who have passed the Class XII qualifying examination in 2010 or 2011 or are appearing in 2012 are eligible to apply. (*Where only Letter grade is given by the Board, a certificate from the Board specifying equivalent percentage marks will be required. In the absence of such a certificate the decision of the respective Admissions Committee will be final.*)
- 2. Age Limit:** General category candidates and Candidates belonging to Other Backward Castes (OBC) born on or after 01 Oct. 1987 are eligible to apply. For SC/ST/PD candidates the age limit is relaxed by 5 years. In any case, the eligibility criterion mentioned in point 1 above must be satisfied.
- 3. Number of Seats and Reservation:** The details of number of seats and their break-up as per statutory government norms have been listed in respective websites of NISER (<http://www.niser.ac.in>) and UM-DAE CBS (<http://www.cbs.ac.in>). This year (2012), the total number of seats is 60 at NISER and 35 at UM-DAE CBS. The admission will be very selective and students who are highly motivated to pursue higher education and research in science and its applications are likely to be selected.
- 4. Application Fee:** Application fee for appearing in NEST is Rs. 600/- for general category and OBC male candidates. For SC/ST/PD candidates and female candidates the amount is Rs. 300/-. The application fee may be paid by demand draft or by electronic mail transfer to NEST account.
Demand Draft: Demand draft may be drawn from any bank provided that it is drawn in the name of NEST and payable at Mumbai.
Electronic Payment:
Required bank details are as follows:
Bank and branch name : Bank of Baroda, Kalina Branch
Account name and number : NEST, 06720100017345
IFSC code : BARB0KALINA
Detailed instructions for payment of fees are available at <http://www.nestexam.in>.
- 5. Application Procedure:** Candidates may apply on-line, by filling up the application form at NEST-2012 website (<http://www.nestexam.in>) or by procuring a paper application form for NEST examination by writing to Chief Coordinator, NEST-2012.
 - *On-line applications:* Applying on-line is a preferred mode of applying. For this, candidates need to have an email address which they regularly use. Candidates should first visit NEST-2012 website and register themselves. Confirmation of registration will be sent to you by email. On receiving the

confirmation email, candidates can begin filling up of the form. The form may be filled in more than one sitting. Candidates should carefully read the instructions for filling of the form given at the web-site. The candidates should not forget to save the filled form and take a print-out for their reference.

It is mandatory that candidates upload their passport-size photograph and signature and fill in details of draft or electronic mail transfer details at appropriate place. Without these the application is incomplete and will not be considered.

If the candidate is paying the fees by demand draft, he/she should write his/her name and application number on the back side of the draft and send it with a photocopy of printed application form to Chief Coordinator.

Last date for completing on-line application, including payment of fees is March 12, 2012

○ *Off-line Applications:* If the candidate wishes to apply off-line, he must write to

The Chief Coordinator, NEST-2012,
UM-DAE CBS,
Health Center Building, University of Mumbai,
Kalina Campus, Mumbai 400 098

for getting the application form. Note that this is the only method of obtaining paper application forms. Photocopied application forms will not be considered.

Candidates should carefully read the instructions accompanying the application form before filling the form. On filling up the form, the candidate should paste passport size photograph at appropriate place and sign his name in the box provided. They should fill correct payment details and send the form along with the draft to Chief Coordinator at the address given above. Candidates should not forget to write their name and application number on the reverse of the draft. If the payment is made by electronic money transfer, they should write the details on the form.

Last date for receiving requests for off-line applications is February 13, 2012.

Last date for receiving completed application forms is March 12, 2012

6. **Examination Schedule:** NEST-2012 examination will be conducted on Sunday May 27 from 2 pm to 5 pm.
7. **Examination Centers:** The names of NEST examination centers are given in Appendix I. Candidates should mark their first and second preferences at appropriate place in the application form. Every effort will be made to allot a center of their choice to the candidates. *However, allotment of an examination center by the chief coordinator, NEST 2012 will be regarded as final and any request to change of center will not be entertained.* The address of the center allotted to a candidate will be mentioned in NEST admit card.
8. **Question paper pattern:** The question paper will have five sections. The first section, which is compulsory for all candidates will include general questions. The next four sections will include questions on (1) biology, (2) chemistry, (3) mathematics and (4) physics. Candidates may opt to answer any three of these four sections. All sections carry equal marks. The questions will be aimed at testing the comprehension and analytic ability of the candidates. The questions will be objective type with four answers given for each question. Some of the questions may have one or more correct

answers. For these questions, candidates are expected to mark all the correct answers and none of the wrong answers. Wrong answers will be awarded negative marks.

The syllabus for the entrance examination is given in Appendix II,

Language of the question paper will be English only.

9. **Admit Cards:** Admit cards will be mailed to candidate's postal addresses from the beginning April 8, 2012. Candidates will have an option of downloading their admit cards from the web site of NEST (<http://www.nestexam.in>). This procedure is recommended for the candidates who have filled the application form on-line. Candidates must ensure that their mailing address entered in the application form is correct and legibly written. NEST office will not be responsible if the admit card does not reach a candidate in time because of postal delay or incorrect address. In case you do not receive the admit card by May 1, 2012, you may write to Chief Coordinator, NEST-2012 by speed post or by email (email address: nest@niser.ac.in). We may be able to send the admit card of such candidates electronically if an email address of the candidate is provided.
10. **NEST Result:** Results of NEST examination will be announced on June 18, 2012 on NEST web site. Candidates can see their result at NEST website (<http://www.nestexam.in>) by entering their application number or admit card number. Dates of counseling for NISER and CBS will be announced on their respective web pages and the candidates will also be informed by emails and letters.
11. **Syllabus for NEST:** The syllabus for NEST examination is basically same as CBSE syllabus of 12th standard. Detailed syllabi of biology, chemistry, mathematics and physics are given in Appendix II. There is no specific syllabus for the general section. This section is expected to test the candidate's familiarity with (and not a detailed understanding of) major historical milestones in astronomy, biology, chemistry, mathematics and physics. The questions based on mathematics up to 10th standard will be included in this section. In addition, there will be questions on given passages to test candidates's ability of comprehension and application.

All the questions will be of objective type with some questions having one or more correct answers. For such questions, marks will be awarded if all correct answers and no wrong answers are marked. There will be negative marking.

Appendix-I

Table 1: List of center names and codes

code	center name	code	center name	code	center name
01	Agartala	14	Delhi South	27	Patna
02	Ahmedabad	15	Guwahati	28	Pune
03	Allahabad	16	Hyderabad	29	Raipur
04	Bangaluru	17	Indore	30	Ranchi
05	Behrampur (Orissa)	18	Jaipur	31	Sambalpur
06	Bhopal	19	Jammu	32	Simla
07	Bhubaneswar	20	Kochi	33	Silchar
08	Chandigarh	21	Kolkata North	34	Srinagar (J & K)
09	Chandigarh	22	Kolkata South	35	Udaipur
10	Chennai	23	Lucknow	36	Vardhaman
11	Dehradun	24	Madurai	37	Varanasi
12	Delhi East	25	Mumbai	38	Vishakhapattanam
13	Delhi North	26	Nagpur		

Appendix-II

Syllabus

- General:** There is no specific syllabus for the 'General' section of NEST 2011. This section aims to test the candidate's general ability to comprehend qualitative and quantitative aspects of a given scientific passage. 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 and astronomy. There will also be questions testing mathematics understanding up to 10th standard and application capabilities of the same to specific simple problems.
- Biology:**
 - **Cell Biology:**

Cell theory Cell as a unit of life. Tools and techniques of cell studies - Microscopy (use of microscope and calibration). Elements of microscope. Biomembranes -Transport mechanism, cellular respiration. Cell organelles: their structure and functions. Discovery and structure of DNA, processes of replication, transcription and translation, principles of the basic techniques in molecular biology.
 - **Zoology:**

Anatomy and Physiology:

 - Digestive System:** Modes of nutrition; Structure of alimentary canal and associated glands, digestive enzymes and their role in digestion, 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.

(iv) Excretory System: Elimination of nitrogenous waste, osmoconformers and osmoregulators; structure and function of kidney tubules, arrangement of excretory organs.

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

(vi) Reproductive System: Sexual and asexual reproduction; General arrangement of reproductive organs.

(vii) 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 only): Human genetics, Human chromosomes, sex-determination, sex-linked inheritance. Evidences and theories of organic evolution. Ecology: Physical and biological factors influencing organisms. Food chains, pyramids of numbers and biomass, biological equilibrium. Interspecific associations.

— **Botony:**

Anatomy and Physiology of Plants: Meristems -Plant growth and development. Internal and external regulators of growth and development in plants, 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.

Genetics: 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.

3. 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 veloci-

ties 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 K_c and K_p 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 K_c ; 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, α , β , γ), 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 - 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 -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-Tiemann 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, $\text{ZnCl}_2/\text{concentrated HCl}$, 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).

Carbohydrates: 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.

4. **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 a 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 of 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 deriva-

tive, 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.

5. **Physics:**

— **General Physics**

Units and dimensions, dimensional analysis; least count, significant figures; Methods of measurement (Direct, Indirect, Null, etc.,) and measurement of length, time, mass, temperature, electrical 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 and its applications.

Wave motion (plane waves only), 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 (CV and CP 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: Parallel plate capacitor 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.