



**Mahatma Gandhi University**

MEGHALAYA  
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**SYLLABUS MANUAL**

**TRADITIONAL PROGRAMME**

**PROGRAMME CODE---321**  
**Bachelor of Science in General (BSC-GENERAL)**

<b>YEAR I</b>		
<b>CODE</b>	<b>SUBJECT</b>	<b>CREDITS</b>
BSCGN11	Elementary Mechanics	6
BSCGN12	Calculus	6
BSCGN13	Cell Biology	6
BSCGN14	Mathematical Methods In Physics-I	7
BSCGN15	Atoms And Molecules & Inorganic Chemistry	7
<b>TOTAL CREDITS</b>		<b>32</b>

<b>YEAR II</b>		
<b>CODE</b>	<b>SUBJECT</b>	<b>CREDITS</b>
BSCGN21	Oscillations And Waves	6
BSCGN22	Ecology	6
BSCGN23	Physical Chemistry	6
BSCGN24	Linear Algebra	7
BSCGN25	Mathematical Methods In Physics-II	7
<b>TOTAL CREDITS</b>		<b>32</b>

<b>YEAR III</b>		
<b>CODE</b>	<b>SUBJECT</b>	<b>CREDITS</b>
BSCGN31	Thermodynamics And Statistical Mechanics	6
BSCGN32	Organic Chemistry	3
BSCGN33	Analytical Geometry	3
BSCGN34	Developmental Biology	6
BSCGN35	Mathematical Methods	7
BSCGN36	Modern Physics	7
<b>TOTAL CREDITS</b>		<b>32</b>

## Detailed Syllabus

### SEMESTER –I

#### **BSCGN11 --- Elementary Mechanics**

**UNIT I:** Kinematics of Motion: Displacement, Velocity and Acceleration; Uniform Circular Motion, Relative Motion.

**UNIT II:** Dynamics of Motion: Force, Newton's Laws of Motion, Applications of Newton's Laws.

**UNIT III:** Equilibrium of Forces; Linear Momentum, Conservation of Linear Momentum; Impulse; Motion with Variable Mass, Rocket Motion.

**UNIT IV:** Work and Energy: Work done by a Constant Force, and a Variable Force; Kinetic Energy and Work-Energy Theorem.

**UNIT V:** Potential Energy and Conservative Forces, Principle of Conservation of Energy, Energy Diagrams.

**UNIT VI:** Elastic and Inelastic Collisions; Power; Angular Motion: Kinematics of Angular Motion: Angular Displacement, Angular Velocity and Angular Acceleration.

**UNIT VII:** Use of Plane Polar Coordinates for describing Circular Motion and General Angular Motion.

**UNIT VIII:** Relations between Linear and Angular Kinematical Variables; Dynamics of Angular Motion; Torque.

**UNIT IX:** Kinetic Energy of Rotation; Angular Momentum, Conservation of Angular Momentum and its Applications.

**UNIT X:** Gravitation: Law of Gravitation; Moon's Rotation about the Earth; Principle of Superposition; Gravitational Field and Potential Intensity, Gravitational Potential Energy due to Spherical Shell and Solid Sphere; Gravity and its Variation, Velocity of Escape; Fundamental Forces in Nature.

**UNIT XI:** Many Particle Systems; Central Conservative Forces: Properties of Motion under Central Conservative Forces; Inverse Square Central Conservative Forces.

**UNIT XII:** Motion of Two-Body Systems.

**UNIT XIII:** Equation of Motion in Centre-of-mass and Relative Coordinates.

**UNIT XIV:** Linear and Angular Momentum and Kinetic Energy.

Dynamics of Many-Particle Systems: Linear Momentum, Angular Momentum and Kinetic Energy of an N-particle System.

**UNIT XV:** Scattering: Scattering Cross-Sections: Differential Cross-Section, Total Cross-Section.

**UNIT XVI:** Laboratory and Centre-of-Mass Frames of Reference, Relations between Angles and Scattering Cross-Sections in the Laboratory and Centre-of-Mass Frames of Reference.

**UNIT XVII:** Impact Parameter, Elastic Scattering of Two Hard Spheres, Rutherford Scattering.

**UNIT XVIII:** Rigid Body Dynamics; Translational, Rotational and General Motion of a Rigid Body.

**UNIT XIX:** Moment of Inertia, Determination of Moment of Inertia of a Rigid Body; Rotational Dynamics of a Rigid Body, Rotational Analogue of Newton's Second Law.

**UNIT XX:** Work and Energy in Rotational Motion, Conservation of Angular Momentum and its Applications, Precession.

**UNIT XXI:** Non-Inertial Frames of Reference: Motion Observed from a Non-Inertial Frame.

**UNIT XXII:** Newton's Second Law and Inertial Forces, Weightlessness.

**UNIT XXIII:** Rotating Frame of Reference: Time Derivatives in Inertial and Rotating Frames, Centrifugal Force, Coriolis Force.

**UNIT XXIV:** The Earth as a Rotating Frame of Reference, Variation of  $g$  with Latitude, Motion on the Rotating Earth, Foucault's Pendulum.

#### **Reference Books:**

1. Elementary mechanics by Harvey Goodwin.
2. Elementary mechanics by John Williams (headmaster at Swindon.)

#### **BSCGN12 --- Calculus**

**UNIT I:** Basic properties of  $\mathbf{R}$ , Absolute value, Intervals on the real line, Functions (Definition and examples), Inverse functions, Graphs of functions, Operations on functions.

**UNIT II:** Composite of functions, Even and odd functions, Monotone functions, Periodic functions.

**UNIT III:** Definition of limits, Algebra of limits, Limits as  $x \rightarrow \infty$  (or  $-\infty$ ), One-sided limits, Continuity (Definitions and Examples, Algebra of continuous functions).

**UNIT IV:** Definition of derivative of a function, Derivatives of some simple functions, Algebra of derivatives, The chain rule, Continuity versus derivability.

**UNIT V:** Derivatives of the various trigonometric functions, Derivatives of inverse function.

**UNIT VI:** The inverse function theorem, Derivatives of inverse trigonometric functions, Use of transformations.

**UNIT VII:** Derivative of exponential function, Logarithmic functions, Hyperbolic functions, Inverse hyperbolic functions.

**UNIT VIII:** Methods of differentiation (Derivative of  $x^r$ , Logarithmic Differentiation, Derivatives of functions defined in terms of a parameter, Derivatives of implicit functions).

**UNIT IX:** Second and third order derivatives,  $n$ th order derivatives, Leibniz theorem.

**UNIT X:** Taylor's series and Maclaurin's series Maxima-minima of functions (Definitions and examples, a necessary condition for the existence of extreme points), Mean value theorems.

**UNIT XI:** Sufficient conditions for the existence of extreme points (First derivative test, Second derivative test), Concavity/convexity, Points of inflection.

**UNIT XII:** Equation of tangents and normal's.

**UNIT XIII:** Angles of intersection of two curves, Tangents at the origin, Classifying singular points, Asymptotes (Parallel to the axes, Oblique asymptotes).

**UNIT XIV:** Graphing a function, Tracing a curve (given its Cartesian equation, or in parametric form, or Polar equation).

**UNIT XV:** Partitions of a closed interval, Upper and lower product sums, Upper and lower integrals.

**UNIT XVI:** Definite integral, Fundamental theorem of calculus.

**UNIT XVII:** Standard integrals, Algebra of integrals, Integration by substitution.

**UNIT XVIII:** Integrals using trigonometric formulas, Trigonometric and Hyperbolic substitutions.

**UNIT XIX:** Two properties of definite integrals, Integration by parts, Evaluation of

$$\int (a^2 - x^2)dx, \int (a^2 + x^2)dx, \int (x^2 - a^2) dx, \int e^x (f(x) + f'(x))dx .$$

**UNIT XX:** Reduction formulas for  $\int \sin^n x dx$ ,  $\int \cos^n x dx$ ,  $\int \tan^n x dx$  and  $\int \sec^n x dx$ , Integrals

involving products of trigonometric functions (Integrand of the type  $\sin^m x \cos^n x e^{ax} \sin^n x$ ),

Integrals involving hyperbolic functions.

**UNIT XXI:** Integration of some simple rational functions, Partial fraction decomposition, Method of substitution.

**UNIT XXII:** Integration of rational trigonometric functions, Integration of Irrational functions.

**UNIT XXIII:** Monotonic functions, Inequalities, Approximate value. Area under a curve (Cartesian equation, Polar equations), Area bounded by a closed curve, Numerical integration (Trapezoidal rule, Simpson's rule).

**UNIT XXIV:** Length of a plane curve (Cartesian form, Parametric form, Polar form), Volume of a solid of revolution, Area of surface of revolution.

#### **Reference Book:**

1. Calculus by Michael Spivak.
2. Calculus by Silvanus P. Thompson.

#### **BSCGN13 --- Cell Biology**

**UNIT I:** Evolution of the Cell; Prokaryotic Structure, Bacteria, Virus;

**UNIT II:** Evolution of Photosynthesis and Aerobic Respiration; Prokaryotes to Eucaryotes;

**UNIT III:** Animal and Plant Cells. Light Microscopy, Electron Microscopy, Radioisotopes, Autoradiography and Antibodies;

**UNIT IV:** Tissue Culture and Cinemicrography. Details of Cell Structure and Functions of Cell Organelles.

**UNIT V:** Chemical Components of Cell, Isolation and Detection of Cellular Macromolecules – Methods of Molecular Separation. Types of Bonds, Proteins, Nucleic Acids, Carbohydrates and Lipids.

**UNIT VI:** Energy Releasing Pathways; Functional Groups and Common Reactions, Glycolysis, Tricarboxylic Acid Cycle, Electron Transport Chain, Regulations;

**UNIT VII:** Degradation of Lipids and Proteins. Biosynthesis; Carbohydrates – Interconversion and Regulations, Structure of Glycogen and Starch, Sucrose and Starch Interconversions;

**UNIT VIII:** Gluconeogenesis; Ketone Bodies; Glyoxylate Cycle.

**UNIT IX:** Synthesis of Fats. Nuclear Envelope and Components – Organisation and Functions, Replication of DNA, Enzymes involved in DNA Replication;

**UNIT X:** Transcription in Prokaryotes and Eucaryotes, Types of RNA; RNA Processing in Eucaryotes.

**UNIT X:** Protein Biosynthesis, Rate of Protein Synthesis; Processing of Protein Molecule; Regulation of Protein Synthesis.

**UNIT XI:** Strategies of Chemical Signalling, Signalling Mediated by Intracellular Receptors and Cell-surface Receptors, Second Messenger, Target Cell Adaptation;

**UNIT XII:** Bacterial Chemotaxis.

**UNIT XIII:** Cell Cycle – Phase and Events; Determination of Cell Cycle Times.

**UNIT XIV:** Regulation of Cell Division, Mitosis.

**UNIT XV:** Molecular Theory of Recombination; Differences between Meiosis and Mitosis.

**UNIT XVI:** Cytokinesis, Distribution of Cytoplasmic Components. Intercellular Recognition and Cell Aggregation.

**UNIT XVII:** Cell Junctions – Desmosomes, Tight Junctions, Gap Junction, Plasmodesmata.

**UNIT XVIII:** Cell Movements – Pseudopodia, Lamellopodia, Filopodia, Ciliary and Flagellar Movements, Phagocytosis.

**UNIT XIX:** Extracellular Matrix – Components, Basal Lamina.

**UNIT XX:** Differentiated Animal Cell Types – A General Classification and functions.

**UNIT XXI:** Tissues and cells.

**UNIT XXII:** Differences between Plant and Animal Cells.

**UNIT XXIII:** Plant Cell Wall; Plant Cell and Tissue Types.

**UNIT XXIV:** Meristems and their Distribution; Plant Cell Growth.

**Reference Books:**

1. Cell Biology by S C Rastogi
2. Cell Biology by Stephen R. Bolsover, Elizabeth A. Shephard

**BSCGN14 --- Mathematical Methods In Physics-I**

**UNIT I:** Ordinary Differential Equations: Classification, General and Particular Solution.

**UNIT II:** Existence and Uniqueness of a Particular Solution, General Properties of the Solutions of Linear ODEs.

**UNIT III:** First Order Ordinary Differential Equations: Equations Reducible to Separable Form: Method of Separation of Variables, Homogeneous First Order ODEs.

**UNIT IV:** Exact Equations, First Order Linear Differential Equations.

**UNIT V:** Equations Reducible to First Order.

**UNIT VI:** Second Order Ordinary Differential Equations with Constant and Variable Coefficients: Basic Terminology; Homogenous and Inhomogenous Linear Equations with Constant Coefficients.

**UNIT VII:** The Method of Undetermined Multipliers; Method of Variation of Parameters.

**UNIT VIII:** Complementary Functions and Particular Integral.

**UNIT IX:** Linear Independence, Wronskian, Power Series Solution.

**UNIT X:** Frobenius Method.

**UNIT XI:** Applications of ODEs in Physics: Mathematical Modelling.

**UNIT XII:** First Order ODEs in Physics: Applications in Newtonian Mechanics, Simple Electrical Circuits.

**UNIT XIII:** Second Order ODEs in Physics: Rotational Mechanical Systems, Planetary Orbits.

**UNIT XIV:** Coupled Differential Equations: Coupled Oscillators.

**UNIT XV:** Coupled Electrical Circuits, Charged Particle Motion in Electric and Magnetic Fields.

**UNIT XVI:** Partial Differential Equations: Functions of More than One Variable.

**UNIT XVII:** Limits and Continuity, Partial Differentiation, Differentiability.

**UNIT XVIII:** Classification of Partial Differential Equations.

**UNIT XIX:** General and Particular Solution; Partial Differential Equations in Physics: Method of Separation of Variables.

**UNIT XX:** Solution of Initial and Boundary Value Problems; Fourier Series: The Need for Fourier Series.

**UNIT XXI:** Determination of Fourier Coefficients, Use of Fourier Series: as an Approximation.

**UNIT XXII:** Even and Odd Functions.

**UNIT XXIII:** Fourier Sine and Cosine Series.

**UNIT XXIV:** Half-range Expansions.

**UNIT XXV:** The Convergence of Fourier Series.

**UNIT XXVI:** Applications of Fourier Series to Partial Differential Equations: Diffusion Equation: Heat conduction and Diffusion of Particles.

**UNIT XXVII:** Wave Equation, The Plucked String Problem, Torsional Vibrations.

**UNIT XXVIII:** Laplace's Equation, Steady State Heat Flow, the Potential Problem.

Reference Books:

1. Mathematical Methods in Physics by Samuel D. Lindenbaum.
2. Methods of mathematical physics by Harold Jeffreys, Bertha Swirles Jeffreys.

### **BSCGN15 --- Atoms And Molecules & Inorganic Chemistry**

**UNIT I:** Old Quantum Theory

**UNIT II:** Wave Mechanics

**UNIT III:** Electronic Theory of Valency

**UNIT IV:** Valence Bond Theory

**UNIT V:** Molecular Orbital Theory

**UNIT VI:** Molecular Properties

**UNIT VII:** Molecular Spectroscopy-I

**UNIT VIII:** Molecular Spectroscopy-II

**UNIT IX:** Nuclear Chemistry

**UNIT X:** The Periodic Table

**UNIT XI:** Periodicity

**UNIT XII:** Hydrogen

**UNIT XIII:** Alkali Metals

**UNIT XIV:** Alkaline Earth Metals

**UNIT XV:** Elements of Group 13

**UNIT XVI:** Elements of Group 14

**UNIT XVII:** Elements of Group 15  
**UNIT XVIII:** Elements of Group 16  
**UNIT XIX:** Elements of Group 17  
**UNIT XX:** Elements of Group 18  
**UNIT XXI:** Transition Elements  
**UNIT XXII:** Inner-Transition Elements  
**UNIT XXIII:** Coordination Compounds  
**UNIT XXIV:** Isolation and Purification of Metals.

Reference Books:

1. Inorganic Chemistry by Huheey.
2. Progress in Inorganic Chemistry by Kenneth D. Karlin.

## **YEAR II**

### **BSCGN21 --- Oscillations And Waves**

**UNIT I:** Basic Characteristics of Simple Harmonic Motion: Oscillations of a Spring-Mass System.

**UNIT II:** Differential Equation of SHM and its Solution.

**UNIT III:** Phase of an Oscillator Executing SHM, Velocity and Acceleration.

**UNIT IV:** Transformation of Energy in Oscillating Systems: Kinetic and Potential Energies; Calculation of Average Values of Quantities Associated with SHM.

**UNIT V:** Examples of Physical Systems Executing SHM: Simple Pendulum, Compound Pendulum, Torsional Pendulum, LC Circuit; Principle of Superposition.

**UNIT VI:** Superposition of Two Collinear Harmonic Oscillations of Same/Different Frequencies; Oscillations in Two Dimensions; Superposition of Two Mutually Perpendicular Harmonic Oscillations of the Same/Different Frequencies; Lissajous Figures.

**UNIT VII:** Damped and Forced Oscillations: Differential Equation of a Damped Oscillator and its Solutions, Heavy Damping, Critical Damping, Weak Damping.

**UNIT VIII:** Characterising Weak Damping: Logarithmic Decrement; Relaxation Time, Quality Factor.

**UNIT IX:** Examples of a Weakly Damped System (LCR circuit).

**UNIT X:** Differential Equation of an Undamped Oscillator and its Solution.

**UNIT XI:** Differential Equation of a Weakly Damped Forced Harmonic Oscillator and its Solutions, Steady State Solution, Resonance.

**UNIT XII:** Examples of Forced Vibrations and Resonance, Power Absorbed by a Forced Oscillator, Quality Factor.

**UNIT XIII:** An LCR Circuit.

**UNIT XIV:** Basic Concepts of Wave Motion: Formation of a Wave.

**UNIT XV:** Graphical Representation of Wave Motion, Relation between Wave Velocity, Frequency and Wavelength.

**UNIT XVI:** Mathematical Description of Wave Motion: Phase and Phase Difference, Phase Velocity, Energy Transported by Progressive Waves, Intensity and the Inverse Square Law.



**UNIT XVII:** One-dimensional Wave Equation: Waves on a Stretched String, Waves in a Field, Waves in a Uniform Rod.

**UNIT XVIII:** Waves in Two and Three Dimensions.

**UNIT XIX:** The Doppler Effect: Source in Motion and Observer Stationary, Source Stationary and Observer in Motion, Source and Observer both in Motion; Shock Waves.

**UNIT XX:** Reflection and Refraction of Waves: The Concept of Wavefront and Huygens' Construction.

**UNIT XXI:** Wave Motion and Impedance, Impedance Offered by Strings, Transverse Waves, Impedance Offered by Gases, Sound Waves.

**UNIT XXII:** Reflection and Transmission; Amplitude Coefficients: Transverse Waves, Longitudinal Waves.

**UNIT XXIII:** Reflection and Transmission Energy Coefficients; Principle of Superposition of Waves; Stationary Waves: Velocity of a Particle at any Point in a Stationary Wave, Harmonics in Stationary Waves.

**UNIT XXIV:** Properties of Stationary Waves; Musical Sound and Noise; Wave Groups and Group Velocity; Beats.

Reference Books:

1. Oscillations And Waves by Fritz Kurt Kneubühl.
2. The Physics of Waves and Oscillations by N. K. Bajaj.

## **BSCGN22 --- Ecology**

**UNIT I:** Concepts of Ecology, Environment, Population, Community, Ecosystem, Biosphere.

**UNIT II:** Detailed studies on the environmental components: Light, Temperature, Atmosphere, Water, and Soil.

**UNIT III:** Ecosystem as a unit of nature; Components of ecosystem; Tolerance range and limiting factor; Trophic level.

**UNIT IV:** Ecological pyramids; Energy input in ecosystem; Energy flow; Food chain and Food web.

**UNIT V:** Ecosystem control; Biogeochemical cycling: Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle, Nutrient budgets and Cycling in forests.

**UNIT VI:** Biomes of the world; Forests; Grasslands; Deserts; Aquatic ecosystems; Lentic ecosystems.

**UNIT VII:** Lotic ecosystems, Marine ecosystems; Estuaries.

**UNIT VIII:** Community studies; Community gradients and boundaries, Analytic characters: Qualitative characters, and Synthetic characters.

**UNIT IX:** Succession: Primary and Secondary succession, Autotrophic and Heterotrophic succession, Autogenic and Allogenic succession.

**UNIT X:** Processes in succession; Kinds of succession; Models of succession; Trends in succession.

**UNIT XI:** Community organisation – Habitat and Niche, Functional roles and Guilds, Keystone species, Dominant species, Stability, Community organisation.

**UNIT XII:** Species interaction; Evolution of competitive ability.

**UNIT XIII:** Predation, Co-evolution of Predator-Prey system.

**UNIT XIV:** Herbivory – Defence mechanisms in plants, Herbivore interactions and counter-measures.

**UNIT XV:** Population – Density, Natality, Mortality, Dispersal, Age distribution, Population distribution.

**UNIT XVI:** Population growth – Factors affecting biotic potential, Carrying capacity.

**UNIT XVII:** Population regulation – Density dependent factors, Genetic diversity of the population; Evolutionary implications of natural regulation.

**UNIT XVIII:** Human evolution in relation to environment – Historical overview, Characteristics of human population growth, Trends in growth of human population.

**UNIT XIX:** Population growth by region; Problems of resource use related to population growth; Future Trends.

**UNIT XX:** Causes of degradation of ecosystem; Defining wildlife.

**UNIT XXI:** Threats to wildlife; Extinct, Threatened and Out of danger species.

**UNIT XXII:** The Red Data Book; Importance of conserving wildlife.

**UNIT XXIII:** Measures for conservation of wildlife, Conservation in India; Pollution of Air, Fresh-water bodies, Ground water, and Marine water, Land.

**UNIT XXIV:** Pollution due to noise; radiation pollution; Control of pollution.

#### **Reference Books:**

1. Ecology by Michael Begon, Colin R. Townsend, John L. Harper.
2. Ecology: individuals, populations, and communities by Michael Begon, John L. Harper, Colin R. Townsend.

#### **BSCGN23 --- Physical Chemistry**

**UNIT I:** Units and Dimensions

**UNIT II:** Kinetic Theory of Gases

**UNIT III:** Real Gases and Their Liquefaction

**UNIT IV:** Liquids

**UNIT V:** Solid State

**UNIT VI:** The First Law of Thermodynamics

**UNIT VII:** Thermochemistry

**UNIT VIII:** The Second Law of Thermodynamics

**UNIT IX:** Free Energy Functions

**UNIT X:** Solutions-I

**UNIT XI:** Solutions-II

**UNIT XII:** Colligative Properties

**UNIT XIII:** Phase Equilibria

**UNIT XIV:** Chemical Equilibria

**UNIT XV:** Ionic Equilibria

**UNIT XVI:** Electrolytic Conductance of Solutions

**UNIT XVII:** Electrochemical Cells  
**UNIT XVIII:** Chemical Kinetics  
**UNIT XIX:** Photochemistry  
**UNIT XX:** Colloids and Macromolecules  
**UNIT XXI:** Surface Chemistry and Catalysis

Reference Books:

1. Physical chemistry: a molecular approach by Donald Allan McQuarrie, John Douglas Simon.
2. Physical Chemistry by Peter Atkins, Julio De Paula.

### **BSCGN24 --- Linear Algebra**

**UNIT I:** Sets, subsets, union and intersection of sets, Venn diagrams, Cartesian product, relations, functions.

**UNIT II:** Composition of functions, binary operations, fields. Plane and space vectors, addition and scalar multiplication of vectors.

**UNIT III:** Scalar product, orthonormal basis, vector equations of a line, plane and sphere.

**UNIT IV:** Definition and basic properties, subspaces.

**UNIT V:** linear combination, algebra of subspaces, quotient spaces.

**UNIT VI:** Linear independence and some results about it, basic results about basis and dimension, completion of a linearly independent set to a basis.

**UNIT VII:** Dimension of subspaces and quotient spaces.

**UNIT VIII:** Definitions and examples of linear transformation, kernel, range space, rank and nullity, homomorphism theorems.

**UNIT IX:**  $L(U, V)$ , the dual space, composition of transformations, the minimal polynomial.

**UNIT X:** Definition of a matrix, matrix associated to a linear transformation, the vector space  $M_{m \times n}(F)$ , transpose, conjugate.

**UNIT XI:** Diagonal and triangular matrices, matrix multiplication, inverse of a matrix, matrix of a change of basis.

**UNIT XII:** Rank of a matrix, elementary operations.

**UNIT XIII:** Row-reduced echelon matrices, applying row reduction to obtain the inverse of a matrix and for solving a system of linear equations.

**UNIT XIV:** Definition and properties, product formula, matrix adjoint and its use for obtaining inverses.

**UNIT XV:** Cramer's rule, determinant rank.

**UNIT XVI:** Definition and how to obtain them, diagonalisation.

**UNIT XVII:** Cayley-Hamilton theorem, minimal polynomial's properties.

**UNIT XVIII:** Definition, norm of a vector, orthogonality.

**UNIT XIX:** Linear functionals of inner product spaces, adjoint of an operator.

**UNIT XX:** self-adjoint and unitary operators.

**UNIT XXI:** Hermitian and unitary matrices.

**UNIT XXII:** Definitions, representation as matrix product.

**UNIT XXIII:** transformation under change of basis.

**UNIT XXIV:** Rank of a form, orthogonal and normal canonical reductions Definitions.

**UNIT XXV:** standard equations, description and some geometrical properties of an ellipse.

**UNIT XXVI:** A hyperbola and parabola, the general reduction.

**Reference Books:**

1. Linear Algebra by Georgii Evgen'evich Shilov.
2. Linear Algebra: A Modern Introduction by David Poole.

**BSCGN25 --- Mathematical Methods In Physics-II**

**UNIT I:** Ordinary Differential Equations: Classification.

**UNIT II:** General and Particular Solution, Existence and Uniqueness of a Particular Solution.

**UNIT III:** General Properties of the Solutions of Linear ODEs.

**UNIT IV:** First Order Ordinary Differential Equations: Equations Reducible to Separable Form: Method of Separation of Variables, Homogeneous First Order ODEs.

**UNIT V:** Exact Equations, First Order Linear Differential Equations; Equations Reducible to First Order.

**UNIT VI:** Second Order Ordinary Differential Equations with Constant and Variable Coefficients: Basic Terminology.

**UNIT VII:** Homogenous and Inhomogenous Linear Equations with Constant Coefficients.

**UNIT VIII:** The Method of Undetermined Multipliers.

**UNIT IX:** Method of Variation of Parameters, Complementary Functions and Particular Integral.

**UNIT X:** Linear Independence, Wronskian, Power Series Solution, Frobenius Method.

**UNIT XI:** Applications of ODEs in Physics: Mathematical Modelling.

**UNIT XII:** First Order ODEs in Physics: Applications in Newtonian Mechanics, Simple Electrical Circuits.

**UNIT XIII:** Second Order ODEs in Physics: Rotational Mechanical Systems, Planetary Orbits.

**UNIT XIV:** Coupled Differential Equations: Coupled Oscillators, Coupled Electrical Circuits.

**UNIT XV:** Charged Particle Motion in Electric and Magnetic Fields.

**UNIT XVI:** Partial Differential Equations: Functions of More than One Variable.

**UNIT XVII:** Limits and Continuity, Partial Differentiation, Differentiability.

**UNIT XVIII:** Classification of Partial Differential Equations, General and Particular Solution.

**UNIT XIX:** Partial Differential Equations in Physics: Method of Separation of Variables.

**UNIT XX:** Solution of Initial and Boundary Value Problems; Fourier Series: The Need for Fourier Series.

**UNIT XXI:** Determination of Fourier Coefficients, Use of Fourier Series: as an Approximation.

**UNIT XXII:** Even and Odd Functions, Fourier Sine and Cosine Series.

**UNIT XXIII:** Half-range Expansions, The Convergence of Fourier Series.

**UNIT XXIV:** Applications of Fourier Series to Partial Differential Equations: Diffusion Equation: Heat conduction and Diffusion of Particles.

**UNIT XXV:** Wave Equation.

**UNIT XXVI:** The Plucked String Problem.

**UNIT XXVII:** Torsional Vibrations.

**UNIT XXVIII:** Laplace's Equation, Steady State Heat Flow, the Potential Problem.

### YEAR III

#### **BSCGN31 --- Thermodynamics And Statistical Mechanics**

**UNIT I:** Thermodynamic Systems and Classification of their Boundaries.

**UNIT II:** Thermodynamic State of a System and Thermodynamic Variables.

**UNIT III:** Thermodynamics Processes, Reversible and Irreversible and Quasistatic Processes.

**UNIT IV:** Representation of a Thermodynamic Process. Zeroth Law of Thermodynamics.

**UNIT V:** Equation of State, Deduction from Equation of State, Principle of Measurement of Temperature.

**UNIT VI:** Physical Properties and Scale of Temperature, Types of Thermometers.

**UNIT VII:** Constant Volume Gas Thermometer, Platinum Resistance Thermometer.

**UNIT VIII:** Thermistors, Thermocouples.

**UNIT IX:** Radiation Pyrometers, the International Temperature Scale.

**UNIT X:** Nature of Heat and Work, Internal and External Work, Work done in Different Systems, Path Dependence of Work and Heat, Internal Energy.

**UNIT XI:** The First Law of Thermodynamics, its Differential Form and Significance, Heat Capacities of a Gas.

**UNIT XII:** Equation of State for Adiabatic Processes, the Adiabatic Lapse Rate: Convective Equilibrium, Adiabatic and Isothermal Elasticities.

**UNIT XIII:** The Enthalpy, Enthalpy and Chemical Processes.

**UNIT XIV:** Standard Enthalpy Changes, Enthalpy of Reaction, Hess's Law (statement only).

**UNIT XV:** Entropy; the Second Law of Thermodynamics. Entropy Change in Natural Processes, the Carnot Cycle.

**UNIT XVI:** Heat Engines and Refrigerators. The Thermodynamic Temperature Scale.

**UNIT XVII:** The Thermodynamic Potential Functions, General Conditions for Thermo-dynamic Equilibrium.

**UNIT XVIII:** Maxwell's Relations in Thermodynamics, Deductions from Maxwell's Equations, TdS-Equations, Energy Equations, Heat Capacity Equations.

**UNIT XIX:** Phase Equilibrium, The Condition for Equilibrium between Phases, First Order Phase Transitions, Higher Order Phase Transitions, Gibbs' Phase Rule.

**UNIT XX:** Different Methods of Cooling, Joule-Thomson Effect, Liquefaction of Gases, Liquid Helium; Cooling by Adiabatic Demagnetization; The Third Law of thermo-dynamics.

**UNIT XXI:** Kinetic Theory of Gases, Kinetic Interpretation of Temperature, Elementary Deductions, Law of Equipartition, Classical Theory of Specific Heats; Mean Free Path, Distribution of Free Paths.

**UNIT XXII:** Experimental Determination, Viscosity, Thermal Conductivity, Self Diffusion.

**UNIT XXIII:** Random Walk, Brownian Motion, Einstein's Theory, Langevin's Theory, Avogadro Number, Deviations from Perfect Gas Behaviour.

**UNIT XXIV:** Regnault's, Andrews'and Amagat's Experiments, Onnes' Equation of State, Claussius and Van Der Waals Equation of State.

Reference Book:

1. Thermodynamics And Statistical Mechanics by Walter Greiner & Ludwig Neise.
2. Thermodynamics And Statistical Mechanics by Phil Attard.

### **BSCGN32 --- Organic Chemistry**

**UNIT I:** Bonding, Functional Group Classification and Nomenclature

**UNIT II:** Stereochemistry-I

**UNIT III:** Stereochemistry-II

**UNIT IV:** Effect of Molecular Architecture on Physical Properties

**UNIT V:** Structure-Reactivity Relationships

**UNIT VI:** Alkanes

**UNIT VII:** Alkenes

**UNIT VIII:** Alkynes

**UNIT IX:** Aromatic Hydrocarbons and Polynuclear Aromatics

**UNIT X:** Heterocyclic Compounds

**UNIT XI:** Halogen Derivatives

**UNIT XII:** Alcohols and Phenols

Reference Books:

1. Organic Chemistry by Thomas N. Sorrell.
2. Organic Chemistry by William H. Brown, Christopher S. Foote, Brent L. Iverson

### **BSCGN33 --- Analytical Geometry**

**UNIT I:** Equations of a line, Symmetry, Change of axes (Translating the axes, rotating the axes), Polar coordinates. Focus-directrix property.

**UNIT II:** Description of standard form of parabola, ellipse and hyperbola; Tangents and normals of parabola, ellipse, hyperbola.

**UNIT III:** Polar equation of conics. General second degree equation, Central and non-central conics, tracing a conic (Central conics, Parabola), Tangents, Intersection of conics.

**UNIT IV:** Points, Lines (Direction cosines, Equations of a straight line, Angle between two lines).

**UNIT V:** Planes (Equations of a plane, Intersecting planes and lines). Equations of a sphere.

**UNIT VI:** Tangent lines and planes, Two intersecting spheres, Spheres through a given circle.

**UNIT VII:** Cones, Tangent plane to a cone, Cylinders.

**UNIT VIII:** Definition of a conicoid, Change of axes (Translation of axes, projection, Rotation of Axes), Reduction to standard form.

**UNIT IX:** A conicoid's centre, Classification of central conicoids, Ellipsoid.

**UNIT X:** Hyperboloid of one sheet, Hyperboloid of two sheets.

**UNIT XI:** Intersection with a line or a plane. Standard equation, Tracing the paraboloids.

**UNIT XII:** Intersection with a line or a plane.

Reference Book:

1. A Textbook Of Analytical Geometry by Jain, P.K.
2. Exercises in analytical geometry by J. M. Dyer.

### **BSCGN34 --- Developmental Biology**

**UNIT I:** Beginning of a New Organism: Development in Eukaryotic unicellular animals; Structure and types of sperms, Process of Spermatogenesis and Spermiogenesis in sperm formation.

**UNIT II:** Oogenesis in Amphibians and Mammals, Types of eggs on basis of presence of yolk and details of Egg Envelopes, Process of fertilization involving events before and after fusion of egg with sperm and at the time of fusion of egg and sperm pro-nuclei, Initiation of development.

**UNIT III:** Cleavage and Gastrulation: Cleavage of Zygote and influence of yolk on cleavage.

**UNIT IV:** Planes, Patterns and Mechanisms of Zygote cleavage; Products of cleavage-Morula and Gastrula; Epiboly and Emboly Morphogenetic movements in gastrulation.

**UNIT V:** Process of Gastrulation in sea urchins, amphibians and amniotes (chick and mammals especially eutherians). Morphogenesis and Tissue Organisation: Types of Morphogenetic processes and Modes of Cell movement in the formation of the Germ layers.

**UNIT VI:** Morphogenesis of Ectodermal derivatives namely neurulation in Amphibians and Chick, Mechanisms of neural plate formation, Morphogenesis of Mesodermal derivatives, Development of heart in amphibians and chick, development of blood cells.

**UNIT VII:** Origin and Morphogenesis of Endodermal derivatives, Origin and Migration of Primordial germ cells in Frog, Chick and Mammals.

**UNIT VIII:** Mechanisms of Cell Interactions: Totipotency and pluripotency, Mechanisms of Cell interaction, Analysis of genomic equivalence of Nuclei, Analysis of developmental potency of nuclei by method of nuclear transplantation in eggs.

**UNIT IX:** Cell determination, interactions and ooplasmic determinants, ooplasmic determinants and somatic determination in Tunicates.

**UNIT X:** Embryonic induction and cell determination in neural ectoderm by induction from dorsal mesoderm (primary embryonic induction), Induction of mesoderm in amphibians.

**UNIT XI:** Secondary induction, instructive interaction between ectoderm and mesenchymal cell, Permissive interaction in Pancreas development.

**UNIT XII:** Organogenesis of Eye and Limb: Structure of adult vertebrate eye, Eye field, Development of vertebrate eye and differentiation of retina.

**UNIT XIII:** lens and cornea, Tissue interactions in development of eye.

**UNIT XIV:** Vertebrate limb and its basic structural pattern, limb field.

**UNIT XV:** Determination of limb polarities and pattern of limb development.

**UNIT XVI:** Metamorphosis: Types of Development and Metamorphic Changes, Larval Forms in Various Animal Groups.

**UNIT XVII:** Metamorphosis in Amphibians; the process of metamorphosis in anurans and urodeles.

**UNIT XVIII:** Hormones and their interactions in Metamorphosis of Amphibia, Neoteny; Development, Growth and Metamorphosis in Insects, Factors Controlling Metamorphosis in insects.

**UNIT XIX:** Comparison between Metamorphosis in Amphibians and Insects. Regeneration: Types of Regeneration.

**UNIT XX:** Patterns of Reparative Regeneration: Limb Regeneration in Amphibians, The Origin of Regeneration cells of Blastema.

**UNIT XXI:** Role of Wound Epidermis, Apical Epidermal cap, Role of Nerves and Hormones in regeneration, Role of Distal Transformation of Blastema.

**UNIT XXII:** Lens Regeneration in Amphibians, Regeneration in Hydra; and in Planarians, Comparison between Regeneration and Embryonic Development.

**UNIT XXIII:** A survey of Regenerative Capacity in the Animal Kingdom, Heteromorphosis. Growth, Aging, Cancer: definition of Growth, Allometric and Isometric Growth, Measurement of Growth, Factors Governing Growth, Aging and its Consequences, Theories of Cellular Aging.

**UNIT XXIV:** Cancer as a result of Developmental Error, Characteristics of Malignant Cells, Causes, Stages and, Mechanism of Carcinogenesis, Multicausal Nature of Cancer.

#### **Reference Books:**

1. Essential developmental biology by Jonathan Michael Wyndham Slack.
2. Developmental biology by Scott F. Gilbert.

#### **BSCGN35 --- Mathematical Methods**

**UNIT I:** Sets, Equality of Sets, Operations on Sets, Venn diagrams, Functions, Types of Functions, Composite Functions, Operations with Functions.

**UNIT II:** Graphs (Exponential and Logarithmic Functions, Trigonometric functions), Trigonometric ratios.

**UNIT III:** Polynomials and Equations, Sequences and Series, Permutations and Combinations, Binomial Theorem. Two Dimensional Coordinate System -Distance between Two points.

**UNIT IV:** Area of a Triangle, Equation of a Line, Angle between Two Lines, Distance of a Point from a Line, Circle, Three Dimensional Coordinate System- Equation of a Straight Line in 3-D.



**UNIT V:** The Plane, The Sphere. Vectors as directed line segments, Algebra of Vectors and their applications (addition and subtraction of vectors, resolution of vectors, dot and cross product).

**UNIT VI:** Limit and Continuity, Derivative of a Function at a Point, Its Geometrical Significance, Rules for differentiation, differentiation of Trigonometric, Exponential and Logarithmic Functions.

**UNIT VII:** Differentiation of Inverse Algebraic and Inverse Trigonometric Functions, Chain Rule, Differentiation of Implicit Functions and Logarithmic Differentiation, Physical Aspects of Derivatives.

**UNIT VIII:** Tangents and Normals, Higher Order Derivatives.

**UNIT IX:** Maxima and Minima, Asymptote.

**UNIT X:** Curve-Tracing, Functions of Two Variables.

**UNIT XI:** Partial Derivatives of Order Two.

**UNIT XII:** Homogeneous Functions, Euler's Theorem.

**UNIT XIII:** Antiderivatives, Integration as Inverse of Differentiation.

**UNIT XIV:** Definite Integral as the Limit of the Sum.

**UNIT XV:** Properties of Definite Integrals, Fundamental Theorem of Integral Calculus Standard Integrals, Methods of Integration, Integration by Substitution, Integration by parts, Integration of Trigonometric Functions.

**UNIT XVI:** Preliminaries, Formation of Differential Equations, Methods of Solving Differential Equations of First Order and First degree (Variables Separable, Homogeneous Equation, Exact Equations and Linear Equations).

**UNIT XVII:** Some Basic Definitions in Statistics, Frequency Distribution, Discrete Random Variables, Continuous Random Variables.

**UNIT XVIII:** Measures of Central Tendency and Dispersion (Mean, Mode, Median, Standard Deviation, Mean Deviation).

**UNIT XIX:** Preliminaries: (Sample Space, Discrete Sample Space, Continuous Sample Space), Rules of Probability.

**UNIT XX:** Conditional Probability, Baye's Theorem.

**UNIT XXI:** Combination of events.

**UNIT XXII:** Binomial Distribution, Poisson Distribution (Emphasis Through Illustrations).

**UNIT XXIII:** Continuous Random Variables.

**UNIT XXIV:** Types of Continuous Distributions (Exponential and Normal Distribution – Emphasis Through Illustrations)

**UNIT XXV:** Sample Selection, Random Sampling Procedure, Measure of Variation and Accuracy.

**UNIT XXVI:** Standard Error, Unbiased Estimator, Accuracy and Precision of Sample Estimator, Types of Sample Design (Random Sampling, Cluster Sampling).

**UNIT XXVII:** Statistical Hypothesis, Level of Significance, Degrees of Freedom, Chi-square Test, t-test.

**UNIT XXVIII:** Analysis of Variance Correlation and scatter diagram, Correlation coefficient, Linear regression, Curve Fitting (Least Square Method).

#### **Reference Books:**

1. Mathematical Methods by Gs Rao.
2. Mathematical Methods by Dr. S. Sivaiah.

## **BSCGN36 --- Modern Physics**

**UNIT I:** Special Theory of Relativity, Discovery of Constancy of Speed of Light.

**UNIT II:** Postulates of Special Theory of Relativity, Lorentz Transformation.

**UNIT III:** Length Contraction, Time Dilation, Examples, Lorentz Invariance.

**UNIT IV:** Velocity Addition Theorem, Doppler Effect.

**UNIT V:** Variation of Mass with Velocity, Energy-Mass Equivalence, Relativistic Energy and Momentum and their Transforms.

**UNIT VI:** Newton's Laws of Motion in Relativistically Covariant Form.

**UNIT VII:** Quantum Mechanics: Birth of Quantum Physics.

**UNIT VIII:** De-Broglie Hypothesis, Wave-Particle Duality, Wave Packet, Group Velocity, the Uncertainty Principle and its Consequences.

**UNIT IX:** Thought Experiments, Complementarity.

**UNIT X:** Postulates of Quantum Mechanics, Time Dependent and Time Independent Schrodinger Equation in One Dimension.

**UNIT XI:** Statistical Interpretation of Wave Function.

**UNIT XII:** Probability Current Density and Continuity Equation.

**UNIT XIII:** Normalization of Wave Functions, Wave Function in Momentum Space.

**UNIT XIV:** Observables and Operators, Linear Momentum, Orbital Angular Momentum, Commutation Relations.

**UNIT XV:** Expectation Values, Ehrenfest's Theorem.

**UNIT XVI:** Applications of Quantum Mechanics: One Dimensional Rectangular Potential Barrier, Tunneling.

**UNIT XVII:** Parity Operator and its Eigenvalues; One Dimensional Potential Well, Particle in a Box, Free Particle, Simple Harmonic Oscillator (Energy Eigenvalues only).

**UNIT XVIII:** Spherically Symmetric Systems: Hydrogen Atom, Separation of Schrodinger Equation in Spherical Polar Coordinates.

**UNIT XIX:** Eigenvalues of  $L^2$ , Spherical Harmonics (mention only), the Solution of Radial Equations (Qualitative), Energy Levels.

**UNIT XX:** Stationary State Wave Function, Discussion of Bound and Continuum States.

**UNIT XXI:** Quantum Numbers and Constants of Motion.

**UNIT XXII:** Spin Angular Momentum: the Magnetic Moment of Electron, Stern-Gerlach Experiment.

**UNIT XXIII:** The Total Angular Momentum Vector, Space Quantization.

**UNIT XXIV:** Optical Spectra of Hydrogenic Atoms, Spectral Notation.

**UNIT XXV:** Pauli's Exclusion Principle and Electronic Configurations, Selection Rules, Allowed and Forbidden Transitions, Half Life of Excited States, Finite Width of Spectral Lines.

**UNIT XXVI:** X-ray Spectra, Characteristic X-ray Spectra, Moseley's Law, X-ray Terms and Selection Rules, Applications of X-rays.

**UNIT XXVII:** Nuclear Physics.

**UNIT XXVIII:** Radioactive Decay Law, Radioactive Equilibria, Naturally Radioactive Series, Nature of  $\alpha$ ,  $\beta$  and  $\gamma$  Spectra and Qualitative Explanation Thereof; General Properties of Nuclei: Mass, Spin, Neutron Number, Magnetic Moment, Size etc.

**Reference Book:**

1. Modern Physics by Kenneth Krane.
2. Modern Physics by Paul A. Tipler.

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